PAIN COMMUNICATION IN COUPLES WITH CHRONIC PAIN

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By
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Michelle Marie Gagnon, candidate for the degree of Doctor of Philosophy in Clinical Psychology, has presented a thesis titled, *Pain Communication in Couples with Chronic Pain*, in an oral examination held on October 31, 2016. The following committee members have found the thesis acceptable in form and content, and that the candidate demonstrated satisfactory knowledge of the subject material.

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*Via Skype*
Abstract

Having a partner with chronic pain (CP) can lead to relationship strain. In couples, poor verbal or non-verbal communication about pain is associated with increased disability (Cano, Johansen, & Geisser, 2004), mental health issues (Kiecolt-Glaser & Newton, 2001), and negative emotions in partners (Miaskowski, Zimmer, Barret, Dibble, & Wallhagen, 1997). There is limited research directly examining pain communication in couples as pain is occurring. Existing CP research in couples has mostly been based on retrospection and self-report, and such research has tended to not include both partners.

This investigation was designed to extend our understanding of pain communication in couples. Specifically, the goals for this study were to determine: (1) if couples with a partner with CP and couples without a partner with CP differ in terms of how well they agree on the pain intensity experienced by a partner; (2) if partners with CP encode pain differently than individuals without CP; (3) if partners of individuals with CP decode expressions of pain differently than partners of individuals without CP; (4) if non-verbal and self-reported pain responses are influenced by relationship variables and pain cognition in couples with and without a partner with CP; and (5) if the communication of pain in couples where one partner is experiencing pain is consistent with the processes described in the biopsychosocial models of pain communication.

Couples where one partner reported current CP (n = 66) and couples without CP (n = 65) completed questionnaires measuring facets of their relationship and experiences with pain. Next, one partner underwent a pain task while the other partner observed. In couples with a CP partner, the person with CP completed the task. In couples without a CP partner, the pain task was sometimes completed by the male partner and sometimes
by the female partner based on the gender of the last person with CP to complete the task (i.e., in order to ensure matching with the CP group). Ratings of pain intensity (partner completing the task) and perceived pain intensity (observing partner) were recorded at multiple intervals and facial expressions were video-recorded throughout the pain task.

Agreement between partners on pain intensity ratings did not differ in couples with and without CP. Pain was encoded and decoded similarly by individuals with and without CP. Women completing the task provided higher pain intensity ratings and had more pain-related facial activity than men. Despite higher pain intensity ratings in women during the task, pain intensity ratings in observers who were men and observers who were women did not differ. Relationship variables and pain cognitions interacted with the presence of CP to affect pain-related facial expression, but not pain intensity ratings, during the task. Individuals with CP showed a stronger positive relationship between catastrophizing and pain-related facial activity compared to individuals without CP. In observing partners, lower scores on relationship variables (i.e., satisfaction and perceived support) were associated with reduced facial activity for partners of individuals with CP and increased facial activity partners of individuals without CP.

The results highlight the importance of considering social and contextual influences in pain responses. When examined alone, pain responses do not differ in couples with and without a partner with CP. When considering the moderating influence of relationship and pain cognition variables, differences in pain-related facial expressions based on the presence of CP emerge. Additionally, the results indicate that pain-related facial expressions are more strongly affected by social and contextual variables than self-report, consistent with pre-existing psychosocial formulations of pain communication.
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Dedication

To my parents and to Marc, thank you for never seeming to doubt that I could do this. The big and small ways you have shown your support are what got me here today.

To Steven, for knowing when I needed to work, when I needed a break, and sticking with me through it all.
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<td>No Chronic Pain</td>
<td>NCP</td>
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<td>Pain Target</td>
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<td>Pain Observer</td>
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Introduction and Literature Review

Overview

In couples, chronic pain (CP) in one partner can result in relationship distress for both members of the dyad (Cano, Weisberg, & Gallagher, 2000; Leonard, Cano, & Johansen, 2006; Porter, Keefe, Wellington, & Williams, 2008). Couples experiencing relationship distress report more health problems (Amato, 2000; Holt-Lunstad, Birmingham, & Jones, 2008; Prigerson, Maciejewski, & Rosenheck, 2000), increased stress, higher rates of psychopathology (Amato, 2000; Fincham, Beach, Harold, & Osborne, 1997; Holt-Lunstad et al., 2008; Rehman, Gollan, & Mortimer, 2008; Whisman & Bruce, 1999; Whisman, 2007), increased health service utilization (Halford, Markman, & Stanley, 2008; Prigerson et al., 2000), and are more likely to require social assistance (Halford et al., 2008) than couples in satisfied relationships. According to Statistics Canada (2010), 9% of men and 12% of women aged 12 to 44 experience CP and prevalence increases with age. Individuals with CP who are experiencing relationship distress report greater pain severity, physical disability, activity limitations, and more psychological concerns (Burman & Margolin, 1992; Cano, Gillis, Heinz, Geisserd, & Forane, 2004; Christensen et al., 2015; Flor, Kerns, & Turk, 1987; Kiecolt-Glaser & Newton, 2001; Williamson, Robinson, & Melamed, 1997). Partners of individuals with CP are more likely to contend with stress, caregiver strain, depression, and other psychological concerns (Leonard & Cano, 2006; Merz et al., 2011; Miaskowski et al., 1997; Schwartz, Slater, Brichler, & Atkinson, 1991).

Biopsychosocial models of pain emphasize that pain is experienced in a social context (Fordyce, 1976; T. Hadjistavropoulos et al., 2011; Turk & Monarch, 2002).
Following this model, a couple’s interactions and characteristics will influence the pain of the individual with CP, and the individual’s pain will influence the couple’s interactions. Communication quality and communication skills within a dyad have been identified as fundamental components to relationship functioning (Markman, Roades, Stanley, Ragan, & Whitton, 2010). Despite pain being a universal form of distress, the communication of pain is complicated by the subjective nature of the experience. Pain, and reactions to pain in a partner, can be communicated verbally and non-verbally. Such communication can occur in an adaptive or maladaptive fashion and has an important influence on dyadic adjustment. Poor communication of incidents of pain can lead to increased pain, psychological distress in individuals with CP, and negative affect in partners. Incongruence in perception of pain between and individual with CP and his or her partner – an indicator of poor communication – can lead to mood problems in both partners (Cano, Johansen et al., 2004). The quality of communication may also be influenced by the gender of the individual with CP. For instance, Cano, Johansen et al. (2004) identified that when the partner with CP is a woman, there is greater incongruence between partners regarding the degree of pain experienced by the partner with CP.

Although research has been conducted in the area of pain in couples, there are a number of methodological improvements that could be made to the way in which pain is assessed in these studies. The existing research has largely been based on self-report measures and conducted in couples in which a CP condition is present, but with pain behaviours not specifically observed during the study. Such methods can present challenges, as couples may inaccurately recall interactions. In cases where pain
behaviours are observed, observations are typically conducted by the researcher in the absence of the partner. Given that both members of the dyad might react differently in each other’s presence than alone or with a stranger, these procedures are also not ideal. In addition, although previous researchers have suggested that the gender of the partner with CP may impact pain communication, the majority of the research examines global trends without differentiating between genders. Conclusions are made about couples with a CP partner without consideration for whether the experience varies depending on the respective gender of each partner. These issues outline the need for direct observation of couples’ pain communication during painful tasks, with both members of the dyad present during the task and with consideration given to potential gender differences.

The aim of this investigation was to address five research questions: (1) do couples with a partner with CP and couples without a partner with CP differ in terms of how well they agree on the intensity of pain experienced by a partner during a painful situation?; (2) is pain encoded (i.e., experienced and expressed) differently by individuals with CP than in individuals without CP?; (3) is pain decoded (i.e., perceived and responded to) differently by partners of individuals with CP compared to partners of individuals without CP?; (4) are non-verbal and self-reported pain responses influenced by relationship variables and pain cognition in couples with and without a partner with CP?; and (5) is the communication of pain in couples where one partner is experiencing pain consistent with the processes proposed by the communications model of pain (T. Hadjistavropoulos et al., 2011)?

To answer these questions, a matched-group quasi-experimental design was used. Two groups of co-habiting couples were recruited. The first group, the chronic pain or
CP group, consisted of individuals with CP and their partner recruited from the community. The second group, the non-chronic pain or NCP group, consisted of couples from the community in which neither partner reported CP. Each partner was asked to complete measures evaluating facets of their relationship and pain cognitions. Subsequently, the couple completed a well-established and safe experimental pain induction procedure. In the CP group, the partner with CP was identified as the pain-target (PT) and underwent the pain induction task while the partner without CP, the pain-observer (PO), observed. To ensure that an equivalent number of men and women were completing the task as the PT in each group, in NCP couples, PT assignment was determined based on the gender of the PT in the previous CP couple. The PO sat facing the PT, so as to observe the PT’s reactions during the task. Each partner rated pain throughout the procedure; the PT rated his or her level of pain, and the PO rated the level of pain he or she believed the PT was experiencing. Each partner’s facial expressions were video-recorded throughout the pain induction task. The recorded facial expressions were analysed using facial coding (Ekman, Friesen, & Hager, 2002a; Lucey et al., 2010), an objective measure of non-verbal communication that detects the frequency and intensity of pain-related facial expressions.

This study provides an important contribution to the research on pain communication in the context of couples. Results highlight the communicative processes that are occurring in couples when one person is experiencing pain. Moreover, the findings allow for consideration of differences in pain communication between couples with and without a partner with CP.
Pain

Pain is a complex, multidimensional phenomenon. The International Association for the Study of Pain (IASP) defines pain as an “unpleasant sensory and emotional experience associated with actual or potential tissue damage, or described in terms of such damage” (International Association for the Study of Pain, 2011). IASP supplements this definition by highlighting the subjective and individual nature of each person’s pain. As a result, pain can be understood as containing an affective, sensory, subjective, and intrapersonal experience.

Given its subjective and emotional nature, pain cannot be inferred through examination of tissue damage. This creates challenges for those around individuals who are in pain, such as romantic partners. An observer cannot necessarily determine the intensity of another person’s pain through direct observation. Having a similar injury to a person in pain does not necessarily lead to an understanding of the person’s pain experience (T. Hadjistavropoulos et al., 2011). Despite not having a comprehensive understanding of another’s pain experience, witnessing another person’s pain leads to specific behaviours and reactions in an observer which, in turn, influence the pain experience of the person in pain (N. Gauthier, Thibault, & Sullivan, 2011; Newton-John & Williams, 2006). These elements point to a social quality of the pain experience.

Current conceptualizations of pain incorporate social factors into the pain experience; however, it is only with the advent of biopsychosocial models that the social aspect of pain has become a focus in pain research. Given the significant contribution of social factors to the pain experience, a cursory overview of the evolution of major pain theories allows for an understanding of how researchers have come to recognize the
Theories of pain and evolution of the social nature of the pain experience. In the 17th century, René Descartes (1596-1650) proposed a theory often considered to be one of the first true theories of pain. His theory was based on the concept of an explicit, unidirectional relationship—described as pain pathways—between the pain stimulus and the sensation of pain (Descartes, 1644/1985). Descartes described the human body to be like a machine. Within this machine, there was a simple pulley and bell system that allowed for the pain experience. Descartes perceived the nerves to be hollow tubes through which spirits flowed in a mechanical manner. These nerves were connected to the brain (Linton, 2005).

Despite being innovative for its time, Descartes’ theory came with limitations. Most noticeably, by suggesting that damage to tissue has a direct relationship to the perception of pain, Descartes excluded the possibility of factors, such as psychological and individual factors, influencing the experience. Given the subjective nature of pain, two patients with the same physical problem may have two very different pain experiences. If one equates tissue damage to pain, those observing a person in pain who have experienced similar tissue damage may perceive that they understand how the individual with pain is experiencing his or her pain. However, the subjective nature of pain suggests that each individual can experience his or her pain differently.

Many health care providers have moved away from the notion that pain is solely linked to tissue damage towards a multidimensional understanding that accounts for the subjectivity of the experience. Nevertheless, the conceptualization of pain as having a direct correspondence to the extent of tissue damage still exists today (Sloan, Gupta,
Such a conceptualization – when held by individuals with CP, their partners or other family members, and their health care providers – may result in the dismissal of significant factors influencing pain and fail to account for the role of social factors in the pain experience.

Although Descartes’ theory has a number of limitations, his contributions served as a springboard for later theories. In the late 19th and early 20th centuries, the specificity theory and the pattern theory became two dominant theories of pain. Supporters of the specificity theory believed pain to be a specific sensation (and not a sensation within touch). Proponents of this theory proposed, and later identified, a pain system within the body. The discovery of the pain system served as strong supporting evidence for the theory. This pain system was found to be exclusively for painful sensations and distinct from previously identified pathways for touch (Clarke & O'Malley, 1996; Dallenbach, 1939; Finger, 1994; Perl, 2007). In direct opposition to the specificity theory of pain was the pattern theory. Proponents of pattern theory posited that pain was generated whenever any sensory stimulus was provided in intense form (Dallenbach, 1939; Perl, 2007). Every sensory stimulus was believed to be capable of producing pain if it reached sufficient intensity (Perl, 2007).

Although specificity and pattern theories made important contributions to the understanding of the pain experience, neither was adequately comprehensive to explain most pain-related phenomena (Melzack & Wall, 1965; Melzack & Katz, 2004). Moreover, both theories explained pain in a biological manner. It was not until 1965 that theories became multifaceted with the introduction of the gate control theory of pain (Melzack & Wall, 1965).
Gate control theory and the neuromatrix model of pain. Countering the notion of one-to-one correspondence between pain and tissue damage, Melzack and Wall (1965) proposed the gate control theory of pain. This revolutionary theory recognized both the physiological basis of pain and additional factors that affect the pain experience.

The gate control theory postulates that when a potentially painful stimulus is felt on the body, three spinal cord systems are activated. These three systems are the cells of the substantia gelatinosa in the dorsal horn, the dorsal column fibres that project toward the brain, and the central transmission (T) cells in the dorsal horn. The substantia gelatinosa, a unit of cells that run the length of the spinal cord, works as a gating mechanism that is activated in the dorsal horn of the spine. This gating mechanism allows the transmission of nerve impulses from the peripheral nerve receptors to be transmitted through afferent fibres to the brain.

Two types of fibres, large-diameter myelinated fibres and small-diameter unmyelinated fibres, transmit the initial stimulus to the substantia gelatinosa and the first central transmission centre. Impulses transmitted through the large-diameter fibres (responsible for transmission of non-nociceptive sensations) inhibit the transmission of sensory input by stimulating inhibitory neurons. The stimulation of the inhibitory neurons prevents the projection neurons from sending a pain signal to the central transmission cells, which, in turn, sends a signal to the brain. Stimulating the inhibitory neurons causes the gating mechanism to close and the brain not to interpret the experience as painful. The small-diameter fibres allow projection neurons to send pain messages to the brain. Stimulation of these fibres causes the gate to open, which prompts the brain to interpret the sensation as painful (Asmundson & Wright, 2004; Melzack &
In addition, the gating mechanism is affected by nerve impulses descending from the brain. Melzack and Wall proposed that a central control trigger exists within the central nervous system that, through selective brain processes, can exert control over the gating mechanism. Cognitive and affective information descending from the brain influences the gating mechanism and, in turn, modulates the pain experience (Melzack & Wall, 1965). This innovative concept of descending transmissions influencing the pain experience transformed the previous understanding of pain. Pain is now understood as an experience that can be influenced by what is felt and how the experience is lived.

The gate control theory had a tremendous impact in the field of pain. In terms of pain assessment and management, recognizing the influence of psychological variables in the pain experience has led to important innovations. The theory has been supported through both physiological (Basbaum & Fields, 1984; Humphries, Johnson, & Long, 1996; Julien & Marchand, 2006; Shrivastav & Musley, 2009) and psychological research (T. Hadjistavropoulos et al., 2011; Hale & Hadjistavropoulos, 1997). Pain management no longer needs to be restricted to the treatment of a physical ailment. Cognitive and psychological pain management strategies have demonstrated benefits (Vranceanu & Safren, 2011; Wetherell et al., 2011). Pain can now be understood as influenced by a multitude of factors, including the personal experience of the individual in pain. This theory also places the psychological component as being elemental to the conceptualization of pain. Moreover, recognition about the subjectivity of the pain experience underscores the challenges of effectively communicating the individual pain experience to those in one’s social environment.
The gate control theory propelled the area of pain into a whole new era. It did not, however, account for all aspects of the pain experience. In particular, pain in persons with paraplegias and phantom limb pain, often experienced by persons with amputated limbs, could not be explained. To address this, Melzack (1989) proposed the concept of a neuromatrix, focusing on the role of the brain, to help account for pain in these instances.

The neuromatrix model of pain supplements the gate control theory and postulates that there is an anatomical substrate of the body – the neuromatrix – located in the brain. This neuromatrix is a network of neurons that forms a pattern of loops between the thalamus and the cortex and between the cortex and the limbic system (Melzack & Katz, 2004). According to this model, there is a continuous processing of various inputs of information that produces and interacts with output processes through the neuromatrix. This interaction generates output patterns from the neuromatrix that are sensory, affective, cognitive, and biological.

The continuous stream of information that is being processed is multidimensional and makes a characteristic pattern, the neurosignature. The neurosignature contains information for the whole body and explains why individuals experience phantom limb pain or why a person with paraplegia feels bodily pain. The neurosignature was created prior to amputation or paralysis and contains information from all the parts of the body.

According to Melzack, each person has his or her own “body-self neuromatrix” (Melzack, 1999). Given the individuality of this system, each person’s experience will be unique. This model and the concept of the body-self neuromatrix remain consistent with the subjective nature of the pain experience.

Together, the gate control theory and the neuromatrix model have revolutionized
how pain is understood. Pain is now conceptualized as a multidimensional, subjective experience influenced by physical, affective, and cognitive factors. This understanding has led to important clinical implications as it necessarily changes the way that pain is assessed and treated. Despite these advances, the social and environmental components are not entirely accounted for by these theories. It was not until biopsychosocial models expanded on the gate control theory that these components became fully appreciated as integral to the pain experience.

**Biopsychosocial models of pain.** Biopsychosocial models of pain emphasize the many factors that interact to influence pain, namely, biological, psychological, cultural, and social factors (T. Hadjistavropoulos et al., 2011; Turk & Monarch, 2002). The recognition of the multiple facets involved in pain had important treatment implications. Most significantly, this comprehensive perspective allowed for recognition of the impact of people in the environment of an individual with CP (e.g., T. Hadjistavropoulos et al., 2011)

In the biopsychosocial approach, there is recognition of a constant reciprocity among biological, psychological, and social factors. The reciprocity among these factors shapes the person’s pain experience and responses. A biological factor, such as tissue damage, may initiate, maintain, and alter physical problems. At the same time, psychological variables influence the individual’s appraisal and perception of his or her own physical experience. Social factors then motivate the individual’s behavioural responses to his or her psychological perception of the physical problem (Turk & Monarch, 2002). The people in the social environment of an individual with CP can take action and provide care in such a way that directly affects the pain experience of the
individual with CP. Throughout the course of disease or impairment, the influence of physical, psychological, and social factors can shift. Variability will exist in the degree to which each of these factors influence a person over time and how each of these factors will influence different people with the same physical problem (Crook, Weir, & Tunks, 1989; Turk & Monarch, 2002). Several biopsychosocial models of pain have been proposed, including the operant model (Fordyce, 1976; Fordyce, Shelton, & Dundore, 1982), the Glasgow model (Waddell, 1987; Waddell, 1991; Waddell, 1992; Waddell, Newton, Henderson, Sommerville, & Main, 1993), the biobehavioral model (Turk, Meichenbaum, & Genest, 1983), fear avoidance models (Lethem, Slade, Troup, & Bentley, 1998; Vlaeyen & Linton, 2000; Vlaeyen & Linton, 2012), and the communications model of pain (Craig, 2009; T. Hadjistavropoulos, Craig, & Fuchslacelle, 2004; T. Hadjistavropoulos et al., 2011).

Researchers have garnered support for the biopsychosocial models. For example, in an examination of psychosocial factors in back pain, Overmeer and colleagues (2006) surveyed health care providers concerning factors that most influence their patients. The most commonly identified factors were social/environmental factors (including family, social support, and environment) and psychological factors (including emotions, cognitions, and self-esteem), which demonstrate the large perceived influence of psychosocial variables as compared to physical variables (Overmeer et al., 2006).

Fordyce was among one of the first investigators to discuss the manner in which environmental factors influence behaviour (Fordyce, 1976). He posited that verbal and non-verbal behaviours engendered positive or negative consequences. These consequences influence subsequent actions as a result of the learning or conditioning that
occurs due to these consequences (Fordyce, 1976). Fordyce also describes the process through which verbal and non-verbal behaviours become discrepant. As an individual with pain learns which behaviours lead to which outcomes, over time he or she can learn to say one thing but act in a different way. For instance, the patient may state that he or she cannot stand for more than 5 minutes, but when observed can be seen doing household tasks (e.g., doing the dishes) that involve standing for extended periods of time.

The biopsychosocial model led to an increasing recognition of relevant environmental factors which, in turn, led to consideration of influential others in one’s environment. Spouses were identified as playing a prominent role in an individual’s life. The proximity of partners and the frequency of their interactions make this dyad an ideal candidate for consideration within operant models. Fordyce’s contributions paved the way for the development of models of operant behaviour within the context of partners or couples. For example, within the operant model it was understood that frequent positive or negative reinforcement of pain behaviours by the partner of the person in pain may have caused such behaviour to become excessive and maladaptive (e.g., Romano et al., 1995; Romano, Jensen, Turner, Good, & Hops, 2000).

A number of researchers have developed models of pain that apply specifically to couples. These models and theories of pain within the dyad will be discussed below. Among these biopsychosocial approaches to understanding pain, one approach, the communications model of pain, forms the framework for this research. The communications model of pain focuses on the way in which social communication within the dyad can influence the pain experience for both the person in pain and the
observer (Craig, 2009; T. Hadjistavropoulos et al., 2004; T. Hadjistavropoulos et al., 2011). Given the central role of communication in the communications model of pain, a review of the function of communication, particularly within the context of pain, is warranted.

**The Communication of Pain**

For the purposes of this study, the definition of communication outlined by Hadjistavropoulos and colleagues (2011) will be employed. Within a model of pain, they define communication as “occur[ring] in dyads, or larger groups, when the actions of sending parties are predicated upon the audience and have an impact upon receiving parties. Typically, communicative acts (e.g., use of speech), intended and consciously received, are accompanied by unintended actions.” Unintended actions, as understood by this group of researchers, include prosody of speech, facial expressions, and body language. They also highlight that these unintended actions almost always accompany speech and influence an observer’s understanding of the communicator's subjective state (T. Hadjistavropoulos et al., 2011).

From an evolutionary perspective, pain serves a protective factor; escaping or avoiding physically dangerous events will increase one’s likelihood of survival (T. Hadjistavropoulos et al., 2011). These evolutionary and protective purposes in and of themselves highlight the social nature of pain. Pain is not simply a personal experience, and it is rarely experienced in an exclusively private manner. The way in which people present their pain – either through reflexive behaviours or reflective actions – communicates their distress and can serve to signal the presence of a potential threat to those around them (T. Hadjistavropoulos et al., 2011; Yamada & Decety, 2009). The
reflexive actions require few cognitive capabilities; however, the reflective actions, including the language used, the thoughts around the pain, and the purposeful behaviours in response to pain, require intentional cognitive processing (Craig, 2009; T. Hadjistavropoulos & Craig, 2002). To a certain extent, reflexive action can be overridden. For instance, facial expressions can be intentionally suppressed or magnified (Craig, Hyde, & Patrick, 1991; Prkachin, 1992; Rinn, 1984). Engaging in a process that actively overrides this type of reflexive action requires a higher level of cognitive processing than the reflexive responses. This is what transforms human pain expressions into a unique form of social process (T. Hadjistavropoulos et al., 2011).

A vital way that humans interact during social processes is through expressive and receptive communicative features (T. Hadjistavropoulos et al., 2011). Pain can be understood as an experience that is communicated within the social environment of an individual in pain. As will be discussed further, observer characteristics, such as anxiety, and observer perceptions of pain can influence how pain cues are interpreted (Craig, Versloot, Goubert, Vervoort, & Crombez, 2010; Schofield, Coles, & Gibb, 2007). Inclusion of the dyadic context and of the characteristics and responses of an observer in the dyad is a significant advancement in the current understanding of pain. Consequently, pain communication can be seen as a dyadic process that includes both expressive and receptive features, and where pain outcomes are not only influenced by the individual experiencing the pain (i.e., the encoder), but also by the pain observer (i.e., decoder) watching the individual experience pain.

Despite these advancements, pain has not always been examined as a social phenomenon. Yet, the indisputably social nature of pain provides a strong basis for
researching pain as a social construct. Within the context of a social construct, the influence of both partners of a dyad, and the communication of pain within that dyad become necessary and essential avenues of investigation to allow for an understanding of pain as it is experienced in a couple.

**Facial expression in the communication of pain.** Facial expression is a powerful form of social communication (Ekman & Rosenberg, 2005). Special attention has been paid to the use of facial expressions in understanding the pain experience. Faces tend to change rapidly, especially when pain is felt, and can represent a range of emotional states. Researchers have extensively examined facial expressions associated with pain, and specific facial reactions have been identified as expressions of pain.

To date, the majority of facial action research has been conducted using the Facial Action Coding System (FACS; Ekman & Friesen, 1978; Ekman, Friesen, & Hager, 2002b). The FACS provides an objective, anatomically-based system. It is designed from an atheoretical perspective and provides thorough descriptions of the facial movements that create facial expression (Craig, Prkachin, & Grunau, 2011; T. Hadjistavropoulos et al., 2004).

The FACS provides an examination of facial action units (AUs). There are 41 AUs, each corresponding to a muscle group movement. Investigations of AUs have been used to examine the facial movements associated with pain. Although there has been some variability across research findings, investigators agree on the core actions that tend to be present in painful situations (Craig et al., 2011). These include: brow lowering (AU4), orbit tightening (comprised of AU6, cheek raiser and lid compressor, and AU7, lid tightener), nose wrinkling (AU9), upper-lip raising (AU10), and eye narrowing or
closure (AU43; Craig et al., 2011; Prkachin, Hughes, Schultz, Joy, & Hunt, 2002). In addition to these core AUs, lip stretching (AU20), lip corner pull (AU12), parted lips (AU25), jaw dropping (AU26) and blinking (AU45) have been identified as other commonly observed facial expressions of individuals in pain (Prkachin, 1992).

FACS coding during pain has been extensively incorporated into research by pain researchers. Despite its use, the FACS is a time-intensive approach to facial coding. Given the consistency with which pain-related AUs have been identified, coding systems that focused uniquely on pain-related AUs have been employed (Prkachin, 1992; Prkachin & Solomon, 2008). This approach facilitates coding of pain expression for researchers examining the communication of pain through facial actions (Prkachin, 1992; Prkachin & Solomon, 2008).

Although there is relative consistency in the AUs associated with pain, the constellation of AUs present during pain can vary based on a number of factors. For instance, differences in AU presentation have been found as a function of pain severity (Lints-Martindale, Hadjistavropoulos, Barber, & Gibson, 2007). Facial reactions increase in frequency and intensity as a function of noxious stimulus intensity (Lints-Martindale et al., 2007). Lower levels of pain typically include the upper facial AUs, while higher levels of pain are more likely to incorporate actions in the lower face. Facial coding is helpful in identifying these differences.

It is also possible to exaggerate or suppress facial actions, even if this form of non-verbal communication is typically understood as a reflexive response to pain. Researchers have identified differences in facial expressions when the pain expression is genuine versus when it is disingenuous (Craig et al., 1991; Prkachin, 1992). Findings
suggest that faked or exaggerated pain tends to be represented through a magnified
eexpression where facial actions (those typically associated with the pain expression as
well as other AUs not typically associated with pain) appear more frequently and with
greater intensity (Craig et al., 2011). The temporal pattern of the pain expressions has
also been found to be disrupted in faked or exaggerated expressions. During genuine
expressions, AUs are displayed in greater temporal contiguity. During faked expressions,
AUs are more likely to be in a less contiguous sequence (Craig et al., 1991; Hill & Craig,
2002). Similarly, subtle differences exist between masked and genuine facial
expressions. When individuals attempt to mask their pain, there is a greater frequency of
mouth opening and residual eyebrow movement (Hill & Craig, 2002).

The communicative function and social nature of facial expressions have been
examined in recent research. Specifically, Karmann and colleagues (2015) investigated
how pain expressions vary depending on whether an individual receiving a pain stimulus
is alone, with a stranger, or with an intimate partner. While the specific AUs expressed
during each situation did not vary, differences occurred in intensity of the facial
expression across conditions. Individuals receiving a pain stimulus expressed more
intense facial expressions when with an intimate partner than when with a stranger or
alone. Conversely, participants were more likely to suppress facial expressions when
with a stranger than when alone (Karmann et al., 2015). Thus, examination of facial
expression in couples may hold important information regarding the communicative
goals of a partner during a painful situation.

Facial expressions can provide valuable information that is not available through
self-reporting. It has been demonstrated in research that non-verbal pain expressions are
frequently inconsistent with self-report and that that self-report measures of pain and non-verbal reactions are often not significantly correlated (Craig et al., 2011; Labus, Keefe, & Jensen, 2003). Researchers have suggested that, while non-verbal expressions represent a reflexive and involuntary reaction to pain, self-report measures are often influenced by factors such as retrospection, anticipated consequences, and social desirability (Craig et al., 2011; Labus et al., 2003). Given this evidence, each type of response appears to serve a different function in an individual’s communication of his or her pain experience (T. Hadjistavropoulos et al., 1998). As many studies examining pain in couples have focused exclusively on self-report measures or retrospection, it is essential that researchers consider the process through which non-verbal reactions influence the dyadic experience. Additionally, contextual variables, such as relationship variables, may have a distinct impact of different types of pain response. Further consideration of influences that affect pain encoding and decoding in couples is needed.

**Impact of facial expressions on pain observers.** Researchers have demonstrated that witnessing the facial expressions of someone in pain initiates a response in the observer. Studies of brain activity have identified that seeing someone else’s pain reaction affects the observer’s brain activity (Betti & Aglioti, 2016; Botvinick et al., 2005; Budell, Kunz, Jackson, & Rainville, 2011; Saarela, Hlushchuk, Williams, Kalso, & Hari, 2007). Observing the painful facial reactions of another activates the same cortical areas in the observer’s brain that would be activated if they themselves were experiencing pain. This points to an empathic brain activity process that transpires when witnessing the pain expressions of others (Betti & Aglioti, 2016; Saarela et al., 2007).

Viewing exaggerated or suppressed facial expressions in an individual
experiencing pain further influences observer reception of the pain message. Investigators have identified that the assumptions made about another’s pain by an observer are more consistent with how the pain experiencer presents him or herself, rather than the pain experience (H. D. Hadjistavropoulos, Craig, Hadjistavropoulos, & Poole, 1996). Researchers have also identified that observers of pain reactions are able to differentiate between genuine reactions and disingenuous reactions (H. D. Hadjistavropoulos et al., 1996; Hill & Craig, 2004). Gender differences in ability to discriminate between genuine and deceptive facial pain expressions have also been reported. Women are found to be significantly more accurate than men at discriminating pain expressions (Hill & Craig, 2004). In heterosexual couples, this would suggest that women can more accurately discriminate genuine and disingenuous reactions to pain in a partner with CP who is a man than men would in a partner with CP who is a woman.

In addition, researchers conducting studies with health care professionals have consistently shown that observers tend to underestimate pain (Kappesser, Williams, & Prkachin, 2006). For instance, in a study of health care professionals assessing pain severity exclusively from facial expressions, it was found that pain severity was largely underestimated (Kappesser et al., 2006; Prkachin, Solomon, & Ross, 2007). Although this trend of underestimation has been repeatedly found in health care settings, it remains unclear whether it extends to other social relationships, such as spousal relationships.

Further clarification is needed to demonstrate how observers perceive the facial expressions of a person in pain and subsequently interpret and respond to that person’s experience. This would elucidate the way in which non-verbal communication of pain by a partner with CP may influence the ability of the observer to accurately interpret the
non-verbal signals, accurately assess the degree of pain experienced by the individual with CP, and appropriately respond to the non-verbal communication.

As well, a better understanding of how facial expressions in a partner with CP impact women observers compared to men observers could provide indications for treatment. In particular, it could allow for the development of treatments that promote helpful verbal and non-verbal communication between partners. For instance, if men are more likely to ignore pain expressions in women with CP, this might influence how pain is experienced by women with CP and their subsequent reactions to painful stimuli. Lack of appropriate regard for the pain experience of a partner may also negatively impact the relationship. By understanding if unhelpful patterns of communication are present and how they exhibit themselves, clinicians can better enable couples to communicate their experiences related to CP in one partner effectively. This may prevent later relationship distress and negative pain outcomes (e.g., increased pain and disability).

Facial action research is a compelling avenue for learning more about reactions to pain in a partner. Investigators have frequently examined facial coding while an individual completes a pain induction task. To date there is limited research exploring the corresponding facial expression of an individual while observing his or her partner in pain. Examining spousal facial reactions might provide valuable information regarding the non-verbal behaviour expressed by partners of individuals with CP. As discussed below, it is understood that the reactions of the observing partner directly impact the subsequent experiences of the partner with pain (e.g., Cano, Barterian, & Heller, 2008). Gaining a better understanding of the non-verbal responses presented by individuals observing pain in a partner will clarify the experience of individuals in a relationship.
with a partner with CP. It would also clarify whether observer responses influence how the partner with CP responds to pain. This study aimed to address this gap in the literature through the facial analysis of both partners in a couple while one partner experiences pain.

**Chronic Pain in Couples**

Social relationships, and particularly marital or other intimate relationships, have been linked to benefits in physical and mental health (Berkman, 1995). The positive benefits are mediated by the quality of the relationship and the interactions within the dyad. Researchers have demonstrated that, compared to couples who are in satisfying relationships, couples who are experiencing distress in their relationship are more likely to have health problems (Amato, 2000), increased stress (Amato, 2000), and higher rates of psychopathology (Amato, 2000; Fincham et al., 1997; Holt-Lunstad et al., 2008; Rehman et al., 2008; Whisman & Bruce, 1999; Whisman, 2007). Moreover, distressed couples use health services more frequently (Halford et al., 2008; Prigerson et al., 2000) and require more social assistance (Halford et al., 2008).

Researchers have demonstrated that marital distress frequently precedes the onset of psychiatric disorders (e.g., Whisman, Uebelacker, & Bruce, 2006). For instance, Whisman and colleagues (2006) found that dissatisfied partners were nearly four times more likely to have a diagnosis of a current alcohol use disorder than partners in satisfying relationships. Similarly, in a year-long examination of couples with and without marital distress, individuals experiencing marital distress were nearly three times more likely to develop a major depressive episode than individuals satisfied in their relationship (Whisman & Bruce, 1999). These findings suggest that preventing marital
distress, or adequately addressing distress, may be instrumental in averting the onset of mental health problems.

Health problems, especially CP, have been associated with relationship distress. Among men and women aged 12 to 44, Statistics Canada (2010) reports that 9% of men and 12% of women experience CP and that these rates increase with age. Pain itself is more likely to be associated with depressive symptoms; however, in individuals with CP, marital variables such as relationship dissatisfaction have been found to contribute to the presence of anxiety and depressive symptoms, over and above the influences of pain and disability alone (Cano et al., 2004). Further, when examining the contributing roles of social and physical dysfunction on well-being in individuals with CP, social relationships, particularly disruption in these relationships, are a major determinant of pain-related emotional distress (Sturgeon, Dixon, Darnall, & Mackey, 2015).

Individuals with CP in relationships where distress is noted report greater pain severity, physical disability (Burman & Margolin, 1992; Cano et al., 2004; Williamson et al., 1997), and limitations to their daily activities (Flor et al., 1987), as well as more psychological concerns such as depression and anxiety (Cano et al., 2004; Christensen et al., 2015; Kiecolt-Glaser & Newton, 2001; Rehman et al., 2008). Partners of an individual with CP are more likely to report increased levels of stress and caregiver burden (Merz et al., 2011; Miaskowski et al., 1997; Schwartz et al., 1991). These partners are also at risk for psychological concerns such as depression and anxiety (Leonard & Cano, 2006; Merz et al., 2011; Miaskowski et al., 1997; Schwartz et al., 1991). These findings emphasize that for couples with a partner experiencing CP, the relationship quality is integral to mental health and physical health outcomes. Improved
awareness of how relationship factors influence pain responses for couples with CP can assist in developing interventions to reduce relationship distress and prevent negative outcomes.

Studies have led to the conclusion that marital discord and partner responses to pain are positively related to pain intensity and physical disability. Moreover, marital variables contribute to distress, over and above the effects of pain severity and physical disability (Cano et al., 2004). Pain alone does not cause a distress response in individuals with CP. The dyadic relationship plays a vital role in negative emotional and affective states for both partners. This knowledge provides the impetus for an improved awareness of how the relationship influences the pain experience and factors that might positively or negatively affect pain outcomes.

**The impact of facing others in pain.** Facing others in distress can have a significant impact on an observer (Goubert, Vervoort, & Crombez, 2009). In couples, the partner of a person in pain is repeatedly faced with watching his or her partner experience pain. Noting the consequences that this can have on a partner could lead to a better understanding of how pain is communicated and addressed within the dyad.

As discussed, studies of the brain have shown that watching another person in pain activates part of the neural pain network of the observer, without the pain being experienced first-hand within the body of the observer (Betti & Aglioti, 2016; Botvinick et al., 2005). Despite these activations being stronger in observers of acute pain than CP (Saarela et al., 2007), it still suggests an important immediate neurobiological influence on a pain observer. The pain experience of the observer also extends past the biological response. Facing others in pain can have important emotional consequences.
Researchers have distinguished between two types of emotional responses – self-oriented (i.e., feelings of personal anxiety and discomfort) and other-oriented emotions (i.e., feelings of sympathy and compassion) – in response to witnessing pain in others (Goubert et al., 2009). Social psychologists who examine the construct of empathy suggest that there are two different motivational processes at play between these types of responses (Batson, 1991; Davis, 1994; Goubert et al., 2009). Self-oriented responses to pain serve to reduce personal distress, while other-oriented responses promote helping behaviours in the observer. The initial response to pain signals appears to be the automatic activation of a threat system in the observer, which will activate self-oriented emotions. It is thought that subsequent to this initial evaluation, adequate regulation of self-oriented emotions may occur, and other-oriented emotions may arise (Goubert et al., 2005; Goubert, Vervoort, Sullivan, Verhoeven, & Crombez, 2008). However, if the observer is too overwhelmed by the experience, the person might not be able to self-regulate his or her own emotional reaction to the other person’s pain, and self-oriented emotions will persist. Persistent self-oriented emotions may make it challenging for the observer to sympathize with the person in pain (Goubert et al., 2005; Goubert et al., 2008).

This understanding of the threat value of pain may have salient implications for couples with a CP partner. It is possible that, at the initial onset of pain in a partner, the partner without pain will be able to self-regulate and provide adequate other-oriented responses. However, the nature of CP is such that it persists over time, with no necessary indications of ever ceasing. This may change the threat evaluation in the partner without CP and cause subsequent pain signals and cues to be more overwhelming due to the
persistent threat of pain. Similarly, it has been proposed that observers underestimate observed pain as a way of coping with their own distress (Batson, 1991). By underestimating pain, observers may allow frustration and distress to be kept at bay, especially when attempts to help have not been successful (Goubert et al., 2005).

It is generally thought that recognizing pain in others can lead to altruistic behaviours. For instance, neonates require assistance from their parents when their cries signal distress. They solicit the parents to engage in a decoding process to identify the source of their child’s distress. This necessitates the parent to engage in prosocial behaviour (T. Hadjistavropoulos et al., 2011). However, this sympathetic reaction also has its limits. For instance, persistent crying can cause a rift in the child-parent bond and increase risk of physical abuse (Crouch, Skowronski, Milner, & Harris, 2008). Similarly, in vulnerable populations such as individuals with an intellectual disability or with dementia, there can be a tendency to ignore the pain needs of the person (T. Hadjistavropoulos et al., 2004; T. Hadjistavropoulos, Breau, & Craig, 2011). Although these findings are limited to the populations studied, it is likely that in CP situations the persistent and ongoing nature of the pain also changes the way pain is communicated. Consistent with this, Cano (2004) found evidence that partners of individuals with CP may become less solicitous to pain behaviours over time. Social relationships can also deteriorate for individuals with CP (T. Hadjistavropoulos et al., 2004). Much like a child whose cries will not stop, CP is incessantly present throughout numerous facets of the couple’s relationship.

Empathy may play a contributory role in pain-related interactions (Goubert et al., 2005; Hurter, Paloyelis, Williams, & Fotopoulou, 2014), both for the individual
observing and the individual experiencing pain. In couples, individuals experiencing pain tend to provide higher pain intensity ratings if they perceive their partner as feeling a high level of empathy for their pain (Hurter et al., 2014). Among dyads of strangers in which observers provided estimated pain ratings for individuals completing a pain task, higher levels of observer empathy were related to higher pain estimates. Similarly, an investigation of couples showed that partners of individuals with CP accurately infer the inner experience of their partner 22% of the time (Leonard, Issner, Cano, & Williams, 2013). Although there is debate as to whether accurately inferring pain can be deemed as a marker of high empathy (Leonard et al., 2013), the accurate identification of pain and perception of empathic response to pain appear to play a role in integral role in pain responses for both partners in a dyad.

Non-responsiveness or negative responses by an observer or caregiver to pain can be understood within a communication perspective as a failure in the communicative interaction. That is, there is a failure of the receiver to understand the cues and symbols offered by the sender (T. Hadjistavropoulos et al., 2011). In examining pain in the context of couples, the responses and reactions to pain by the other partner should be seen as a transaction. This transaction occurs within the dyad and is influenced by both partners. This necessitates a focus on the behaviours of each partner, including the sender of the pain information (i.e., the partner with CP) and the receiver of the pain messages (i.e., the partner without chronic pain).

Understanding if communication failures are occurring in couples with a CP partner could lead to better ways of helping individuals with CP and their partners to communicate about the pain. Instrumental in making this determination would be an
assessment of whether differences occur in the communication of pain in couples where there is an individual with CP and couples where neither partner has CP. For instance, it would be imperative to determine whether there are greater discrepancies between a partner’s reported pain and the observer’s perception of the degree of pain experienced. If this discrepancy is larger in couples with a CP partner, this could highlight communication failures that arise as a result of having CP in the dyad.

Differences in the facial expressions of individuals with CP who experience a painful stimulus compared to individuals without CP who experience the same painful stimulus would also suggest differences in non-verbal communication of pain across these two groups. For instance, if individuals with CP display more facial reactivity to the same stimulus than individuals without CP, this could point to different communicative processes or goals occurring between these groups. Similarly, if partners of individuals with CP have fewer facial responses to pain in their partner than partners of individuals without CP, this might suggest that the pain message is being decoded differently by the observing partners across groups.

The current study aimed to examine these differences by comparing non-verbal communicative responses (i.e., facial expression) and experienced and perceived pain levels (i.e., discrepancy in pain ratings) in couples with and without a partner with CP. The intent of the study was to clarify how having a partner with CP in the dyad can influence reactions and responses to pain. Such comparisons allow for a better understanding of the unique communication processes that occur in couples with a CP partner. In addition, the current study aimed to investigate the role played by empathy in an exploratory nature. Given the current research in the area of empathy, identifying
correlates of empathy could prove an important first step to developing a better understanding of the role that empathy plays in the pain communication of couples with a partner in CP. Specifically, determining whether associations exist between empathy and pain-related facial expressions in both partners, or empathy and discrepancies in pain ratings may help identify an important factor in the experience of couples with a partner in CP.

**Theoretical Models of Pain in a Couples’ Context**

As pain has become increasingly accepted as a social phenomenon, models and theories of pain have been developed to incorporate this shift. Given the important role that the dyadic relationship plays in an individual’s life, many of these models focus on the interpersonal nature of CP. These models provide the framework for much of the research that has been conducted on pain in couples. The following overview of these models highlights the current status of pain models in the dyadic context and allows for a better understanding of needed directions in couples’ pain research.

**Operant models.** The operant model of pain, discussed previously, is a model that has been applied specifically to the context of the dyadic relationship. Initially proposed by Fordyce (1976; 1982), the operant model focuses on the pain behaviours in the relationship. Operant models have long been used to understand CP in couples, with mounting evidence in support of this model (Romano et al., 1995; Romano et al., 2000).

Operant models of pain in the spousal relationship suggest that pain behaviours (either verbal or non-verbal) made by individuals in pain communicate pain to others in the social environment (Cano & Williams, 2010). These behaviours are either rewarded (e.g., providing help), punished (e.g., with an angry response), or ignored by those
around them (Fordyce, 1976). Partners or significant others often have the most opportunity to respond to these behaviours due to frequency of contact. The responses of partners of individuals with CP to pain and pain behaviours in the individual with CP have become the centre of focus in pain research. Among these responses, solicitous and negative or punishing responses have received the greatest attention (Newton-John, 2002). Each of these responses can serve to reinforce or decrease pain behaviours in an individual with CP.

**Spousal responses to pain.** Different spousal responses to the pain of an individual in CP have been examined, and certain responses by a partner can elicit specific pain behaviours in those in pain. Solicitous responses are defined as responses to pain behaviours that tend to reinforce the sick role, such as discouraging activity or expressing concern or sympathy (Romano et al., 2000). Solicitous responses typically encompass three domains, including positive reinforcement of pain behaviours, negative reinforcement of pain behaviours, and insufficient reinforcement or active discouragement of well behaviours (Newton-John, 2002). For the most part, solicitous responses by a partner to pain behaviours of the partner in pain have been shown to result in increases in pain behaviours (Romano et al., 1995).

In one of the few studies directly examining pain behaviours in partners, Romano and colleagues (1995) found that solicitous responses to a partner’s pain behaviours were associated with more pain behaviours and greater disability, but only in those participants who reported depression. Romano et al. videotaped couples where one partner had CP doing routine household tasks, such as changing the linens on a bed and sweeping the floor. The resulting behavioural interactions were coded for non-verbal and
para-verbal responses made by the partner in pain and solicitous and discouraging responses made by the partner not experiencing pain. Solicitous responses were a significant predictor of the rate of non-verbal pain behaviours in the partner in pain, especially among those who reported greater pain. However, solicitous responses were not a predictor of psychosocial dysfunction (Romano et al., 1995).

In a similar study conducted by the same group of researchers (Romano et al., 2000), Romano and colleagues found that partner behaviours explained 31% of the variance in patient non-verbal pain behaviours and 14% of the variance in patient verbal pain behaviours. A higher frequency of solicitous behaviours by the partner without pain was associated with higher rates of observed verbal and non-verbal pain behaviours. These findings suggest that solicitous responses can lead to negative outcomes in terms of pain levels and disability.

In contrast to solicitous responses, punishing or negative partner responses to pain behaviours in a partner with CP can be characterized by expressions of disapproval, disagreement, or displeasure (Newton-John, 2002). Punishing responses have been found to be negatively associated with the rate of patient non-verbal pain behaviour (Romano et al., 2000). Similarly, punishing partner responses have been associated with less disability (Newton-John, 2002). These results, however, were limited in that they were gathered through self-report methods without active observation during pain and subsequent responses. Despite this evidence, punishing responses have not consistently been found to directly result in improved pain behaviours or disability. Weiss and Kerns (1995) found that individuals with CP who had partners with highly punishing responses only reported lower pain levels when they were satisfied with their relationship. In
dissatisfied couples, the partner in pain reported more pain when his or her partner provided punishing responses than when the partner without pain responded solicitously (Weiss & Kerns, 1995). These findings are inconsistent with operant theory, which suggests that punishing responses can decrease pain behaviour and pain intensity. Although these inconsistencies may be due in part to problems with the methods used in the studies, these inconsistencies also allude to the operant model as being insufficiently comprehensive for understanding and studying pain in couples.

Although operant models have been extensively researched in partner interactions where pain is present, they are limited in their applicability. Specifically, operant theories rarely account for emotional valence when examining responses (Romano et al., 2000). Studies examining the emotional tone of a response have demonstrated a hostile-solicitous response category (Newton-John, 2002), which cannot be encompassed within the operant model. It has been suggested that the behavioural focus of this model is too limited to provide a comprehensive understanding of the dyadic pain experience and its true outcomes (Newton-John, 2002). Examining only surface level responses (i.e., content of responses) also discounts the possibility that partners might be reacting incongruously with how they feel or that response modulation is occurring. Research on interactions in partners when one partner is in CP requires a more inclusive perspective of the various components involved in partner interactions, with greater focus on variations in partner responses.

**Emotion regulation theory.** Emotion regulation theory of pain in couples extends beyond the notion that the pain experience is limited to the punishment and reinforcement of behaviours. Emotion regulation theory suggests that marital interactions
influence the emotion regulation of the individual with CP and the partner (Cano et al., 2008). In an emotion regulation model, the interactions of focus are validating and invalidating responses. Validating partner responses (also referred to as empathic responses) convey acceptance and an attempt to understand the experience of the partner in pain. Invalidating responses (or non-empathic responses) convey disrespect, contempt, and non-acceptance of the partner’s pain experience (Cano et al., 2008). An individual with CP can have invalidating and validating responses to his or her own pain, in addition to the partner’s ability to respond in these manners.

In contrast to a conceptualization where responses to pain are interpreted as reinforcing or extinguishing behaviour, validating responses are thought to promote intimacy, emotional closeness, and enhanced emotion regulation. Invalidating responses increase emotional distance and emotion dysregulation (Cano et al., 2008). Intense forms of self-invalidation (i.e., anger or contempt) may have an influence on a partner’s perception of the pain in the individual with CP. For instance, Johansen and Cano (2007) found that when an individual with CP exhibits anger or contempt, the partner rates the individual’s pain as being more severe. Moreover, recent research involving validation training in partners of individuals experiencing pain demonstrated that validating a partner in pain leads to decreased negative affect in the partner experiencing pain (Edlund, Carlsson, Linton, Fruzzeti, & Tillfors, 2015). Further contrasting operant models from the emotion regulation model is the partner of focus. The emotion regulation model takes into consideration the effect of the responses on the dyad by examining both partners’ reactions. Conversely, operant models focus solely on one partner’s response (Cano et al., 2008).
Despite this initial evidence providing a potential avenue for improved theoretical understanding, there is currently limited research support for the emotion regulation model in couples. Moreover, the degree to which non-verbal communication is incorporated within this model is limited. To date, researchers studying couples from an emotion regulation framework have mainly employed interview procedures in which the couples talk about their pain (e.g., Cano et al., 2008). Although this methodological approach allows for the emotional content of communication to be examined, it does not permit examination of direct reactions to pain and pain responses. Consequently, such an approach could lead to a lack of congruence between how pain is thought to be experienced within couples compared to how pain is actually experienced in the couple during painful interactions.

**The intimacy process model of interactions.** Intimacy models (Cano & Williams, 2010; Reis & Shaver, 1988) share a number of elements with emotional regulation theory; however, the perceived motivation behind the spousal interactions differs slightly. Reis and Shaver (1988) suggested that intimacy develops when one person’s self-disclosure of emotions is met with the partner’s empathic and validating responses (Cano & Williams, 2010; Reis & Shaver, 1988). The focus of this model is on verbal communication, such that verbal communications about one’s thoughts and feelings may entail attempts to disclose emotion, recruit emotional support, and build intimacy.

In an intimacy process model of pain, some forms of verbal communication, including talking about one’s thoughts or feelings about pain, are seen as self-disclosure (Cano & Williams, 2010). This is in contrast to operant models, in which talking about
pain is seen as a pain behaviour that should be extinguished (Cano & Williams, 2010). Operant models view positive social attention and concern from a partner as reinforcing verbal pain behaviours. However, in operant models, the emotional valence of the communication is ignored (Cano & Williams, 2010). Researchers have demonstrated that emotional tone varies greatly in partner responses to pain behaviours, suggesting that consideration of emotional valence is essential (Newton-John & Williams, 2006).

At this time, there remains little empirical support for the intimacy process model within the context of pain. It is also not known whether non-verbal behaviour can be understood using an intimacy framework (Cano & Williams, 2010). Given the prominence of non-verbal communication in pain, a comprehensive model of pain should include this component. Thus, the current status of the intimacy model is limited given the degree to which these models overlook critical communication information.

**The communal coping perspective.** The communal coping perspective of pain proposes that individuals with CP engage in painful or catastrophizing behaviours or express catastrophic thoughts to those around them as a means of garnering support (Sullivan, Tripp, & Santor, 2000; Sullivan et al., 2001). From a communal coping perspective, it is assumed that the person who catastrophizes either desires or feels entitled to more pain-related support or attention than is being received (Cano, Leon, Heller, & Lutz, 2009).

As with the previous models, the communal coping perspective suggests that pain reduction is not the primary goal in pain behaviours and expressions. Rather, interpersonal goals, such as receiving empathy or support, motivate an individual’s response to pain in an effort to cope with the pain. Consequently, catastrophizing
behaviours are not only seen as maladaptive ways of responding to pain, but rather are part of a broader coping perspective (Thorn, Ward, Sullivan, & Boothby, 2003). It has been proposed that individuals with CP who engage in a high degree of catastrophizing do so as a means of maximizing social proximity and support or to solicit assistance or empathic responses from their social environment (Sullivan et al., 2001; Sullivan, Martel, Tripp, Savard, & Crombez, 2006). Within the communal coping perspective, individuals who catastrophize show a preference for dealing with pain and distress in a social context (Sullivan et al., 2001). Unfortunately, individuals who catastrophize may be making their pain experience more distressing, as catastrophizing behaviours are known to increase negative pain outcomes (Keefe et al., 2000; Sullivan, Bishop, & Pivik, 1995).

The communal coping perspective has been supported in the literature, primarily through research examining the relationship between catastrophizing, self-reported pain, pain behaviours, and pain observed others (Sullivan et al., 2001). For instance, Keefe, Kashikar-Zuck and Robinson (1997) found that the more a partner with CP catastrophizes, the less the partner without pain perceives the partner with CP as being able to cope effectively with pain (Keefe et al., 1997). In addition, the social purpose of pain catastrophizing behaviours is highly evidenced through findings identifying that individuals who catastrophize are more expressive when experiencing pain around others than alone (Sullivan, Adams, & Sullivan, 2004).

In an examination of the communal coping perspective involving undergraduate students, participants were video recorded during the cold pressor task, a safe method of experimentally inducing pain through ice water. Observers then watched the recordings
and rated the intensity of pain they perceived the person to be experiencing. Results demonstrated that high levels of pain catastrophizing in the individuals completing the cold pressor task accounted for a significant portion (15%) of variance in observers’ inferred pain ratings (Sullivan et al., 2006). The social value of catastrophizing behaviours is strongly evidenced in these findings. The researchers of this study, however, underscored that the results did not provide direct evidence that individuals who catastrophize enact these behaviors specifically to attain certain interpersonal goals. The relationship among these variables, although proposed by the model, remains undetermined and open to speculation (Sullivan et al., 2006).

The communal coping perspective’s restricted focus on catastrophizing behaviours limits the applicability of this model. Pain is a broad experience and responses beyond catastrophizing will influence how pain is experienced within a dyad. The model also recognizes the communicative and social nature of catastrophizing behaviours in pain, but ignores the social consequences of the numerous non-catastrophizing behaviours. The communal coping perspective is also more limited in terms of the dyadic communicative process, such that the focus of the communication is on the sender of the pain messages and the role of the observer is largely overlooked. Discussions of the receiver’s role tend to be focused on the degree of pain the person in pain is perceived to be experiencing (e.g., Sullivan et al., 2006). The interactive influence these perceptions might subsequently have on the partner in pain is neglected.

**The communications model of pain.** The communications model of pain (T. Hadjistavropoulos & Craig, 2002; T. Hadjistavropoulos et al., 2004; T. Hadjistavropoulos et al., 2011; Prkachin & Craig, 1995) provides a framework for
understanding pain from a biopsychosocial perspective. This model includes the biological component of the pain experience, intrapersonal determinants, and environmental and social determinants (T. Hadjistavropoulos et al., 2004). The communications model of pain takes into account the person in pain and the caregiver or the observer of that person. In the partner relationship, this would represent the interactions occurring between an individual with CP and his or her partner.

The communications model is based on an A → B → C formulation by Rosenthal (1982), wherein A represents the internal experience, which is then encoded as B – the expressive behaviour – which leads to C, which encompasses the observers’ inferences about the nature of the sender’s experience or the decoding. The three stages described in the model are influenced by personal characteristics and the social context (T. Hadjistavropoulos & Craig, 2002; T. Hadjistavropoulos et al., 2004). The communications model also recognizes that the sender and the observer mutually influence each other’s subsequent reactions; how the sender responds to pain will impact how the observer decodes the message and how the observer decodes and reacts to the pain message will influence the receiver’s continued response or future responses to pain (T. Hadjistavropoulos et al., 2004). This model of pain is consistent with findings in the pain literature (T. Hadjistavropoulos et al., 2011), and treatment of pain is dependent on the observer’s (e.g., health professionals) ability to decode another’s expressive behaviours (T. Hadjistavropoulos et al., 2004).

Pain can be communicated intentionally, for example, in response to someone’s query, or unintentionally, for example, as a reflexive pain reaction. It can be observed through verbal (e.g., being told about the pain) and non-verbal indicators (e.g., rubbing
and guarding; (T. Hadjistavropoulos et al., 2004)). The challenge arises in knowing how to interpret an encoded message to obtain a meaningful understanding of an individual’s pain. In the dyadic relationship, verbal and non-verbal communication methods have been demonstrated to significantly affect how partners of individuals with CP react to pain behaviours. Individuals are more likely to display more intense facial expression during pain when in the presence of a significant other (Karmann et al., 2015), suggesting that the nature of the relationship between the sender and the observer influences the encoding process. Moreover, the manner in which pain is communicated can result in increased or decreased support (Morley, Doyle, & Beese, 2000; Porter et al., 2008). This communication can also influence levels of anxiety, depression, strain, physical disability, pain levels, and pain behaviours in both partners (Cano et al., 2000; Cano, Johansen et al., 2004; Cano & Leonard, 2006; Leonard & Cano, 2006; Pence et al., 2006). Thus, communication is vital to all pain interactions and outcomes.

The communications model of pain addresses many of the limitations of previously proposed models of pain communication, without disregarding the strengths of these models. Further, the previously discussed models can be conceptualized within the framework of communicative processes occurring within the dyad. The comprehensive nature of the communications model encompasses the significant components of the communal coping model, empathy models, and the intimacy process model. For instance, it includes the behavioural and non-verbal components presented by operant models; it considers the influences of both partners in the pain experience, much like the intimacy process model and empathy models; and it recognizes intrapersonal characteristics, such as the catastrophizing central to the communal coping model.
Although dyadic interactions are integral to the communications model, the romantic dyad has not been extensively investigated within this framework. Research examining pain in couples framed within the communications model of pain would enrich the conceptualization of this model. Understanding the encoding and decoding processes specific to couples, as well as specific factors that influence how pain is communicated in couples, will clarify the applicability of the model to dyadic relationships. Such an approach will provide a stronger conceptual framework for future research on pain in couples.

Factors Associated with Pain in the Dyad

Within the literature on pain in couples, numerous factors have been considered to influence how pain in one partner is experienced and responded to by both partners in the dyad. Among the factors explored, degree of divergence in perception between partners of pain-related variables experienced by the partner with CP, gender of each partner, social support, and communication have yielded relevant considerations for the dyadic functioning. Each of these will be explored in detail below. The manner through which the current study expands on each factor will be discussed.

Divergence in perception of pain-related variables. Varying perceptions between the individual with pain and his or her partner around pain variables have negative consequences. Cano, Johansen et al. (2004) demonstrated that differing perceptions between the person in pain and his or her partner regarding the degree of pain severity and disability are related to depression. In a study examining 110 couples where one partner had CP, couples where depression was experienced by a partner in the dyad reported significantly larger differences in disability ratings than couples without a
partner with depression (Cano, Johansen et al., 2004). Several indicators of incongruence were evidenced. For instance, partners of individuals with CP rated the level of pain experienced by the partner with CP as being more severe than the pain rating provided by the partner in pain. However, the degree of disability rated by the partner in pain was higher than the perception of disability reported by the partner without pain. Dyads were more incongruent when the partner with CP was diagnosed with a depressive disorder (Cano, Johansen et al., 2004).

In a separate study, Cano (2004) found that partners of individuals in pain become less solicitous over time. She speculated that this might be a result of the partner without pain discounting the pain of his or her partner as time progresses. These findings suggest that living with an individual with CP may lead to habituation or desensitization to a partner’s pain experience. This hypothesis, however, has not fully been explored by researchers.

Diverging perceptions between partners on degree of disability experienced by a partner in pain have been related to exaggerated pain behaviours (Keefe et al., 2000; Wise, Price, Myers, Heft, & Robinson, 2002), particularly when the partner in pain is a woman. Men may be less accurate assessors of their partner’s degree of disability (Ickes, Gesn, & Graham, 2000; Keefe et al., 2000; Newton-John & Williams, 2006; Wise et al., 2002). This may provoke women to engage in more catastrophizing and exaggerated pain behaviours.

There is some controversy in the literature over the degree of convergence in partner perceptions over time. Researchers have argued that a habituation effect occurs gradually when partners are consistently exposed to the facial expressions of another’s
pain (Prkachin, Mass, & Mercer, 2004; Prkachin & Rocha, 2010). Alternatively, it has been proposed that an observer’s accuracy can increase as a result of spending more time with the individual with pain CP (Miaskowski et al., 1997).

The current study aimed to clarify this relationship. Given the existing research demonstrating distress in couples with a CP partner, desensitization of the partner without pain to the experience of the partner with pain could be an explanation for the miscommunication that occurs. It would then follow that the partner with pain increases or exaggerates his or her reactions to painful situations in an effort to communicate pain to a desensitized partner. Examining if dyads differ in congruence of perceptions based on whether there is a partner with CP in the couple could help elucidate this question.

This study also aimed to determine if relationship satisfaction and perceived social support is related to pain ratings made by individuals with CP and observed pain rated by the partner without pain. It is possible that discrepancies in ratings given to a partner’s pain develop over time, as a result of the nature of the couple’s relationship. If an interaction is found between CP status of the couple (i.e., whether there is a CP partner in the dyad), relationship outcomes, and non-verbal behaviour, this would provide avenues for treatment in couples with CP. Treatment providers could aim to improve relationship and pain outcomes by enhancing the accuracy of pain communication within the dyad.

**Gender of individuals and partners of individuals with CP.** It has been demonstrated that women are more sensitive to pain and provide higher ratings of pain during painful experiences (Berkley, 1997; Bulls et al., 2015; Wiesenfeld-Hallin, 2005). Additionally, chronic pain appears to be more prevalent in women (Berkley, 1997).
Given these established gender differences, it is reasonable to expect that gender might play a role in how pain is experienced in the dyad. Only a limited number of studies have examined the association between gender and how pain is experienced in couples with a CP partner.

Researchers have identified pain sensitivity differences in women and men based on the construction of their social environment (Vigil et al., 2013). Consequently, it is not surprising that the gender of the partner in pain may play a role in how pain is experienced within the dyad; however, there are inconsistencies within existing research findings. In terms of pain severity, Beaupre and colleagues (1997) found more incongruent ratings of pain when the partner with pain was a woman (Beaupre et al., 1997). These findings were not replicated by Cano and colleagues (2004). Cano and colleagues (2004), however, did identify differences in congruence on perceptions of disability that were dependent on the gender of the partner. More incongruent ratings of the disability level experienced by the partner in pain occurred when the partner in pain was a woman.

Men have been reported as less accurate perceivers of disability than women and less aware of pain behaviours exhibited by women (Ickes et al., 2000; Newton-John & Williams, 2006). Consistent with this, it has also been shown that both men and women are slower and less accurate at recognizing pain expressions on the faces of women (Riva, Sacchi, Montali, & Frigerio, 2011). In the couple’s context, this would be most evidenced as men being less aware of pain in partner with CP who is a woman, given the predominance of heterosexual couples in research. Further, it has been demonstrated that partners with CP who are women are more likely to exaggerate pain or catastrophize
than partners with CP who are men (Keefe et al., 2000; Wise et al., 2002), potentially in an attempt to increase awareness and empathy in their partner.

Methodological differences across studies may point to why findings are inconsistent with regard to gender differences. Beaupre and colleagues (1997) collected pain ratings from the partner without pain while the partner with CP was engaging in physical activity. Conversely, Cano and colleagues (2004) collected ratings through self-report measures, without direct observation of the partner with CP by the partner without CP. Initial evidence suggests that gender differences are present in couples with CP. Inconsistencies in findings, however, point to a need for increased research with more rigorous methods of assessing congruence in ratings of pain in the partner with CP. Examining pain simultaneously through both objective methods, such as coding of facial reactions, and subjective methods, such as self-report, may clarify sources of disagreement in ratings. For instance, if an individual with CP is expressing pain vigorously and intensely through facial activity, then incongruent pain ratings may be caused by accurate perception by the partner without pain of a strong facial expression that may not correspond to the self-report of the partner in pain.

Potential gender differences have also been found in terms of perception of support received from a partner. The social report literature, which will be further elaborated on below, suggests that expectations for receiving social support differs based on the gender of the caregiver or partner without pain (Barrera Jr, 1986). Couples have been identified as having more congruent perceptions of the support provided by the partner without pain when that partner is a man. When the partner with pain was a man, these men reported their wives to be less solicitous than the wives perceived themselves
to be (Cano, Johansen et al., 2004). It has been proposed that this might be due to
expectations that women should fulfill traditionally feminine gender roles in caring for ill
family members (Cano, Johansen et al., 2004). If the partner in pain perceives himself as
not receiving the necessary support, this could lead to exaggerated pain expression in
order to garner the support. The relationship between perception of support and degree to
which pain is communicated genuinely could be a potential avenue for identifying
important gender differences in the pain experience. Also, examination of the non-verbal
behaviours of the partner not experiencing pain could provide further understanding of
the experience of partners who are in a relationship with an individual with CP.

Understanding if men and women have different perceptions and reactions to
their partner’s pain can have important implications from both a theoretical and a
practical perspective. From a theoretical perspective, researchers have highlighted a need
for better-informed models of sex or gender issues in pain communication (Keogh,
2014). Clarifying whether there are consistent gender differences in encoding and
decoding processes would enhance the current conceptualization of the pain
communications model. From a practical perspective, little differentiation is made in
treatment approaches based on the gender of the partner in pain (Cano & Leonard, 2006).
By providing further clarity to the impact of gender differences, treatments could be
improved by bringing based modifications to treatment (e.g., increasing attention within
the treatment protocol given to the couple’s communication patterns) based on the
respective genders of the partners.

Research on gender differences is also limited in terms of whether gender
differences pre-exist the onset of CP in the dyad. Examining if gender patterns of
reacting to pain in a partner exist regardless of whether a partner has CP or if they emerge subsequent to a partner developing CP could have valuable preventative implications. Relationship factors might be influencing the way that the couple interacts over time, and these interactions may differ based on the gender of the individual with CP. Support expectations or pain behaviours to increase support may develop over time as a result of a persistent pain condition in a partner in the dyad. This could lead to maladaptive outcomes for couples that experience CP that are not present in healthy couples. The current study was designed to allow for evaluation of gender differences in dyads with a partner with CP and dyads without a partner with CP. These between-groups comparisons help determine whether the presence of a partner with CP in the relationship influenced how each gender behaved, depending on their role as the partner with or without pain.

**Relationship quality.** Relationship factors, such as support and marital satisfaction are frequently evaluated in the literature on pain in couples. In individuals suffering from CP, social support – specifically from a partner – can increase psychological wellness and pain outcomes (Cano et al., 2004; Feldman, Downey, & Schaffer-Neitz, 1999; Kiecolt-Glaser & Newton, 2001). Lack of social support and increases in conflict or relationship concerns, however, have been associated with greater depression and somatization (T. Hadjistavropoulos et al., 2004). Social support can be understood to encompass a number of components, including ability to ask or communicate need for assistance, and sense of support entitlement.

Indirect support seeking can negatively influence received social support. One reason individuals may not openly disclose their pain experience to others is due to the
belief that this disclosure will draw a negative social reaction (Morley et al., 2000). Individuals who do not disclose their pain may be more likely to rely on indirect or non-verbal methods of pain communication (Morley et al., 2000). Indirect support-seeking behaviours tend to repel support providers who are more inclined to react in an unsupportive or rejecting manner. Conversely, direct support seeking has been related to more supportive and fewer unsupportive responses by individuals in a social network (S. L. Williams & Mickelson, 2008). In the context of pain in couples, similar results have been found. Direct support seeking, such as talking openly about pain, has been related to fewer negative outcomes. Indirect ways of seeking support, such as exaggerated pain behaviours, have the opposite effect (Cano et al., 2009). These negative outcomes are particularly seen among individuals with CP who feel that they are entitled to receive support (Cano et al., 2009).

The degree to which an individual with CP perceives his or her partner to be providing support is an essential element of the pain experience. When partners hold discrepant perceptions of the level of support being provided to the partner with CP, the members of the dyad are more incongruent in ratings of the pain and disability experienced by the partner with CP. This is particularly the case when the partner with CP is experiencing depression (Cano, Johansen et al., 2004). Perception of social support remains integral to pain-related outcomes as it mediates the relationship between pain behaviours and pain-related outcomes (Buenaver, Edwards, & Haythornthwaite, 2007).

Despite support variables being discussed in the literature, the way in which support is measured provides limited information. Support tends to be operationalized as a reaction to pain behaviours, such as solicitous responses. Researchers have most often
relied on the Multidimensional Pain Inventory (Kerns, Turk, & Rudy, 1985) which assesses pain-related support. Only a few investigators have considered a broader construct of support (Cano, Johansen et al., 2004; Cano et al., 2009). Although information about pain-related support is valuable, it is limited in terms of what can be gleaned about the relationship as a whole. In addition to overlooking other aspects of support, it ignores the support perceived to be received by the partner without CP. The current study aimed to address this issue by assessing the support that each partner perceives to be receiving from the other.

Marital or relationship satisfaction is a second construct frequently examined in the literature. Many researchers incorporate a measure of relationship satisfaction in their study. The Dyadic Adjustment Scale (DAS; Spanier, 1976) is a widely used measure of marital satisfaction. Despite its customary use in this area, concerns have been raised regarding its value. Firstly, the DAS’s intended purpose is to examine adjustment and not satisfaction (Fletcher, Simpson, & Thomas, 2000). This is problematic given that authors frequently purport to measure satisfaction using this scale. Secondly, there are issues with the psychometric properties of this measure. Upon initial construction, Spanier identified four dimensions of marital adjustment measured by the DAS: (a) consensus on matters of importance to marital functioning; (b) dyadic satisfaction; (c) dyadic cohesion; and (d) affectional expression (Fletcher et al., 2000). Nonetheless, factor analytic investigations have not yielded these factors, and researchers are often limited to using only a global score (Busby, Christensen, Crane, & Larson, 1995; Crane, Busby, & Larson, 1991; Sharpley & Cross, 1982). A third concern is that the score used to identify distress in couples is inconsistent across studies (Cano, Miller, & Loree, 2009;
Newton-John & Williams, 2006). This leads to unreliable use of this tool. Careful selection of relationship measures was undertaken in the current investigation in order to provide the most accurate assessment of relationship factors that might be influencing pain responses. Moreover, given the limited scope of examining only adjustment or satisfaction, studying constructs such as empathy and support allowed for a broader perspective on relationship concerns of couples touched by CP.

**Communication.** Communication involves numerous facets. The ability to be open about experiences is one of these facets researched in couples with pain. Lack of openness, often referred to as holding back, influences pain-related outcomes in the couple’s relationship. Porter and colleagues (2008) demonstrated that individuals with CP who reported holding back from their partner in discussions around pain reported higher levels of depression, anxiety, and pain catastrophizing. Partners without pain who reported withholding their concerns in discussions about their partner’s pain reported higher levels of caregiver strain and greater negative affect.

Perception of ability to communicate pain – another facet of communication explored – differs between individuals with CP and their partners. Individuals with CP report being more confident in the task of communicating their pain and reported higher levels of self-efficacy for pain communication than their partners (Porter et al., 2008). Conversely, partners of individuals with CP perceive themselves as having lower self-efficacy for understanding and responding effectively to their partner’s pain.

Porter and colleagues identified that perceived self-efficacy in communicating pain (2008) is associated with a number of pain-related variables. Specifically, individuals with CP with high self-efficacy for pain communication reported much lower
levels of pain, physical disability, psychological disability (i.e., depression and anxiety), and pain catastrophizing (Porter et al., 2008). Conversely, partners of individuals with CP who reported greater perceived self-efficacy in decoding the pain communication of their partners reported more positive affect (Porter et al., 2008). These associations were found to be independent of the pain level of the individual with CP.

Non-verbal communication has not been extensively researched in the context of couples with a CP partner. Examining the degree to which non-verbal communication accounts for relationship factors such as ability to accurately interpret the pain experiences of partner, perception of support, satisfaction, and intimacy can provide information regarding the value of non-verbal communication in the dyadic relationship. Understanding the influences of non-verbal communication on the relationship can provide health care providers with indications of helpful or unhelpful communication occurring in the relationship. In couples experiencing negative relationship outcomes, this knowledge may be an avenue for improving relationships and could help health care providers and clinicians assist couples in communicating pain more effectively.

Limitations of Previous Research on Pain in Couples

Although there is a substantial literature base that examines pain in couples, there are a number of limitations to the existing research. Among these limitations are methodological issues, sample limitations, and theoretical limitations. These issues are reviewed, and the manner in which the current study aimed to address these issues is discussed.

Methodological limitations. Pain is a challenging phenomenon to examine in an ethical and realistic manner. Interview, self-report, and pain induction procedures are the
most common methods for studying pain. The use of self-report presents a number of methodological concerns not limited to research on pain in couples. Self-report measures often rely on retrospection and are susceptible to inaccurate recall (Pence et al., 2006). In addition, self-report measures are subject to situational demand characteristics. Many studies examining pain in couples rely solely on the self-report of pain (e.g., L. R. Gauthier et al., 2012; Papas, Robinson, & Riley J. L. III, 2001). In pain research, it is noted that self-report ratings of pain are not always consistent with behavioural indicators of pain (T. Hadjistavropoulos et al., 1998; Labus et al., 2003). This suggests that additional sources of data (e.g., behavioural observations) are integral to obtaining a more complete and accurate understanding of the pain experience.

Interviews with partners are a procedure commonly used to examine the content of communication about pain, including empathic statements and expressions of emotion (e.g., Cano et al., 2008; Cano & Williams, 2010; Johansen & Cano, 2007). Dyads are asked to discuss either a randomly selected topic or a pain-specific topic. Systems such as the Validation and Invalidation Behavior Coding System (VIBCS), developed to assess couples’ interactions (Cano et al., 2008; Fruzzetti & Iverson, 2006), can then be used to code the exchanges (Cano et al., 2008; Johansen & Cano, 2007). Coders determine the frequency of validating and invalidating responses made in a couple’s interaction to establish the way in which the couple is interacting.

Although interview procedures allow for more objective assessments of the dyad’s pain experience, there are limitations to this method as well. Most notably, they do not allow for examination of interactions in instances when pain is occurring. Couples may respond differently in painful situations than when talking about how pain
influences their relationship (Pence et al., 2006). Interview procedures rely on retrospection and may not be accurate depictions of how pain is actually experienced in the relationship. Depending on the coding method used, interview procedures may also ignore non-verbal components of the interaction. Behaviours can influence how pain is experienced and partners may be reacting to non-verbal cues that are not captured through interview coding systems.

Pain induction procedures represent a compelling method for pain research, as they address the issues of reliance on retrospection and lack of actual direct observation of the pain experience. A number of different procedures are available to induce pain. A common method used by researchers is the cold pressor task. This safe and ethical pain induction task requires participants to place their hand or arm in cold water. Other pain induction apparatuses used in pain research include the induction of pain through thermal stimulation (e.g., Hampton, Hadjistavropoulos, Gagnon, Williams, & Clark, 2015; Thibodeau, Welch, Katz, & Asmundson, 2013). The sensation of pain can be induced by a sensor that expels either heat or cold. Such equipment typically includes a square surface (thermode) of approximately 30mm x 30mm that is placed on the skin and can produce temperatures between 0°C and 55°C.

Although studies have been conducted using pain induction tasks with couples, they are limited in number. Additionally, when pain induction tasks are used, often the partners are not in the room at the same time. Rather, the pain experience is viewed by the partner through video. For instance, Gauthier et al. (2008) asked patients with CP to engage in a simulated occupational lifting task while reporting their level of pain and being video-recorded. The partners who had not completed the task (i.e., the partner
without CP) were later asked to view the video to rate their partners’ pain (L. R. Gauthier et al., 2012; N. Gauthier et al., 2008; N. Gauthier et al., 2011). Given what is known about the social communication of pain, there is reason to believe that the responses of both partners may vary if the observing partner is in the room compared to if the observing partner is not in the room.

A number of methodological improvements could be made to current research on pain in couples. First, examination of painful responses within the dyad would allow for a more accurate examination of how pain is experienced by both partners in the dyad. Secondly, when using pain induction methods to examine the interactive and communicative components of pain in the dyad, both members of the dyad should be present throughout the task. Finally, although self-report measures are a valuable source of information, the additional use of objective measures, such as coding systems, could allow for a more complete examination of reactions to pain. Coding systems that allow for examination of non-verbal components of communication have not been commonly used in the research on couples. An examination of non-verbal factors could provide considerable advancement to the current conceptualization of pain in couples. The current study addressed these limitations to existing research. Observational and self-report measures were used, both members of the dyad were included in the observational task, and facial expressions were examined through the use of a validated facial expression coding system.

Sample limitations. Several researchers have included both partners in their examination of the pain experience in couples. Others examined the responses of one partner to make inferences about the dyadic relationship. It has been argued that there is
an interactive process among initial pain reactions, spousal responses, and subsequent pain experiences (Cano et al., 2004; Cano, 2004). Given this process, examination of data from both partners may provide a more complete picture of the pain experience in the dyad. Moreover, the effects of pain on the observers remain, by and large, unexplored (Goubert et al., 2005). The observing partners’ perspectives and responses should be better incorporated into research in couples.

Gender differences also exist in how pain affect couples with a CP partner (Beaupre et al., 1997; Berkley, 1997; Ickes et al., 2000; Newton-John & Williams, 2006; Wiesenfeld-Hallin, 2005; Wise et al., 2002). Despite these identified differences, there are unanswered questions regarding gender and the experience of couples with a CP partner. Many researchers (e.g., Cano et al., 2009; Issner, Cano, Leonard, & Williams, 2012; Porter et al., 2008) do not focus on these gender differences, in spite of gathering data from men and women with CP. To continue advancing the understanding of how pain is experienced within the dyadic relationship, gender differences should be explored.

A final sample issue observed in research with couples is the lack of a control or comparison group. Although valuable data can be collected without the addition of a control group, the degree to which researchers can conclude that the findings only occur in samples with CP is limited. By examining interactions in healthy couples, and comparing these interactions to couples with a CP partner, behaviours or outcomes that are characteristic of a CP sample can be identified.

The current study aimed to address the sample limitations that exist in previous investigations. Observational and self-report data were collected from both partners. This
allowed for an improved examination of how the partners’ reactions to the pain experience influenced subsequent outcomes. In addition, the current study aimed to determine if the dyadic pain experience differed based on the respective gender of the individual with CP and the partner. Finally, by using a comparison group of healthy couples, this study helped determine whether observed outcomes are limited to couples with a partner with CP or if there are common outcomes among couples regardless of pain status.

**Theoretical limitations.** Numerous models and theories have been proposed to understand the experience of couples with a CP partner. As previously discussed, there are a number of limitations to these models. Many do not provide a sufficiently comprehensive perspective to encompass all components of the pain experience. The theoretical understanding of pain should continue to be advanced, as theoretical models act as a catalyst for future research. A solid theoretical grounding also permits the development of appropriate assessment and treatment protocols.

The communications model of pain provides significant potential in terms of advancing pain research. This model has been explored in research with pain in dementia and pain in children (Eritz & Hadjistavropoulos, 2011; T. Hadjistavropoulos et al., 2011; T. Hadjistavropoulos et al., 2011). The communications model incorporates relevant facets of existing models, with a number of additions that make it an innovative, complex, and inclusive perspective. It allows for the social environment – in this case, individuals with CP and their partners – to be included in the understanding of the pain experience.

The application of the pain communications model to the context of couples
could provide a comprehensive theoretical framework for the dyadic pain experience. In particular, clarification of how the observer reacts to pain in a partner could alter how pain communication is conceptualized in couples. The effects of pain on observers remain largely unexplored (Goubert et al., 2005). There is little research examining the communicative aspect of pain behaviours of individuals with CP, the influence of the behaviour on the partner without CP, and the global impact on the relationship. Examining the support for this model in couples will have significant implications for the current theoretical understanding of how pain is experienced in couples with a CP partner.

**Purpose and Hypotheses**

This study aimed to address gaps in research on couples with CP and to advance the theoretical understanding of pain in the context of couples. With these aims in mind, the following research questions were derived from the limitations of existing research.

**Research question 1.** Do couples with a partner with CP and couples without a partner with CP differ in terms of how well they agree on the intensity of pain experienced by a partner during a painful situation? Discrepancy in pain ratings between partners can be interpreted as a marker of communication. Determining whether couples are consistent in their pain intensity ratings could elucidate whether miscommunications are occurring in the communication of pain in couples. Moreover, clarification of this question would help establish whether communication occurs more effectively in couples without a partner with CP or couples with a partner with CP.

**Research question 2.** Is pain experienced and expressed differently to partners by individuals with CP than by individuals without CP? Although the experience of
individuals in pain has been explored in previous research, the use of a comparison group has largely been ignored. This allows for only limited conclusions, as it remains unclear whether pain experiences and expressions are influenced by the presence of a partner with CP in the couple or occur regardless of the couple’s CP status. Moreover, although it has been demonstrated that gender differences exist in the pain experience, differences between genders in the context of a romantic relationship have not been comprehensively examined. To provide a more exhaustive examination of this research question, the following sub-questions were devised:

2a. Are there differences in pain intensity ratings provided by individuals with and without CP when pain is experienced in the presence of a partner?

2b. Are there differences in intensity of facial expressions expressed by individuals with and without CP when pain is experienced in the presence of a partner?

2c. Do gender differences exist in terms of pain intensity ratings and intensity of facial expressions provided by individuals with and without CP when pain is experienced in the presence of a partner?

**Research question 3.** Is pain perceived and responded to differently in partners of individuals with CP than partners of individuals without CP? Given the social nature of the pain experience, an individual’s response to witnessing pain in a partner will influence the partner’s subsequent behaviour. Understanding these responses may clarify the role played by the partner without pain on the pain experience of an individual experiencing pain. It will also provide clarification of the impact that witnessing pain in a partner can have on the partner without pain. The use of a control group would assist in
determining whether partner responses are influenced by the presence of a partner with CP in the couple. Gender differences must also be considered for a comprehensive understanding of an individual’s experience when witnessing his or her partner in pain. The following sub-questions assisted in answering research question 3:

3a. Do individuals with and without a partner with CP differ in their perception of the pain intensity experienced by a partner in pain?

3b. Do gender differences exist in an individual’s perception of the degree of pain intensity experienced in a partner, depending on whether the partner experiencing pain is an individual with or without CP?

3c. Are facial responses to a partner in pain different in couples without a partner with CP than couples with a partner with CP?

**Research question 4.** Do relationship variables and cognitions about pain influence non-verbal communication of pain in couples with and without a partner with CP? Although relationship outcomes are frequently examined in couples’ research, the direct impact of relationship variables on the communication processes, such as pain ratings and facial expressions in response to pain, have not been comprehensively considered. Additionally, the influence of cognitions of pain, particularly pain catastrophizing in relation to a partner experiencing pain, has not been extensively examined in the dyadic context. Examining the influence of relationship quality and pain cognitions on communication outcomes would help elucidate how the communication of pain may be more broadly influenced by relationship or contextual variables. As with the previous research questions, understanding differences between couples with a partner with CP and couples without a partner with CP is imperative. Therefore, the following
sub-questions were devised to better address research question 4:

4a. Do variables such as relationship satisfaction, relationship support, and pain catastrophizing influence self-report and non-verbal responses to pain (i.e., numeric pain ratings and facial expression in both partners) in each partner?

4b. Does having a partner with CP in the couple affect how relationship satisfaction, relationship support, or pain catastrophizing influence self-report and non-verbal responses to pain (i.e., numeric pain ratings and facial expression in both partners)?

Research question 5. Can the experience of pain in couples be applied within the context of the pain communications model? Determining the applicability of this model to couples would allow for an improved understanding of the theory behind pain in couples. In particular, examining pain in couples with a CP partner could give indications of encoding and decoding processes that may be unique to couples. The following sub-questions further explore this research question:

5a. Does the formulation of the pain communications model in which the internal experience of pain (A) is encoded by an individual through expressive behaviours (B), and subsequently decoded by an observe (C) apply in couples when one partner is experiencing pain?

5b. What automatic and controlled processes (examined through facial expression intensity and pain intensity ratings) are occurring in the pain encoders (i.e., the individuals experiencing pain) to communicate pain to a partner?

5c. Do individuals with CP demonstrate different automatic and controlled
processes (examined through facial expression intensity and pain intensity ratings) in response to pain than individuals without CP?

5d. What automatic or controlled responses (examined through facial expression intensity and perceived pain intensity ratings) are occurring in pain decoders when observing their partner experience pain?

5e. Do partners of individuals with CP demonstrate different automatic and controlled responses (examined through facial expression intensity and perceived pain intensity ratings) to their partner’s pain compared to partners of individuals without CP?

**Hypotheses and study predictions.** In order to address these research questions, ten hypotheses were proposed. From each hypothesis, specific predictions were derived:

- **Hypothesis I:** Couples with a partner with CP will have more incongruous perceptions regarding the pain experienced by the partner with CP.
  
  - **Prediction I:** It was predicted that couples in which one partner has CP would demonstrate more discrepancy in their pain ratings (i.e., larger difference between pain intensity reported by the individual with CP and observing partner’s rating of perceived pain intensity) than couples without an individual with CP. This prediction was based on previous research suggesting that partners of individuals with CP become less solicitous over time (Cano, 2004). Habituation might be at play when one is consistently exposed to the facial expressions of another. If habituation is occurring, partners of individuals with CP may be underestimating the level of pain in the individual with CP.
- **Hypothesis II**: Pain intensity will be higher in individuals with CP.
  - **Prediction II**: In the current study, it was predicted that individuals with CP undergoing an experimentally-induced pain task would provide higher pain intensity ratings than individuals without CP completing an experimentally-induced pain task. This prediction was based on established research identifying greater sensitivity to pain in individuals with CP conditions (Giesecke et al., 2004).
- **Hypothesis III**: Women with CP undergoing a painful situation will experience higher pain intensity than women without CP and men with or without CP undergoing the same painful situation.
  - **Prediction III**: In the current study, it was predicted that women would have higher pain intensity ratings than men, but women with CP would have higher pain intensity ratings than women without CP. This prediction was proposed given that women are purported to report greater pain intensity than men (Berkley, 1997; Wiesenfeld-Hallin, 2005) and that individuals with CP report greater sensitivity to pain than healthy individuals (Ernberg, Lundeberg, & Kopp, 2000; Giesecke et al., 2004).
- **Hypothesis IV**: Continued exposure to pain in a partner will lead to less accurate perceptions of a partner’s pain.
  - **Prediction IV**: In the current study, it was predicted that partners of individuals with CP would perceive their partner to be experiencing a lower level of pain intensity during an experimentally-induced pain task than the pain perceived by partners of individuals without CP. This prediction was
based on literature indicating that partners become less solicitous to the pain of the individual with CP over time, possibly due to habituation (Cano, 2004). Repeated exposure to individuals with pain has also been suggested to lead to habituation of painful facial expressions (Prkachin et al., 2004; Prkachin & Rocha, 2010). It was anticipated that the ongoing presence of CP in couples with a CP partner would lead to decreased sensitivity to pain expressions by the partner without CP in couples with a CP partner. This process would not have occurred in couples without an individual with CP in the couple, leaving the partner sensitive to the true level of pain experienced by the individual undergoing the pain task.

- **Hypothesis V:** Pain in a partner with CP will be less accurately perceived by men who are a partner of a woman with CP than by women who are a partner of a man with CP, as well as by men who are a partner of a woman without CP.
  - **Prediction V:** In the current study, it was predicted that men would provide lower ratings of perceived pain intensity in their partners than women, but that men who are partners of individuals with CP would have lower ratings of perceived pain intensity than men who are partners of individuals without CP. This prediction was consistent with the habituation process that is believed to occur in couples with CP discussed in prediction IV. Additionally, it was expected that inaccuracy in pain perception would be more prominent in men based on previous findings, suggesting greater incongruence in perception of pain and disability in a partner when the partner with pain is a woman (Beaupre et al., 1997; Cano, Johansen et al., 2004). Men are also less accurate
in perceiving disability and less aware of pain behaviours in partners who are women than women are in partners who are men (Ickes et al., 2000; Newton-John & Williams, 2006). This prediction was also supported by previous research demonstrating that men and women are slower and less accurate at recognizing pain expressions on the faces of women (Riva et al., 2011).

- **Hypothesis VI:** Non-verbal responses to pain will be greater in individuals with CP than individuals without CP.
  
  o **Prediction VI:** In the current study, it was predicted that individuals with CP would exhibit more pain-related facial activity while completing an experimentally-induced pain task than individuals without CP. Given that individuals with CP are reported to experience greater pain intensity and sensitivity (Berkley, 1997; Wiesenfeld-Hallin, 2005), it was predicted that the pain-related facial activity of these individuals would parallel the level of pain experienced. Therefore, individuals with CP would have greater pain-related facial activity due to a heightened pain experience. This hypothesis was also based on the habituation process that has been proposed to occur when confronted with the painful facial expressions of a partner over time (Prkachin et al., 2004; Prkachin & Rocha, 2010). If occurring in couples with a CP partner, then the individual with CP may need to exaggerate their pain to gain the attention of their partner.

- **Hypothesis VII:** Women with CP will exhibit more pain-related facial activity while experiencing pain than women without CP and men with or without CP.
  
  o **Prediction VII:** In the current study, it was predicted that women would have
more pain-related facial activity in response to experimentally-induced pain than men, but that women with CP would display more pain-related facial activity than women without CP. Because researchers have established that women experience pain at a greater intensity (Berkley, 1997; Wiesenfeld-Hallin, 2005), it was expected that their facial expressions would parallel this experienced intensity, such that they would have greater facial activity than men. However, researchers have demonstrated that partners with CP who are women are likely to exaggerate pain or catastrophize (Keefe et al., 2000; Wise et al., 2002), pointing to possible greater intensity of facial expression in women. Added to this, given that men have been found to be less accurate perceivers of pain than women (Ickes et al., 2000; Newton-John & Williams, 2006), it was anticipated that habituation among CP couples would lead individuals with CP who are women to have exaggerated facial behaviour in an effort to elicit appropriate awareness and empathy from their partner.

- **Hypothesis VIII**: Relationship satisfaction will predict non-verbal pain responses in both partners and the association between these variables will be moderated by the presence of an individual with CP in the relationship.

  - **Prediction VIII**: In the current study it was predicted that pain-related facial activity would be negatively predicted by relationship satisfaction for the individual undergoing the pain task and positively predicted by relationship satisfaction for the partner observing the pain task. The presence of CP in the relationship was expected to moderate the relationship between pain-related facial activity and relationship satisfaction in each partner. For participants
completing the task, it was anticipated that the negative association between pain-related facial activity and relationship satisfaction would be stronger in individuals with CP than in individuals without CP. In partners observing the task, it was anticipated that the positive association between pain-related facial activity and relationship satisfaction would be stronger in partners of individuals without CP than in partners of individuals with CP. In individuals experiencing the pain task, this prediction was based on research suggesting that dissatisfaction among couples where one partner experiences CP is associated with indirect support seeking (Cano et al., 2009). Facial expressions in response to pain, particularly more intense facial expressions, may be seen as a form of indirect support seeking. It was suspected that individuals less satisfied in their relationship may not be receiving the desired responses from their partner when faced with pain and would have more exaggerated non-verbal responses in an effort to gain the desired responses. This pattern of responding was expected to be stronger in couples with CP due to the ongoing nature of pain in the relationship. In the observing partner, this prediction was based on previous research findings that the presence of CP negatively affects relationship satisfaction (Flor, Turk, & Scholz, 1987) and that habituation may occur as a result of repeated exposure to observing painful reactions in others (Prkachin et al., 2004; Prkachin & Rocha, 2010). In the current investigation, habituation was thought to be related to decreased sensitivity and empathy for a partner’s pain, resulting in less responsiveness to partner’s pain by observers. It was anticipated that
demonstrations of empathy for a partner’s pain would be more likely to occur and occur with greater intensity (i.e., more pain-related facial expression) in observers who were more satisfied in their relationship and who had less exposure to pain reactions in their partner.

- Hypothesis IX: Relationship satisfaction will predict pain intensity ratings in both partners and the relationship between these two variables will be moderated by the presence of an individual with CP in the couple.
  - Prediction IX: In the current study, it was predicted that pain intensity ratings would be negatively predicted by relationship satisfaction for the individual undergoing the pain task and positively predicted by relationship satisfaction for the partner observing the pain task. The presence of CP in the relationship was expected to moderate the relationship between pain intensity ratings and relationship satisfaction in each partner. For participants completing the task, it was anticipated that the negative association between pain intensity ratings and relationship satisfaction would be stronger in those with CP than in individuals without CP. For partners observing the task, it was anticipated that the positive association between pain intensity ratings and relationship satisfaction would be stronger in partners of individuals without CP than in partners of individuals with CP. This prediction was based on findings that a number of relationship variables influence pain ratings in the individual experiencing pain (McClelland & McCubbin, 2008). It was anticipated that the repeated exposure to pain in individuals with CP would lead to a stronger negative relationship between these variables than in individuals without CP.
In partners observing the pain task, similar to the rationale for the association between relationship satisfaction and pain-related facial expression, observers who report higher levels of pain may be demonstrating better empathy to their partners’ level of pain. It was anticipated that partners who report higher perceived pain ratings would be more satisfied in their relationship and have had less exposure to pain reactions in their partner. This prediction is consistent with previous research findings that the presence of CP negatively affects relationship satisfaction (Flor, Turk et al., 1987) and that habituation may occur as a result of repeated exposure to observing to painful reactions (Prkachin et al., 2004; Prkachin & Rocha, 2010).

- **Hypothesis X**: Perceived relationship support will predict non-verbal pain responses in both partners and the association between these variables will be moderated by the presence of CP in the couple.
  - **Prediction X**: In the current study, it was predicted that pain-related facial activity would be negatively related to perceived relationship support for the individual undergoing the pain task and positively related to perceived relationship support for the partner observing the pain task. The presence of CP in the relationship was expected to moderate the relationship between pain-related facial expression and perceived relationship support in each partner. For participants completing the task, it was anticipated that the negative association between pain-related facial activity and perceived relationship support would be stronger in individuals with CP than in individuals without CP. In partners observing the task, it was anticipated that
the positive association between pain-related facial activity and perceived relationship support would be stronger in partners of individuals without CP than in partners of individuals with CP. The rationale for this prediction was consistent with that for prediction VIII. It was expected that perceived relationship support would function in a similar manner to relationship satisfaction. Specifically, it was anticipated that perceived relationship support would significantly influence non-verbal reactions by both partners and that through habituation processes (Prkachin et al., 2004; Prkachin & Rocha, 2010) different patterns of responding would be observed in couples with and without a partner with CP.

- **Hypothesis XI**: Perceived relationship support will predict pain intensity ratings in both partners and the relationship between these two variables will be moderated by the presence of CP in the couple.
  
  - **Prediction XI**: In the current study, it was predicted that pain intensity ratings would be negatively predicted by perceived relationship support for the individual undergoing the pain task and positively predicted by perceived relationship support in the partner observing the pain task. The presence of CP in the relationship was expected to moderate the relationship between pain intensity ratings and perceived relationship support in each partner. For participants completing the task, it was anticipated that the negative association between pain intensity ratings and perceived relationship support would be stronger in individuals with CP than in individuals without CP. In partners observing the task, it was anticipated that the positive association
between pain intensity ratings and perceived relationship support would be
stronger in partners of individuals without CP than in partners of individuals
with CP. The rationale for this prediction was consistent with that for
hypothesis IX as it was anticipated that various markers of relationship
quality, in this case perceived support, would function in the same manner as
relationship satisfaction.

- **Hypothesis XII:*** Pain catastrophizing about the pain of the partner experiencing pain
  will lead to more non-verbal responses to pain in both partners, and this will occur to
  a greater degree in couples with a CP partner.

  o **Prediction XII:** In the current study, it was predicted that higher levels of pain
catastrophizing in the individual completing the pain task would result in
more pain-related facial expression. In individuals observing the task, higher
levels of catastrophizing about the partners’ pain were predicted to lead to
more pain-related facial expression in the observer. Further, it was predicted
that the presence of CP in the couple would moderate the relationship
between pain catastrophizing and pain-related facial expression, such that the
relationship would be stronger in couples where one partner experiences CP.
This prediction was based on findings that in couples where one partner
experiences CP, greater pain catastrophizing in the individual with CP was
related to increases in pain behaviours in the presence of a partner without CP
(Burns et al., 2015). It was anticipated that the relationship between
catastrophizing and facial expression would be stronger in individuals with
CP as a result of repeated exposure to pain. Although pain catastrophizing in
partners of individuals with CP has only been examined in a limited number of investigations, the relationship between catastrophizing and pain behaviours is well documented in individuals experiencing pain, and it was anticipated that a similar pattern of responding would be seen in the observing partners.

- **Hypothesis XIII:** Pain catastrophizing about the pain of the partner experiencing pain will result in higher pain intensity ratings in both partners and the relationship between these variables will be moderated by the presence of CP in the relationship.
  
  - **Prediction XIII:** In the current study, it was predicted that higher levels of pain catastrophizing in the individual completing the pain task would result in a higher pain intensity rating. In individuals observing the task, higher levels of catastrophizing about their partner's pain was expected to lead to higher perceived pain intensity ratings by the observer. Further, it was predicted that the presence of a CP partner in the couple would moderate the relationship between pain catastrophizing and pain intensity ratings, such that the relationship would be stronger in couples where one partner experiences CP. In individuals completing the pain task, this prediction was based on findings that pain catastrophizing has consistently been reported to predict pain intensity ratings in a number of situations, including in self-report questionnaires (Lefebvre, Lester, & Keefe, 1995; Sullivan, Stanish, Sullivan, & Tripp, 2002), in experimental settings using a cold-pressor task (Sullivan, Rouse, Bishop, & Johnston, 1997), and in pain diaries of daily pain (Burns et al., 2015). It was anticipated that the relationship between catastrophizing and
pain intensity ratings would be strengthened in individuals with CP as a result of repeated experiences with pain. The relationship between pain catastrophizing in observers about their partner’s pain and the observers’ pain ratings of their partner’s pain has not been extensively examined. However, catastrophizing in individuals experiencing pain has been associated with higher pain intensity ratings in observers (Sullivan et al., 2006). It was expected that observers’ catastrophizing about pain in their partner would influence the observers’ ratings of pain while their partner completes the task. It was anticipated that a stronger association between observer catastrophizing and observer pain ratings would occur in couples where one partner has CP.

**Exploratory analyses.** This study was also exploratory, specifically regarding facial expressions of partners of individuals with CP. First, given that the non-verbal behaviours, particularly facial expressions, have rarely been examined in the research on pain in couples, facial expressions that emerged in partners without pain while observing the individual in pain were investigated. Moreover, the potential implications such expressions might have on how pain is experienced in the couple were considered. This provided indications as to how an individual with CP may be encoding pain messages in the context of a couple. It also allowed for conclusions to be made regarding how these encoded messages were decoded by a partner of an individual with CP.

The relationship between empathy of the partner not experiencing pain and various variables such as intensity of facial expression, pain ratings of both partners, and discrepancy ratings of pain between partners were explored. Although no specific
experimental hypotheses were proposed, it was anticipated that a partner’s level of empathy (measured through self-report) would be associated with non-verbal and self-reported pain. Examination of the relationship between empathy and other variables helped provide indications of the role that empathy plays when one person is experiencing pain in the relationship.

In addition, exploratory analyses were conducted to examine whether trends in pain ratings existed over time. Examination of emerging trends provided important information regarding whether partners in pain and partners observing pain demonstrated patterns in their reports of pain intensity (for the individual experiencing pain) and reports of perceived pain intensity (for the individual observing his or her partner in pain). This helped further determine whether the pain experience was influenced by partner responses and whether differences existed between couples with and without a partner with CP.

Lastly, the results of this investigation were examined within the context of the communications model of pain to allow for further validation of this model in the dyadic relationship. This allowed for consideration of whether distinct encoding and decoding processes were occurring in couples with and without a partner with CP. Individual and contextual variables that may have affected self-reported and non-verbal pain responses in couples throughout the pain task were considered within the pain communications framework.

**Method**

**Participants**

Prior to beginning recruitment, ethics approval was obtained from the University
of Regina’s Research Ethics Board. During the course of the recruitment period, ethics approval was also obtained from the Regina Qu’Appelle Health Region. Ethics approval certificates can be found in Appendix A.

Using a matched group experimental design, two groups of heterosexual couples were recruited. All couples were required to have been co-habiting for a minimum of 6 months. The first group, the chronic pain or CP group, consisted of individuals with CP and their partners. Interested individuals were asked to contact the Health Psychology Laboratory at the University of Regina. Subsequently, the partners of the interested individuals were contacted to determine their interest in participating in the study. The second group, the no chronic pain or NCP group, consisted of couples in which neither partner reported chronic pain.

A number of recruitment strategies were used to identify participants. Participants for the CP and the NCP groups were recruited through posters, emails sent to pain-related organizations, newspaper and online advertisement, presentations at community organizations, and word-of-mouth. Couples were offered $40 ($20 per person) as incentive for their participation. Participants recruited for the CP group were individuals and partners of individuals who self-identified as suffering from CP conditions, such as musculoskeletal pain (e.g., low back pain), spine problems (e.g., degenerative disc disease, scoliosis), chronic post-surgical pain, or other CP conditions. Interested individuals for both the CP and NCP groups were excluded based on the following criteria: (1) being under the age of 19; (2) co-habiting for fewer than 6 months; (3) currently experiencing a serious psychiatric condition; (4) suffering from a terminal illness or cancer; (5) expecting a child; (6) and having an internal electrical device, such
as a pacemaker. These criteria were based on the criteria of researchers conducting similar studies of pain in couples (Cano et al., 2000; Cano, Johansen et al., 2004; Cano et al., 2008; R. R. Edwards, Haythornthwaite, Sullivan, & Fillingim, 2004).

A power analysis executed using G*Power (Faul, Erdfelder, Buchaner, & Lang, 2009) indicated that a minimum sample size of 114 couples was required to provide sufficient power for the detection of medium-size effects. This power calculation assumed a 1-beta of .80 and an alpha level (α) of .05. Given that several analyses were conducted, power calculations were completed for each analysis. The analysis requiring the greatest number of participants (multiple regression analysis with 12 total predictors) was used to determine the required number of participants. Participants were actively recruited over a 16-month period. Upon completion of the recruitment period, a total of 195 couples expressed interest in participating. Sixty-four couples either did not meet the study’s eligibility criteria or chose not to participating after learning about the study. The final sample consisted of 131 couples, 66 couples in the CP group and 65 couples in the NCP group.

Measures

**Pre-screen Questionnaire.** To ensure that both partners in a couple were suitable for the study, couples completed a pre-screen (Appendix B). The pre-screen questionnaire was conducted over the phone with each partner. All exclusion criteria were queried in the pre-screen questionnaire.

**Demographic information sheet.** Each partner was asked to complete a demographic information sheet (Appendix C). The demographic information sheet, developed for the purposes of this study, queried age, gender, level of education, average
annual income, ethnic background, and length of time in the relationship. Within the
couples with CP, the partner with CP was asked to list the type of injury or pain
experienced, the location of the pain, the cause of the injury or pain, and the length of
time that pain had been experienced. If the injury was recurrent, then participants were
asked to estimate the total sum of months they have been experiencing CP. The partner
without chronic pain in CP couples and both partners in NCP couples were asked to list
any current or past injuries that they might have experienced.

**Couples Satisfaction Index.** The Couples Satisfaction Index (CSI; Funk &
Rogge, 2007) is a measure of couple satisfaction that was designed in an effort to address
a number of the issues with previous relationship satisfaction measures (e.g., Dyadic
Adjustment Scale, Marital Adjustment Test) and to bring greater precision to assessing
the construct of relationship satisfaction (Funk & Rogge, 2007). The CSI measures
couple’s satisfaction through various queries, such as degree of happiness; agreement or
disagreement in decision making, time spent together, and affection shown; ability to
confide in the partner, willingness to continue the relationship; degree to which needs are
met in the relationship; degree to which one would rate the relationship in terms of
characteristics such as interesting/boring, good/bad, full/empty, etc. The CSI is a 32-item
scale answered on a Likert scale (0 to 5) with anchor values that vary based on the
question. Scores range from 0 to 161, with scores below 104 implying relationship
distress.

The CSI has demonstrated strong internal consistency, with an alpha coefficient
of $\alpha = .98$. It has also been demonstrated to be a valid measure, showing strong
convergent validity with existing measures of relationship satisfaction. The CSI has been
reported as being statistically stronger than other measures of relationship satisfaction, as it was constructed using item response theory (Funk & Rogge, 2007). That is, compared to other measures of relationship satisfaction, modeling of items on the CSI revealed dramatic improvements in the precision (i.e., less measurement error) and greater power to detect differences in relationship satisfaction between groups and across time (Funk & Rogge, 2007). In the current sample, Cronbach’s α was calculated for individuals with and without pain separately. Internal consistency was excellent in the partners identified as having CP (α = .97) and in all other participants (i.e., CP group without chronic pain and NCP group; α = .97).

**Source-Specific Social Provision Scale.** The Source-Specific Social Provision Scale (SS-SPS; Cutrona, 1989) was used to measure perceived relationship support. This measure was developed as an adaptation for the Social Provision Scale, which was originally developed to assess perceived general support for the entire network of an individual. The SS-SPS examines perceived support from specific individuals in the network and has been used in previous research to examine perceived support from romantic partners (Cano et al., 2009). This measure is comprised of 12 items with respondents rating items on a 3-point scale (“no,” “sometimes,” or “yes”). Higher scores correspond with greater perceived support.

The SS-SPS has been shown to have strong internal consistency. Upon initial validation, this measure had a Cronbach’s alpha of .78 for romantic partners. The SS-SPS has subsequently been used in other studies, including studies of pain in couples, and has continued to demonstrate strong internal consistency. In a CP sample, Cano and colleagues (2004) reported a strong inter-item reliability of the full scale of items of .87.
In the current study, Cronbach’s α was strong across participants with CP (α = .77) and across participants without CP (α = .75).

**The Pain Catastrophizing Scale and Pain Catastrophizing Scale – Spouse Version.** The Pain Catastrophizing Scale (PCS; Sullivan et al., 1995) and the spouse version of the Pain Catastrophizing Scale (PCS-S; Cano, Leonard, & Franz, 2005) were administered to each couple. In each couple the partner who would be completing the pain task completed the PCS while the partner who would be observing the pain task completed the PCS-S.

The PCS was developed to measure the degree to which individuals may exaggerate negative cognitions surrounding actual or anticipated painful experiences. Catastrophizing is conceptualized as a multidimensional construct, comprised of rumination, magnification, and helplessness (Sullivan et al., 1995). The PCS evaluates these three facets of catastrophizing through a 13-item scale. Participants are asked to reflect on past pain experiences and rate each question using a 5-point Likert scale (ranging from “not at all” to “all the time”).

The PCS has been extensively used in research across samples with and without pain conditions (e.g., R. R. Edwards et al., 2004; Sullivan, Stanish, Waite, Sullivan, & Tripp, 1998) and has demonstrated strong internal consistency. In his initial validation study, Sullivan reported a coefficient alpha of .87 (Sullivan et al., 1995). Strong temporal stability has also been reported, with test-retest reliability ranging from .75 at 6 weeks to .70 at 10 weeks (Sullivan et al., 1995).

The spouse version of the PCS was developed to examine catastrophizing that occurs in partners without pain regarding their significant other’s pain (Cano et al.,
The PCS-S’s questions parallel the original PCS; catastrophizing is evaluated using a 13-item scale. Participants provide responses to each question using a 5-point Likert scale (ranging from “not at all” to “all the time”). Each question requires the respondents to identify their cognitions regarding their partner’s painful experiences.

The PCS-S has been reported to have strong psychometric properties. In the initial validation scale of the measure, coefficient alpha was reported to be .89 in a sample of spouses of individuals with CP. Similarly, high inter-item reliability has been reported in subsequent CP samples (e.g., Cano et al., 2009).

In the current sample, individuals completing the pain task completed the PCS. Cronbach’s alpha on the PCS in partners identified as having CP was excellent, $\alpha = .95$. In partners without CP Cronbach’s alpha was also robust, $\alpha = .94$. Individuals not completing the pain task completed the PCS-S. Cronbach’s alpha was strong in this group of participants, $\alpha = .91$.

**Interpersonal Reactivity Index.** The Interpersonal Reactivity Index (IRI; Davis, 1980; Davis, 1983) is a self-report measure of empathy that aims to measure dispositional tendencies of empathy. This measure was developed to assess both cognitive empathy and emotional empathy. It is comprised of four subscales, each with 7 items that are answered on a 5-point Likert scale (ranging from “does not describe me well” to “describes me very well”). For the purposes of this study, only the empathic concern (EC) subscale and the perspective taking (PeT) subscales were used. The EC subscale assesses affective components of empathy, and examines the tendency to perceive and respond to distress in others with sympathy and compassion. The PeT subscale assesses the tendency to adopt the psychological point of view of others (Davis,
The IRI is one of the most widely used measures of empathy (Pulos, Elison, & Lennon, 2004) and has demonstrated acceptable internal consistency. In his initial validation of the IRI, Davis (1980) reportalpha values of .68 for men and .73 for women. Since this validation, additional investigations have reported alpha values of .70 to .80 (Cliffordson, 2001; Gilet, Mella, Studer, & Gruhn, 2013). The IRI has demonstrated strong temporal stability, with test-retest coefficients reported as .72 for men and .70 for women (Davis, 1980). In the current sample, Cronbach’s alpha was excellent in the CP group partners identified as having CP for the full scale (α = .89), the EC subscale (α = .79), and the PeT scale (α = .86). For all participants without CP (i.e., partners in the CP group without pain and all partners in the NCP group), Cronbach’s alpha was .83 for the full scale and .77 and .81 for the EC and PeT subscales, respectively.

Marlowe-Crowne Social Desirability Scale – Short Form. A short form of the Marlowe-Crowne Social Desirability Scale (MC-10; Crowne & Marlowe, 1960; Strahan & Gerbasi, 1972) was used to control for the influence of socially desirable behaviours and responses. The original form of this measure comprised 33 true/false items describing socially desirable behaviours that have a low probability of occurring (Crowne & Marlowe, 1960). Short forms of this measure have been developed to improve homogeneity and decrease test-taking time. The MC-10, developed by Strahan and Gerbasi (1972), is comprised of 10 true or false items. It has been assessed as being among the strongest of the various short forms of the Marlowe-Crowne Social Desirability Scale (Fischer & Fick, 1993). The MC-10 has been shown to have good internal consistency, with reported reliability coefficients of .70 and .66 in university
men and women, respectively. This measure remains highly correlated with the original form of the Marlowe-Crowne Social Desirability Scale \((r = .96; \text{Strahan} \& \text{Gerbasi}, 1972)\). For the current sample, in the CP group Cronbach’s alpha was .72. In all other participants, Cronbach’s alpha was acceptable at .65.

**Numeric rating scale.** The numeric rating scale (NRS; Appendix D) was used to measure subjective experience of pain intensity. A 101-point numeric rating scale was completed by each participant at several intervals throughout the pain task. As only one person in each couple completed the pain task while the other observed, completion of this measure differed for each partner. The partner undergoing the pain task completed the NRS based on his or her own experience by rating pain throughout the task from 0 to 100, with 0 representing “no pain” and 100 representing “pain as bad as it can be” (Jensen & Karoly, 2011). Conversely, the observing partner used the NRS to rate his or her perception of the pain experienced by the partner completing the task, using the same 0 to 100 scale.

The NRS has been found to be a valid measure of pain intensity, and has been reported as being positively and significantly associated with other measures of pain intensity (Jensen & Karoly, 2011; Strong, Ashton, & Chant, 1991). In a study comparing eight pain intensity measures, the NRS was among the top two measures in terms of fewest incorrect responses and the highest loading on a pain intensity factor (Strong et al., 1991). Similarly, in a study comparing six different subjective measures of pain intensity, including the NRS, the 101-point NRS appeared to be the most practical index. The NRS was the most sensitive index to small changes in pain intensity and had the greatest relationship with other pain intensity indices (Jensen, Karoly, & Braver, 1986).
Equipment and Materials

The thermal pain stimulator. The thermal pain stimulator (TPS) is a system that allows for administration of cold or heat stimulus in a programmable and precise manner. Both heat and cold can be used to simulate the pain experience. The TPS used in this investigation was developed by the Medoc Pathway Pain and Sensory Evaluation System, ATS model (Medoc Advanced Medical Systems Ltd, Ramat Yishay, Israel). Temperatures between 0°C and 53°C at a rate of increase of up to 8°C per second can be precisely produced through a thermode that is placed on the skin. The thermode is a flat, rectangular surface that is approximately 30mm by 30mm square. The TPS has been reliably used as a measure of pain induction (Thibodeau et al., 2013) and has the advantage of providing more precise pain stimuli. For each participating couple, the thermode was placed on the anterior antecubital region (inner forearm) of the non-dominant hand of one of the partners. The partners then completed a baseline, threshold, tolerance, and trial task (described below).

Video recording materials. Two webcams were used to video-record facial expressions throughout the pain induction tasks. Cameras were positioned such that each partner’s facial expressions were recorded during the task. The researcher controlled the cameras from a laptop, which allowed for the two recordings to be started and stopped simultaneously, allowing for complete synchronization of the two videos.

Facial Coding. Two separate coding systems were used to examine facial expressions of partners throughout the pain procedure, the Facial Action Coding System (FACS; Ekman & Friesen, 1978; Ekman, Friesen, & Hager, 2002a), and the FaceReader system (Den Uyl & van Kuilenburg, 2005) which is based on the FACS. The FACS
categorizes facial behaviours based on the muscles that produce them. It examines
discrete muscle movements, or action units (AUs), which correspond to one of 41
discrete facial actions and head movements.

As the foundation for these two systems, the FACS is well validated and shows
excellent inter-rater reliability (Sayette, Cohn, Wertz, Perrott, & Parrott, 2001). Validity
of the FACS has also been investigated and found to be good. Concurrent validity has
been established by examining electrical activity (Ekman, Schwartz, & Friesen, 1978),
computer simulation (Massaro, Cohen, Beskow, Daniel, & Cole, 1998; Parke & Waters,
1996), and performed actions (Kanada, Cohn, & Tian, 2000). These examinations have
suggested that FACS scoring can accurately distinguish the type and intensity of an
action. Stability over time (i.e., similar intensity and frequency of AUs in parallel
situations over time) has also been reported for FACS coding. Over a four-month
interval, Cohn and colleagues (2002) found moderate to strong stability, and person
recognition from FACS AUs was on par with recognition from a leading face
recognition algorithm (Cohn, Schmidt, Gross, & Ekman, 2002). The FACS can easily
distinguish between pain and non-pain states (Craig et al., 2011).

**Core pain-related AUs.** As research using the FACS during painful stimuli has
increased, investigators have identified a core set of AUs that correspond to a pain
expression (Craig et al., 2011). The facial actions of brow lowering, orbit tightening,
levator tightening, and closing of the eyes are among those consistently identified. These
four facial actions can be derived from six AUs: brow lowering (AU 4), cheek raising
and lid compression (AU 6), lid tightening (AU 7), nose wrinkling (AU 9), upper lip
raising (AU 10), and eye closure (AU 43). Given the labour-intensive nature of coding
using the full FACS, researchers have argued that relying on these six AUs to identify pain expressions is sufficient (Prkachin, 1992; Prkachin & Solomon, 2008).

When isolating only the six AUs listed above in a sample of individuals with shoulder injuries, obvious and significant increases in these AUs were visible across participants during manipulation of the injured shoulder (Prkachin & Solomon, 2008). Across testing occasions in the same participants, the reliance on only these six AUs has been shown to have good test-retest reliability, with Pearson correlations of .74 over a 20-minute retest period (Prkachin & Solomon, 2008) and .71 over a three-day retest period (Prkachin et al., 2002).

Given the focus on pain in the current study, the 6-AUS approach was used. The 6 AU approach codes four components. AUs 6 and 7 are collapse into a single component as are AU 9 and 10, given the overlap observed between these AUs (Prkachin & Solomon, 2008). An intensity score ranging from 1 to 5 is provided for AUs 4, AUs 6/7, and AUs 9/10, based on the degree of movement observed. AU 43 is coded as either present (1) or absent (0). A total intensity score can be calculated based on the sum of the AUs in a specific period.

**FaceReader.** The FaceReader is a program developed by Noldus Information Technology. The system, based on Ekman and Friesen’s FACS (1978; 2002a), recognizes 20 commonly used AUs, which in turn allows the program to distinguish six basic emotions – happy, angry, sad, surprised, scared, disgusted – as well as neutral faces. The FaceReader has been reported to accurately identify facial expressions at a rate of 89% (Den Uyl & van Kuilenburg, 2005).

**Procedure**
Upon expressing interest in the study, couples completed a pre-screening by phone to ensure that they did not meet any of the study’s exclusion criteria. Both members of the dyad independently completed the pre-screening with the researcher. Couples that were eligible to participate selected a time to complete the experiment at the Health Psychology Laboratory.

Upon arrival at the Health Psychology Laboratory, the goals and procedures of the study were outlined to the couples. In particular, participants were informed of the purpose of the study, reminded of the nature of the pain task, and reminded that video recording would occur throughout the task. Prior to participating, each partner was required to indicate that the study had been explained and that they were providing their informed consent to participate (see Appendix E).

For each couple, one partner was identified as the pain observer (PO) and the other as the pain target (PT). The PT completed the experimentally-induced pain task while the PO observed the PT completing the task. In the CP group, the individual with CP was automatically assigned to be the PT. If both partners reported CP, the partner evaluated by both partners as having the most severe or disabling pain was identified as the PT. To ensure that an equivalent number of men and women were completing the task as the PT in each group, an effort was made to match the PO and PT selection for the NCP group based on gender in the CP group. Therefore, each time an NCP couple participated, PT assignment was determined based on the gender of the PT in the previous CP couple. Participants who were chosen to be the PT were asked to provide additional confirmation that they are amenable to completing the pain induction task.

Once both partners had agreed to participate in the study and the PT had been
determined (for the NCP group), each partner was asked to complete independently the Demographic Information Sheet and all study questionnaires (i.e., CSI, SS-SPS, PCS/PSC-S, IRI, and MC-10). Upon completion of the measures, the couple was brought to the pain task area, and the experiment was explained.

**Pain task protocol.** Partners were seated on chairs facing each other, knee to knee at approximately 10 to 20 centimetres distance. The TPS was secured to the PT’s non-dominant hand. A table was placed beside the participants, with the tabletop hidden from the other partner by a small divider placed on the table. This allowed participants to provide pain ratings and perceived pain ratings without one partner seeing the other partner’s responses. One camera was placed beside and slightly behind the head of the PT facing the PO so as to capture the PO’s facial expressions throughout the task. Similarly, the second camera was placed beside and slightly behind the head of the PO so as to capture the PT’s facial expressions throughout the pain induction task.

Through the use of standardized instructions, the researcher explained to the couple the NRS (Appendix F) as well as the different tasks involved during the pain procedure, which included: (1) the baseline period (Appendix G); (2) the threshold task (Appendix H); (3) the tolerance task (Appendix I); (4) the pain trial task (Appendix J). To keep the procedure as simple as possible for participants, instructions were provided before each task.

After securing the TPS on the PT’s arm, the participants were provided a description of the NRS and how to provide a pain rating using the NRS. The PT was instructed that he or she would be asked to provide a rating of his or her own pain throughout the various tasks using the NRS. The PO was instructed that he or she would
be reporting his or her perception of the PT’s pain, throughout the various tasks, using the NRS. A practice rating was then completed to ensure that each partner understood how to complete the scale.

Next, the couple completed the 4-minute baseline period. The couple was instructed to look straight into the camera placed behind the other partner’s shoulder for the 4-minute baseline. They were asked to keep their facial expression as neutral as possible and to refrain from talking to their partner throughout the task. At the end of the four minutes, participants were asked to provide a rating of the PT’s level of pain using the NRS.

Following the baseline, the PT was given the release trigger and shown how to stop the administration of the painful stimuli at any point using the release trigger. The participants were also instructed that from this point forward they could speak to each other and that there were no restrictions in terms of what they talked about (i.e., they could talk about the pain task or about topics unrelated to the pain task, should they wish).

The pain threshold task was then explained to the couple. Pain threshold was assessed with the thermode set at a baseline of 32°C. The temperature was increased at a rate of 0.5°C per second. The PT was advised that the thermode would begin to heat and that once he or she first began to feel the sensation of pain, he or she was to push the release trigger, which would automatically decrease the heat (Hampton et al., 2015; Keefe, Lefebvre, Maixner, Salley, & Caldwell, 1997; Thibodeau et al., 2013). The PO was instructed to observe the PT throughout the threshold task.

Upon completion of the threshold task, the pain tolerance task was explained to
the partners. Once again, the thermal pain stimulator was set to a baseline temperature of 32°C. The temperature was increased at a rate of 0.5°C per second. This time, the PT was instructed to let the thermode heat up until it became intolerable (to a maximum of 51°C), at which point he or she should push the trigger, which would automatically decrease the heat (Hampton et al., 2015; Keefe et al., 1997; Thibodeau et al., 2013). The PO was again instructed to observe the PT throughout the tolerance task.

Lastly, the pain trial task was explained to the couple. The couple was instructed that the thermode would heat up, hold a temperature, and cool down 5 times. Each time just prior to cooling down, the researcher would say the word “report” indicating to the couple that they should provide a rating of the PT’s pain using the NRS. Partners were reminded that they could talk (or not talk) about whatever they wished throughout the task. Prior to beginning the task, participants were reminded to look back towards their partner after writing down their rating in order to maximize the cameras’ ability to capture facial expressions throughout the trial task. In the current study, the thermode temperature was consistently increased and held at a temperature of 47°C. This temperature has previously been used without incident in pain induction research (Hampton et al., 2015). The trial task lasted approximately 4 minutes.

**Video editing and analyses.** The videos of each couple’s facial expressions throughout the pain protocol were edited to be coded using the FACS and analyzed using the FaceReader. Consistent with previous research, videos were edited to reflect segments most likely to contain facial responses to pain (Hampton et al., 2015). In a procedure similar to that used by Sullivan and colleagues (2006) and Hampton and colleagues (2015), segments were edited into 10-second clips, resulting in a total of 6
clips (i.e., baseline and 5 clips during the trial task) for each participant. The baseline segment consisted of the final 10 seconds of the baseline period. The trial task segments were created using the 5 seconds before the peak of thermal intensity and the first 5 seconds during which the maximum intensity was held. This resulted in a 10-second segment for each peak of the trial task. The same time period was used for the PT and PO clips for each partner, resulting in segments from corresponding time periods for each partner. The segments were then randomized into 3 blocks each consisting of one third of the couples and analysed using the two facial coding systems.

**FACS coding.** A trained FACS coder who had passed the qualifying examination prepared by the FACS developers coded each 10-second video clip, blind to the participants’ group (i.e., CP or NCP) and assignment (i.e., PT or PO). The pain-related FACS system results in a global pain score for a facial expression, based on the presence and frequency of the 4 pain-related AUs. Thus, if participants made several facial expressions throughout the segment, then more than one pain score could be calculated. In order to have only one pain score per clip reflective of the maximal pain expression, a video annotation program (ELAN; Wittenburg, Brugman, Russel, Klassman, & Sloetjes, 2006) was used to assist with the coding. This program allowed coders to timestamp each expression at its peak intensity. Subsequently, the expression with the highest global pain score was identified for use in the analyses.

A second trained FACS coder coded a random 15% of segments from each of the three blocks to establish inter-rater reliability (Lints-Martindale et al., 2007). To calculate inter-rater reliability, a correlation was calculated between the global pain scores for each segment coded by the second coder and the primary coder’s rating (i.e.,
correlation of global pain score for 15% of the sample). To ensure that the same expression was being used within a segment, the timestamps were compared and the facial expression in question was considered to be the same if it was within .5 seconds of the primary coder’s highest rated expression. In cases where coders disagreed on the highest expression, the expression considered as highest by the primary coder was used. There was a strong positive correlation between coder one and coder two ratings on the videos, \( r = .81, n= 234, p < .001 \), suggesting good reliability of the FACS coding completed in the study. Following coding, a global trial task FACS score was calculated by averaging the FACS score on each of the 5 trials.

**FaceReader analyses.** The same six segments for each participant were also analysed with the FaceReader program. FaceReader allows for a global facial analysis to be calculated for each segment. Therefore, for each segment, a total percent of each emotion (i.e., neutral, happy, sad, angry, surprised, disgusted, scared, other) was reported. A total average score for each emotion expressed was calculated for each participant by averaging the frequency of each emotion across the 5 trial task segments.

In order for the FaceReader analyses to be completed, optimal video recording conditions are often required. In cases where shadows are cast on a participant’s face or a participant turns his or her head away from the camera, the program is unable to analyze facial expression. As a result, not all segments were analysable for each participant. In cases where missing data occurred, the total average score was calculated if 4 of the 5 trial results were available.

**Data Preparation and Statistical Analyses with Dyadic Data**

Data were verified for entry errors by randomly checking 10% of cases. Missing
data were handled through person mean replacement; in cases of missing items on a measure, the individual’s mean score on that measure was used when less than 20% of data for the measure was missing. The person mean replacement approach has been identified as appropriate approach to missing data when fewer than 20% of respondents have missing data and fewer than 20% of items are missing (Downey & King, 1998).

Given the dyadic nature of the data, a database in which entry was based on a dyad structure was used. Each entry accounted for one couple. For each dyad, a score on every variable was entered for each partner within the single record. Dyadic data presents a unique challenge to statistical analyses. The very nature of the relationship between participants (i.e., married couples) is one of interdependence, which violates the assumption of independence that is integral to many statistical analyses (Tabachnick & Fidell, 2007). To address this issue in the current study, mixed effects models were employed. Mixed effects models use both fixed effects and random effects within the same model. The fixed effects represent the effects of factors of interest while the random effects capture the correlated measurement occurring within units or subjects (Seltman, 2009). In the current study, the random effect of the mixed model captured the interdependence between dyads and takes this into account.

For the analyses of the current study, interdependence emerged as an issue in predictions that included variables for both members of the dyad, as was the case for predictions VIII through XIII, as well as for several of the exploratory analyses. For these analyses, analysis of variance (ANOVA) and multiple regression analyses that incorporated mixed effects were employed. The interdependence between partners was taken into account by the random effects of the models. Moreover, interdependence is
not an issue in the regression analyses by only having dependent variables for one member of the dyad in each analysis, despite having independent variables for both partners.

For the remaining predictions (i.e., predictions I through VII) and exploratory analyses, non-independence was not identified as a concern. The remaining analyses either relied on difference scores calculated between partners or only examined variables and outcomes for one member of the dyad. Consequently, interdependence issues that emerge when variables from both members of the dyad were included in the model were not a concern. In such cases, t-tests or ANOVAs were employed.

Given that variables exists for each member of the dyad, throughout the results below, variable names will be preceded by the participant assignment to allow for differentiation between members of the dyads. For instance, the Couple Satisfaction Index scores for the pain observer and pain target will be referred to as PO CSI and PT CSI, respectively.

**Results**

**Demographic Characteristics**

A total of 262 individuals (131 dyads) completed the study. Demographic characteristics of couples with and without chronic pain are discussed separately below. Full sample and group characteristics are summarized in Table 1.

**CP group characteristics.** A total of 66 couples where one partner reported CP participated in the study. In 39 couples (59%), the woman was identified as the partner with CP. Members of the couples ranged in age from 22 years to 84 years of age, with a mean age across couples of 50.69 (SD = 13.78). Average length of relationship, based on
### Table 1

**Participant Demographic Characteristics**

<table>
<thead>
<tr>
<th>Variable</th>
<th>Overall sample (N=262)</th>
<th>CP group (n=132)</th>
<th>NCP group (n=130)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>43.57 (15.60)</td>
<td>50.69 (13.78)</td>
<td>46.42 (17.04)</td>
</tr>
<tr>
<td><strong>Gender</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Men</td>
<td>131</td>
<td>66</td>
<td>65</td>
</tr>
<tr>
<td>Women</td>
<td>131</td>
<td>66</td>
<td>65</td>
</tr>
<tr>
<td>$M$ length of relationship (years)</td>
<td>20.47 (16.08)</td>
<td>20.53 (15.93)*</td>
<td>20.41 (16.36)**</td>
</tr>
<tr>
<td>$M$ time living together (years)</td>
<td>19.33 (15.99)</td>
<td>19.17 (15.72)*</td>
<td>19.49 (16.38)**</td>
</tr>
<tr>
<td>Years education</td>
<td>16.12 (3.30)</td>
<td>15.58 (3.52)</td>
<td>16.67 (2.97)</td>
</tr>
<tr>
<td><strong>Net Income</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt; $20,000</td>
<td>14 (5.3%)</td>
<td>9 (6.8%)</td>
<td>5 (3.8%)</td>
</tr>
<tr>
<td>$20,000 to $39,999</td>
<td>17 (6.5%)</td>
<td>7 (5.3%)</td>
<td>10 (7.7%)</td>
</tr>
<tr>
<td>$40,000 to $69,999</td>
<td>37 (14.1%)</td>
<td>21 (15.9%)</td>
<td>16 (12.3%)</td>
</tr>
<tr>
<td>$70,000 to $89,999</td>
<td>32 (12.2%)</td>
<td>16 (12.1%)</td>
<td>16 (12.3%)</td>
</tr>
<tr>
<td>$90,000 +</td>
<td>125 (47.7%)</td>
<td>58 (43.9%)</td>
<td>67 (51.5%)</td>
</tr>
<tr>
<td>Prefer not to disclose</td>
<td>37 (14.1%)</td>
<td>21 (15.9%)</td>
<td>16 (12.3%)</td>
</tr>
</tbody>
</table>

* $n = 66$
** $n = 65$
the average length reported between couples, was 20.53 years ($SD = 15.93$, Range = 1.5-65). The average years living together, based on the average length reported by couples, was 19.2 years ($SD = 15.72$, Range = .79-63.50). Number of years of education ranged from 8 to 26 years ($M = 15.58$, $SD = 3.52$). Income composition was 6.8% making <$20,000; 5.3% making from $20,000 to $39,999; 15.9% making from $40,000 to $69,999; 12.1% making from $70,000 to $89,999; 43.9% making $90,000 and over; and 15.9% choosing not to disclose. Among individuals reporting CP and assigned to the pain task in the CP group, the average pain duration was 127.23 months ($SD = 131.40$, Range = 8-588 months).

**NCP group characteristics.** A total of 65 couples participated where neither partner reported CP. Of these couples, 34 women (52%) completed the pain task. The average age of participants was 46.4 ($SD = 17.04$, Range = 20-84). Average length of relationship reported by couples in the NCP group was 20.42 years ($SD = 16.36$, Range = .92-60.50). The average length of time couples reported living together was 19.49 years ($SD = 16.38$, Range = .5-60). The average level of education reported across couples was 16.67 years (2.50, Range = 9.50-23.50). Across participants in the NCP group, 3.8% reported an annual income of <$20,000; 7.7% reported an income from $20,000 to $39,999; 12.3% reported an income from $40,000 to $69,999; 12.3% reported an income from $70,000 to $89,999; 51.5% reported making $90,000 and over; and 12.3% chose not to respond.

**Group comparisons.** Participants in the CP and NCP were compared on all demographic variables. Age and years of education were compared using independent samples $t$-tests. A significant difference was found between the NCP ($M = 46.42$, $SD =$
17.04) and CP ($M= 50.69, SD = 13.78$) group for age, $t(247.57) = -2.23, p = .03$, two-tailed. A significant difference was also identified between the NCP ($M=16.67, SD=2.97$) and CP ($M=15.59, SD=3.42$) group for years of education, $t(260) = 2.72, p<.01$, two-tailed. There were no significant differences between groups with respect to average length of relationship, $t(129)= -.04, p=.97$, two tailed; or average years living together, $t(129) = .114, p=.97$, two tailed. A Chi-square test for independence was used to identify whether groups differed in terms of the categorical variable of income. No significant difference in income ($p = .57$) was found between the CP and NCP group. As a result of the group comparisons, variables where significant differences were identified were controlled for throughout the analyses. Full sample and group means for each variable are summarized in Table 2.

**Prediction Testing**

Each prediction was tested using analysis of variance (ANOVA), analysis of covariance (ANCOVA), or multiple regression approaches. Prior to each analysis, the statistical assumptions were examined to ensure that no violations occurred. In instances where violations of normality occurred, data were transformed and analyses were conducted both with and without transformed variables in order to determine if transformed variables led to improvements in normality and statistical significance of results. Concerns with normality were identified for certain variables through examination of histograms and residual plots. In all instances of non-normal data, transformations did not lead to improvements in normality and no differences were found in the analyses result. Consequently, non-transformed results were used for each interpretation. Sixteen analyses were used to assess the 13 study predictions. Instances where one analysis addresses more than one prediction are noted below.
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<thead>
<tr>
<th>Variables</th>
<th>NCP</th>
<th>CP</th>
<th>Full Sample</th>
</tr>
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<tbody>
<tr>
<td></td>
<td>PO $M$ (SD)</td>
<td>PT $M$ (SD)</td>
<td>PO $M$ (SD)</td>
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<tr>
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<td>SS-SPS</td>
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<td>20.43 (3.13)</td>
<td>19.57 (3.30)</td>
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<tr>
<td>PCS/PCS-S</td>
<td>16.15 (8.74)</td>
<td>12.29 (9.45)</td>
<td>22.01 (8.94)</td>
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<tr>
<td>IRI-PeT</td>
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<td>19.06 (4.59)</td>
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<tr>
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<td>48.02 (20.13)</td>
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<td>$M$ FACS</td>
<td>1.08 (1.17)</td>
<td>1.39 (1.36)</td>
<td>.99 (1.16)</td>
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</tbody>
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*Note.* NCP = No Chronic Pain Group; CP = Chronic Pain Group; PO = Pain Observer; PT = Pain Target; CSI = Couples Satisfaction Index; SS-SPS = Source-Specific Social Provision Scale; PCS = Pain Catastrophizing Scale; PCS-S = Pain Catastrophizing Scale – Spouse Version; IRI-EC = Interpersonal Reactivity Index – Empathic Concern; IRI-PeT = Interpersonal Reactivity Index – Perspective Taking; MC-10 = Marlowe-Crowne Social Desirability Scale – Short Form; NRS = Numeric Rating Scale; FACS = Pain-Related Facial Action Coding System Score.
**Prediction I.** It was predicted that couples in the CP group would be more inconsistent (with each other) in NRS reports during the task than couples in the NCP group. Initial examination of means (see Table 2) pointed to higher average NRS scores in the CP group than in the NCP group. These means indicated that further exploration of this prediction was warranted.

A two-way repeated measures ANOVA was conducted to examine whether group membership (i.e., CP or NCP) influenced agreement in pain ratings throughout the pain task. NRS scores for POs and PTs were compared between the CP group and the NCP group. The interaction effect between NRS scores and group was not significant, $F(1, 129) = .33, p = .57$. The main effect of group was also not significant, $F(1,129) = 2.30, p = .13$, suggesting that those in the CP and NCP group reported similar NRS scores. The main effect of NRS score across assignment (PO or PT) was significant, $F(1,129) = 30.50, p < .001$. This main effect suggested that PTs and POs significantly differed in NRS ratings (see Figure 1). POs had consistently lower NRS ratings ($M = 44.85, SD = 1.80$) than PTs ($M = 56.61, SD = 2.18$). Although PTs reported consistently higher NRS scores, given that there was not more discrepancy in scores between PTs and POs in the CP group compared to the NCP group, prediction I was not confirmed.

**Predictions II and III.** According to predictions II and III, group membership (prediction II) and gender (prediction III) would impact pain intensity ratings in those completing the pain task. It was anticipated that women PTs in the CP group would report higher NRS scores than men in the CP group, and higher NRS scores than either partner in the NCP group. Given the higher means in the PT group (see Table 2) as well as higher means among women in both groups (see Table 3), further consideration of the
Figure 1. Group and assignment comparison on average NRS scores. NCP = No Chronic Pain; CP = Chronic Pain; NRS = Numeric Rating Scale; PO = Pain Observer; PT = Pain Target.
Table 3

*Means and Standard Deviations for Variables Used in the Analyses Divided by Gender and Assignment*

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<td>Women M (SD)</td>
<td>Men M (SD)</td>
<td>Women M (SD)</td>
<td>Men M (SD)</td>
<td>Women M (SD)</td>
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<tr>
<td>MC-10</td>
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<td>1.01 (1.16)</td>
<td>1.47 (1.51)</td>
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</tbody>
</table>

*Note.* NCP = No Chronic Pain Group; CP = Chronic Pain Group; PO = Pain Observer; PT = Pain Target; CSI = Couples Satisfaction Index; SS-SPS = Source-Specific Social Provision Scale; PCS = Pain Catastrophizing Scale; PCS-S = Pain Catastrophizing Scale – Spouse Version; IRI-EC = Interpersonal Reactivity Index – Empathic Concern; IRI-PT = Interpersonal Reactivity Index – Perspective Taking; MC-10 = Marlowe-Crowne Social Desirability Scale – Short Form; NRS = Numeric Rating Scale; FACS = Pain-Related Facial Action Coding System Score.
A two-way between-groups ANOVA was used to examine the influence of group membership (CP or NCP) and gender (man or woman) on PT pain intensity ratings. Group membership (i.e., CP or NCP) and gender of the PT were used as the independent variables. Average NRS score across the 5 trials was used as the dependent variable. The interaction between group membership and gender was not statistically significant, $F(1, 127) = .97, p = .33$. The main effect for group membership was not significant, $F(1, 127) = .39, p = .54$, contrary to prediction II. A statistically significant main effect for gender occurred $F(1, 127) = 6.42, p = .01$, which demonstrated a small to medium effect size (partial eta squared = .05). As predicted in prediction III, PTs who were women reported significantly higher average pain intensity ratings on the NRS ($M = 61.54, SD = 23.93$) than PTs who were men ($M = 50.43, SD = 24.98$). Figure 2 highlights the results of this analysis.

**Predictions IV and V.** Predictions IV and V examined the impact of group membership (prediction IV) and gender (prediction V) on the pain intensity ratings of the PO. It was predicted that POs in the CP group would perceive a lower intensity of pain experienced by the PT during the pain task compared to POs in the NCP group. It was also anticipated that the men’s NRS ratings of men would be lower than the women’s NRS ratings among POs. Examination of means identified higher ratings on the NRS among POs in the CP group (see Table 2); however, higher means were found among men POs than women POs (see Table 3). Based on these means, prediction IV warranted further examination, but prediction V was not supported and the role of gender in PO pain ratings became exploratory.
Figure 2. Average NRS score in PTs by gender and by group. NCP = No Chronic Pain; CP = Chronic Pain; NRS = Numeric Rating Scale; PT = Pain Target.
A two-way between-groups ANOVA was used to examine the impact of group membership (CP or NCP) and gender (man or woman) on average PO pain intensity ratings using the NRS. Only POs were used in this analysis. Group membership and gender were used as the independent variables and average NRS rating across the 5 trials was used as the dependent variable. The interaction between PO group membership and PO gender was not statistically significant, $F(1, 127) = .53, p = .47$. Contrary to what was predicted, the main effect for group membership was not statistically significant, $F(1, 127) = 2.52, p = .12$, nor was the main effect for gender, $F(1, 127) = 1.32, p = .25$.

**Predictions VI and VII.** Predictions VI and VII related to the impact of group membership (prediction VI) and gender (prediction VII) on pain-related facial activity in those completing the task. It was predicted that women PTs would have more pain-related facial activity than men PTs and, that among women PTs, those in the CP group would display more pain-related facial activity than women in the NCP group. Initial examination of means indicated higher pain-related FACS scores among PTs in the CP group compared to PTs in the NCP group (see Table 2), and higher pain-related FACS scores among women PTs compared to men PTs (see Table 3). Consequently, further examination of these predictions was warranted.

A two-by-two between-groups analysis of covariance (ANCOVA) was conducted to test predictions VI and VII. Group (CP or NCP) and gender (man or woman) were entered as the independent variables. Average pain-related FACS score was entered as the dependent variable. Age was entered as a covariate as this variable was found to correlate with the dependent variable. After controlling for the influence of age, there was no significant interaction effect, $F(1,124) = 0.02, p = .90$. The main effect of group
was not significant, $F(1,124) = .64$, $p = .43$, contrary to what was anticipated in prediction VI. The main effect of gender was statistically significant, $F(1,124) = 5.13$, $p = .03$, with partial $\eta^2 = .04$. Confirming prediction VII, adjusted marginal means, shown in Figure 3 demonstrated that women displayed more pain-related facial activity during the pain task than men when controlling for the influence of age.

**Influence of relationship and catastrophizing variables on pain-related FACS scores and NRS scores.** Predictions VIII through XIII related to predictors of pain-related facial activity and numeric ratings of pain in both partners. Relationship variables, including satisfaction and perceived support, as well as pain catastrophizing were the primary predictors of interest. Interactions among predictors of interest, gender, and group were also examined.

Given the number of predictors involved in each analysis, the variables in question – couple satisfaction (CSI), perceived relationship support (SS-SPS), and pain catastrophizing (PCS/PCS-S) – were examined in separate regression models. This approached allowed for the control of demographic variables and for interactions to be examined for each of the three predictors without overparameterizing the models. To account for the increased risk of Type I error due to multiple comparisons, Bonferroni’s correction was used to adjust the $p$ value that would be considered as statistically significant. Twelve analyses were conducted resulting in a Bonferroni adjusted level of .004 (i.e., .05/12).

In the following analyses, pain-related FACS scores were used as the dependent variable for predictions VIII, X, XII, while NRS scores were the dependent variable for predictions IX, XI, and XIII. The influence of both partners’ predictor variables was
Figure 3. Average pain-related FACS score in PTs by gender and by group. NCP = No Chronic Pain; CP = Chronic Pain; FACS = Pain-Related Facial Action Coding System Score; PT = Pain Target. Covariates appearing in the model are evaluated at the following values: age PT = 48.16.
considered, and both partners’ outcome variables were also of interest. Consequently, given that pain-related FACS scores and NRS scores were available for both partners, initial analyses were conducted using multivariate regression, in which two dependent variables (one for each partner) were entered in the model. However, this approach resulted in severe multicollinearity within the predictor variables. To address this issue, univariate regressions were employed. This approach allowed for a determination of the influence of each partner on a specific partner’s pain-related FACS score or NRS score, while reducing the multicollinearity. Therefore, each prediction was examined using two analyses: the first employing the PT dependent variable and the second the PO dependent variable. Any remaining multicollinearity was examined on an analysis-by-analysis basis to decide whether variables should be dropped. Predictor variables were centred around the mean to further address issues of multicollinearity that occur with interaction terms (Tabachnick & Fidell, 2007).

The intercorrelations among variables included in predictions VIII through XIII are presented in Tables 4 and 5. Table 4 summarizes intercorrelations for variables used in regression analyses focusing on PT outcomes. Table 5 summarizes intercorrelations among variables used for regression analyses examining PO outcomes.

**Prediction VIII.** Prediction VIII related to the influence of relationship satisfaction (CSI) on pain-related facial activity. It was predicted that pain-related facial activity would be negatively predicted by CSI in PTs and positively predicted by CSI in POs. It was also predicted that the relationship between these variables would be stronger among PTs in the CP group than in the NCP group, and stronger among POs in the NCP group than in the CP group.
Table 4

*Correlation Matrix for Variables Used in Regression Equations Predicting PT NRS Scores and Pain-Related FACS Scores*

<table>
<thead>
<tr>
<th>Variables</th>
<th>PT Age</th>
<th>PT Years</th>
<th>Group</th>
<th>PT Gender</th>
<th>PT MC-10</th>
<th>PO CSI</th>
<th>PT CSI</th>
<th>PO SS-SPS</th>
<th>PT SS-SPS</th>
<th>PO PCS</th>
<th>PT PCS</th>
<th>PO FACS</th>
<th>PT FACS</th>
<th>PT NRS</th>
</tr>
</thead>
<tbody>
<tr>
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*Note.* PT = Pain Target; PO = Pain Observer; Years PT= Years Living Together as Reported by PT; MC-10 = Marlowe-Crowne
Social Desirability Scale – Short Form; CSI = Couples Satisfaction Index; SS-SPS = Source-Specific Social Provision Scale; PCS = Pain Catastrophizing Scale (PT PCS)/Pain Catastrophizing Scale – Spouse Version (PO PCS); FACS = Pain-Related Facial Action Coding System Score; NRS = Numeric Rating Scale.

*p ≤ .05; **p ≤ .01
Table 5

*Correlation Matrix for Variables Used in Regression Equations Predicting PO NRS Scores and Pain-Related FACS Scores*

<table>
<thead>
<tr>
<th>Variables</th>
<th>PO Years</th>
<th>Group</th>
<th>PO Gender</th>
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<th>PT CSI</th>
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</table>

*Note.* PT = Pain Target; PO = Pain Observer; Years PO= Years Living Together as Reported by PT; MC-10 = Marlowe-Crowne
Social Desirability Scale – Short Form; CSI = Couples Satisfaction Index; SS-SPS = Source-Specific Social Provision Scale; PCS = Pain Catastrophizing Scale (PT PCS)/Pain Catastrophizing Scale – Spouse Version (PO PCS); FACS = Pain-Related Facial Action Coding System Score; NRS = Numeric Rating Scale.

*p ≤ .05; **p ≤ .01
Two hierarchical regressions analyses were used for this prediction. The regressions aimed to examine the ability of satisfaction (CSI) to predict pain-related FACS scores over and above the influence of the opposite partners’ pain-related FACS scores, as well as gender and group membership, after controlling for the influences of age, duration of relationship, and social desirability factors. An examination of VIF and tolerance statistics, as well as an examination of the variance proportion of each regression coefficient across the eigenvalues suggested minor multicollinearity between PO CSI and PT CSI. The PO CSI and the interaction between PO CSI x Group was dropped from the equation to examine the impact on the model. No differences in the regression model results or improvements in multicollinearity were observed based on the elimination of these predictors. Consequently, the original regression was maintained to allow for a report of PO and PT predictor variables.

To examine the dependent variable of PT pain-related facial expression, a three-step model was developed. The variables entered at each step and their associated variance are summarized in Table 6. R was significantly different from zero at the end of the each step and at Step 3 once all variables were entered into the equation, $R^2 = .49$, $F(11, 116) = 10.20, p < .001$.

PT age, duration of relationship, and PT MC-10 were entered at Step 1. These variables explained 8% of the variance in PT pain-related FACS scores, $F_{\text{change}}(3, 124) = 3.52, p = .02$. None of the predictor coefficients were statistically significant at Step 1. In Step 2, group membership, PT gender, and PO pain-related FACS scores were entered. Step 2 explained 27% of the total variance in the model, $F_{\text{change}}(3, 121) = 10.89, p < .001$. PT gender ($\beta = -.24, p = .003$) and PO pain-related FACS scores ($\beta = .42, p < .001$)
Table 6

**Hierarchical Multiple Regression Analysis Predicting PT Pain-Related FACS Scores**

*from Demographic Variables, PO Pain-Related FACS Scores, and CSI Scores.*

<table>
<thead>
<tr>
<th>Predictors</th>
<th>$\Delta R^2$</th>
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<th>$t$</th>
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<tr>
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*Note:* $\Delta R^2$ = Change in $R^2$; $\beta$ = Standardized coefficient (Beta); PT = Pain Target; PO =
Pain Observer; MC-10 = Marlowe-Crowne Social Desirability Scale – Short Form;
FACS = Pain-Related Facial Action Coding System Score; CSI = Couples Satisfaction Index.

*p < .05; **p < .01; ***p < .001
significantly contributed to Step 2 of the model. In Step 3, PT and PO CSI, the CSI x Group interaction term for PO and PT, and the CSI x Gender interaction term for PT were entered into the model. The full model following the inclusion of these variables accounted for 49% of the variance in PT pain-related FACS scores, $F_{\text{change}}(5, 116) = 9.15, p < .001$. In the final model, gender ($\beta = -.21, p = .003$), PO pain-related FACS scores ($\beta = -.14, p = .003$), and the interaction between PT CSI and PT gender ($\beta = .47, p < .001$) significantly contributed to the model variance. When examined more closely, the PT CSI x PT gender interaction suggested a stronger negative relationship between PT CSI and PT pain-related FACS scores for men than for women. The interaction between PT CSI and PT gender is modeled in Figure 4.

PT and PO variables were subsequently reversed, and a second regression was conducted to examine the influence of relationship satisfaction, group, and demographic variables of PO pain-related facial activity. Multicollinearity was once again observed between the CSI variables and the associated interactions. PT CSI and the interaction between PT CSI and PT group were dropped from the regression, but this did not result in a significant change to the overall model. All variables were included in the model to account for PT and PO influences.

The predictor variables were entered in three steps. Each step and the associated variance are summarized in Table 7. All three steps of the regression were significant, and after Step 3, $R^2 = .36, F(11, 116) = 5.57, p < .001$; however, there was not a statistically significant increase between Step 2, $R^2_{\text{change}} = .05, p = .16$ and Step 3.

In Step 1, after PO age, PO MC-10, and years together as reported by the PO were entered into the equation, $R^2 = .168, F_{\text{change}}(3, 124) = 8.33, p < .001$. In Step 2, the
Figure 4. Interaction between PT centred CSI score and PT gender for the predicted value of PT pain-related FACS score. CP = Chronic Pain; PT = Pain Target; FACS = Pain-Related Facial Action Coding System Score; CSI = Couple Satisfaction Index.
Table 7

*Hierarchical Multiple Regression Analysis Predicting PO Pain-Related FACS Scores from Demographic Variables, PT Pain-Related FACS Scores, and CSI Scores.*

<table>
<thead>
<tr>
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<th>$t$</th>
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<tr>
<td>PO MC-10</td>
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<td>-2.01*</td>
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<td>PO MC-10</td>
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<td>Group</td>
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<td>-.04</td>
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<td>-1.69</td>
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<td>PO CSI x PO Gender</td>
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<td>-1.04</td>
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</table>

*Note: $\Delta R^2$ = Change in $R^2$; $\beta$ = Standardized coefficient (Beta); PT = Pain Target; PO =*
Pain Observer; MC-10 = Marlowe-Crowne Social Desirability Scale – Short Form;
FACS = Pain-Related Facial Action Coding System Score; CSI = Couples Satisfaction Index.

*p < .05; **p < .01; ***p < .001
addition of PT pain-related FACS scores, group membership, and PO gender accounted for 31% of the variance in PO pain-related FACS scores, \( F_{\text{change}}(3, 121) = 8.34, \ p < .001 \). In the final step of the model, with the addition of PT and PO CSI, the interaction between CSI and group for the PO and the PT, and interaction between CSI and gender for the PO, \( R^2 = .36, \ F_{\text{change}}(5, 116) = 1.62, \ p = .16 \).

Several coefficients were significant in the final step. PT pain-related FACS scores (\( \beta = .37, \ p < .001 \)), PO CSI (\( \beta = .44, \ p < .001 \)), and the interaction between PO CSI and group (\( \beta = -.35, \ p = .02 \)) significantly contributed to the variance accounted for in the model. The interaction between PO CSI and group is modelled in Figure 5. The interaction between PO CSI and PO pain-related FACS scores suggested that in partners of individuals with NCP, higher scores on the CSI were related to more pain-related FACS scores; however, the opposite was true for the CP group. For couples with CP, higher PO CSI scores were associated with fewer PO pain-related FACS scores.

Based on the results of these regressions, prediction VIII was partially confirmed. A relationship was observed between relationship satisfaction and pain-related facial activity; however, this was only the case for POs. As anticipated, the presence of a partner with CP moderated the relationship between PO relationship satisfaction and pain-related facial activity. Greater pain-related facial activity was associated with higher relationship satisfaction among POs without a CP partner. In POs with a CP partner, lower relationship satisfaction was associated with more pain-related facial activity.

**Prediction IX.** Prediction IX examined the influence of relationship satisfaction on pain intensity scores during the pain task for both partners. It was predicted that NRS scores would be negatively predicted by CSI scores in PTs and positively predicted by
Figure 5. Interaction between PO centred CSI score and PO group for the predicted value of PO pain-related FACS score. NCP = No Chronic Pain; CP = Chronic Pain; PT = Pain Target; FACS = Pain-Related Facial Action Coding System Score; CSI = Couple Satisfaction Index.
CSI scores in POs. It was also predicted that among PTs, the relationships between these variables would be stronger in the CP group than in the NCP group. Among POs it was anticipated that the relationship between these variables would be stronger in the NCP group than the CP group. Two regression equations were employed to examine this prediction. Concerns with multicollinearity were identified between PO CSI and PT CSI variables in both regressions; however, when variables were dropped to reduce multicollinearity, no changes were observed in the models. Consequently, all variables were included in the regressions to account for PT and PO influences.

In the first regression, a three-step hierarchical regression was used in which PT NRS scores were entered as the dependent variable. The variables entered at each step as well as the variance explained by each step are summarized in Table 8.

To control for the influence of demographic variables and social desirability, PT age, years together reported by the PT, and PT MC-10 were entered in Step 1. In the second step, group membership, PT gender, and PO pain-related FACS scores were entered into the equation. Step 3 included the CSI scores for each partner as well as interaction terms between PT CSI and group, PO CSI and group, and PT CSI and PT gender. $R$ was not significantly different from zero at any of the three steps. At Step 3, once all predictors had been entered into the equation, $R^2 = .09, F(11, 116) = 1.03, p = .43$.

In the second regression, a three-step hierarchical regression was used in which PO NRS scores were entered as the dependent variable. The same predictors as in the previous regression were used; however, PT and PO variables were reversed such that PT NRS scores were entered as the dependent variable and PO variables were used as
Table 8

Hierarchical Multiple Regression Analysis Predicting PT NRS scores from Demographic Variables, PO Pain-Related FACS Scores, and CSI Scores

<table>
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<tr>
<th>Predictors</th>
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*Note: $\Delta R^2 =$ Change in $R^2$; $\beta =$ Standardized coefficient (Beta); PT = Pain Target; PO =
Pain Observer; MC-10 = Marlowe-Crowne Social Desirability Scale – Short Form;
FACS = Pain-Related Facial Action Coding System Score; Couples Satisfaction Index.

*p < .05; **p < .01; ***p < .001
control and predictor variables. Table 9 summarizes the variables entered at each step and the contribution of each variable at each step. The second regression model was also not statistically significant at any step, and at Step 3 $R^2 = .06$, $F(11, 116) = .72, p = .72$.

Based on the results of both regressions, relationship satisfaction was not found to influence pain intensity ratings in either partner, and prediction IX was not confirmed.

**Prediction X.** Prediction X evaluated the influence of perceived relationship support on pain-related facial expression during the pain task. Specifically, it was predicted that pain-related FACS scores would be predicted by perceived support scores. It was predicted that perceived support and pain-related FACS scores would be negatively associated for PTs and positively associated for POs. Further, it was anticipated that the relationship between these variables would be stronger among PTs in the CP group than in the NCP group, and stronger among POs in the NCP group than in the CP group.

Two regression equations were employed to test this prediction, one with PT pain-related FACS scores as the dependent variable and one with the PO pain-related FACS scores as the dependent variable. In both regressions, concerns with multicollinearity were observed between PT SS-SPS and PO SS-SPS. The regression models were re-examined dropping problematic variables; however, this did not lead to improvements in the multicollinearity or improvements in the model. Consequently, the original regressions with all predictors included were used to examine prediction X.

A three-step hierarchical regression was used in the first regression. Each step of the regression and the variance explained at each step is summarized in Table 10. All three steps of the regression were significant including the final step, $R^2 = .30$, $F(11,$
Table 9

*Hierarchical Multiple Regression Analysis Predicting PO NRS Scores from* 
*Demographic Variables, PT Pain-Related FACS Scores, and CSI Scores*

<table>
<thead>
<tr>
<th>Predictors</th>
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*Note: $\Delta R^2$ = Change in $R^2$; $\beta$ = Standardized coefficient (Beta); PT = Pain Target; PO =*
Pain Observer; MC-10 = Marlowe-Crowne Social Desirability Scale – Short Form;
FACS = Pain-Related Facial Action Coding System Score; CSI = Couples Satisfaction
Index.

*p < .05; **p < .01; ***p < .001
Table 10

*Hierarchical Multiple Regression Analysis Predicting PT Pain-Related FACS Scores from Demographic Variables, PO Pain-Related FACS Scores, and SS-SPS Scores*

<table>
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*Note: $\Delta R^2 =$ Change in $R^2$; $\beta =$ Standardized coefficient (Beta); PT = Pain Target; PO =*
Pain Observer; MC-10 = Marlowe-Crowne Social Desirability Scale – Short Form;
FACS = Pain-Related Facial Action Coding System Score; SS-SPS = Source-Specific
Social Provision Scale.

*p < .05; **p < .01; ***p < .001
In Step 1, PT age, years together as reported by the PT, and PT MC-10 were entered to control for the influence of these variables. Step 1 accounted for 8% of the variance, $F_{change} (3, 125) = 3.56$, $p = .02$. Group membership, PT gender, and pain-related FACS scores of the PO were entered in Step 2, leading to an $R^2$ increase of .20 and accounting for 27% of the variance in PT pain-related FACS scores, $F_{change} = 10.96$, $p < .001$. In Step 3, PT and PO SS-SPS score, and interaction terms between PT SS-SPS and group, PO SS-SPS and group, and PT SS-SPS and PT gender were entered. The addition of these variables did not lead to a significant increase in the variance accounted for by the model, $R^2 = .30$, $F_{change} = .90$, $p = .49$. In the final step, only PT gender ($\beta = -.25$, $p = .003$) and PO pain-related FACS scores ($\beta = .47$, $p < .001$) significantly contributed to the model variance.

A similar model with all variables reversed for PO and PT was used to examine the influence of perceived support on PO pain-related facial activity during the pain task. The three steps of the second regression model can be found in Table 11.

All three steps of the model were statistically significant, with the final model accounting for 38% of the variance, $F (11, 117) = 6.45$, $p < .001$. In Step 1, PO age, years together as reported by the PO, and the PO MC-10 were entered to control for the influence of these variables. Step 1 accounted for 17% of the variance, $F_{change} = 8.63$, $p < .001$. Group membership, PO gender, and PT pain-related FACS scores were entered in Step 2, resulting in a significant increase in variance, $R^2_{change} = .14$, $F_{change} (3, 122) = 8.49$, $p < .001$. In Step 3, SS-SPS scores for each partner, as well as the interaction terms between PT SS-SPS and group, PO SS-SPS and group, and PO SS-SPS and gender were
Table 11

Hierarchical Multiple Regression Analysis Predicting PO Pain-Related FACS Scores from Demographic Variables, PT Pain-Related FACS Scores, and SS-SPS Scores

<table>
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<th>$t$</th>
</tr>
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*Note: $\Delta R^2$ = Change in $R^2$; $\beta$ = Standardized coefficient (Beta); PT = Pain Target; PO =
Pain Observer; MC-10 = Marlowe-Crowne Social Desirability Scale – Short Form;
FACS = Pain-Related Facial Action Coding System Score; SS-SPS = Source-Specific Social Provision Scale.

*p < .05; **p < .01; ***p < .001
added to examine whether these variables added additional predictive value of PO pain-related FACS scores over and above the influence of demographic variables and PT pain-related FACS scores. Step 3, led to a significant increase in variance, accounting for 38% of the variance, $R^2_{\text{change}} = .06$, $F_{\text{change}}(5, 177) = 2.36, p = .05$. In Step 3 PT pain-related FACS scores ($\beta = .39, p < .001$), PO SS-SPS ($\beta = .40, p = .01$), and the interaction between PO SS-SPS and group membership ($\beta = .24, p < .04$), were statistically significant predictors to the model.

The interaction between PO SS-SPS and group membership is modelled in Figure 6. The interaction indicated that higher levels of perceived support in POs was related to higher PO pain-related FACS scores, but only in the NCP group. In the CP group, higher scores on PO SS-SPS were associated with lower PO pain-related FACS scores.

Based on the results of these two regressions, prediction X was partially confirmed. Perceived support positively predicted pain-related facial activity for POs; however, no relationship was found between pain-related facial activity and perceived support in PTs. The relationship between PO pain-related FACS scores and PO SS-SPS was moderated by group membership. As anticipated, greater pain-related facial activity was associated with higher perceived support among partners of individuals without CP. In partners of an individual with CP partner, lower perceived support was associated with more pain-related facial activity.

**Prediction XI.** Prediction XI examined whether perceived relationship support influence pain intensity ratings for each partner, after controlling for the influences for age, relationship, and social desirability factors, as well as pain-related facial activity,
Figure 6. Interaction between PO centred SS-SPS score and PO group for the predicted value of PO pain-related FACS score. NCP = No Chronic Pain; CP = Chronic Pain; PO = Pain Observer; FACS = Pain-Related Facial Action Coding System Score; SS-SPS = Source-Specific Social Provision Scale.
gender, and group membership. It was predicted that the relationship between perceived support and NRS scores would be negatively related for PTs and positively related for POs. Further, it was anticipated that the relationship between these variables would be stronger among PTs in the CP group than in the NCP group, and stronger among POs in the NCP group than in the CP group. Two hierarchical regressions were used to examine this prediction, one with PT NRS as the dependent variable and the second with the PO NRS as the dependent variable. Multicollinearity was not identified as an issue in either regression.

A three-step hierarchical regression was first used in which PT NRS scores were entered as the dependent variable. The three steps of this model and variance associated with each step are summarized in Table 12. None of the steps were statistically significant, and in Step 3, $R^2 = .10$, $F(11, 117) = 1.13$, $p = .35$.

Similarly, in the second regression where NRS PO was the dependent variable, none of the steps were statistically significant. The complete model with all steps included was not significant, $R^2 = .05$, $F(11, 117) = .59$, $p = .87$. Regression results, including variables entered at each step and associated variance, are summarized in Table 13. Based on the results of these two regressions, prediction XI was not confirmed.

**Prediction XII.** Prediction XII was focused on the influence of pain catastrophizing and its interaction with group in predicting both partners’ pain-related facial activity. It was predicted that higher scores on the PCS would predict greater pain-related facial activity in both PTs and POs. Further, it was predicted that the relationship between the PCS and pain-related FACS scores would be stronger in the CP group than in the NCP group. Two hierarchical regressions were used to examine this prediction: the
### Table 12

*Hierarchical Multiple Regression Analysis Predicting PT NRS Scores from Demographic Variables, PO Pain-Related FACS Scores, and SS-SPS Scores*

<table>
<thead>
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<th>Predictors</th>
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<th>$t$</th>
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*Note: $\Delta R^2$ = Change in $R^2$; $\beta$ = Standardized coefficient (Beta); PT = Pain Target; PO =*
Pain Observer; MC-10 = Marlowe-Crowne Social Desirability Scale – Short Form;
FACS = Pain-Related Facial Action Coding System Score; SS-SPS = Source-Specific Social Provision Scale.

*p < .05; **p < .01; ***p < .001
Table 13

**Hierarchical Multiple Regression Analysis Predicting PO NRS Scores from Demographic Variables, PT Pain-Related FACS Scores, and SS-SPS Scores**

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<thead>
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*Note: $\Delta R^2$ = Change in $R^2$; $\beta$ = Standardized coefficient (Beta); PT = Pain Target; PO =*
Pain Observer; MC-10 = Marlowe-Crowne Social Desirability Scale – Short Form; FACS = Pain-Related Facial Action Coding System Score; SS-SPS = Source-Specific Social Provision Scale.

*p < .05; **p < .01; ***p < .001
first with PT pain-related FACS scores as the dependent variable and the second with PO pain-related FACS scores as the dependent variable. Multicollinearity among predictor variables was not identified as a concern in either regression. PCS scores for both partners are referred to as PO PCS and PT PCS throughout; however, it should be noted that POs completed the spouse version of the PCS (i.e., PCS-S) and the PTs completed the original version of the PCS.

In the first regression, a three-step hierarchical regression was used in which PT pain-related FACS scores were the outcome variable of interest. The three steps of this model as well as the variance accounted for at each step are summarized in Table 14. Each step of the model was statistically significant, with the final model accounting for 34% of the variance, $F(11, 115) = 5.49, p < .001$.

Years together as reported by the PT, PT age, and PT MC-10 were entered in Step 1 to control for the influence of these variables, $R^2 = .08, F(3, 123) = 3.33, p = .02$. In Step 2, group membership and PO pain-related FACS scores were added to the equation resulting in a statistically significant increase in variance explained by the model, $R^2_{\text{change}} = .20, F_{\text{change}}(3, 120) = 11.05, p < .001$. The PCS scores for each partner, as well as interaction terms between PT PCS and group, PO PCS and group, and PT PCS and gender were entered in Step 3. The inclusion of the variables in Step 3 led to a small, but statistically significant increase in variance accounted for by the model, $R^2_{\text{change}} = .07, F_{\text{change}}(5, 155) = 2.42, p = .04$. In this final stage of the model, PT gender ($\beta = -.22$, $p = .007$), PO pain-related FACS scores ($\beta = .47, p < .001$), and the interaction between PT PCS and group ($\beta = .28, p = .04$) were statistically significant contributors to the variance accounted for by the model.
Table 14

*Hierarchical Multiple Regression Analysis Predicting PT Pain-Related FACS Scores*

from Demographic Variables, PO Pain-Related FACS Scores, and PCS Scores

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<thead>
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<tr>
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<tr>
<td>PT Years Together</td>
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<td>.57</td>
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<tr>
<td>PT MC-10</td>
<td>.02</td>
<td>.30</td>
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</tr>
<tr>
<td>Group</td>
<td>.04</td>
<td>.44</td>
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<tr>
<td>PT Gender</td>
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<td>-2.74**</td>
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<tr>
<td>PO FACS</td>
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<td>PO PCS</td>
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<td>.90</td>
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<tr>
<td>PT PCS</td>
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<td>PT PCS x Group</td>
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<td>PT PCS x PT Gender</td>
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*Note: $\Delta R^2$ = Change in $R^2$; $\beta$ = Standardized coefficient (Beta); PT = Pain Target; PO =*
Pain Observer; MC-10 = Marlowe-Crowne Social Desirability Scale – Short Form; FACS = Pain-Related Facial Action Coding System Score; PCS = Pain Catastrophizing Scale (PT PCS)/Pain Catastrophizing Scale – Spouse Version (PO PCS).

*p < .05; **p < .01; ***p < .001
The interaction between PT PCS and group is modelled in Figure 7. As demonstrated by the figure, the interaction suggested that the effect of PT PCS on PT pain-related FACS scores was influenced by the presence of CP in the couple. A stronger positive relationship was observed between PT PCS scores and PT FACS scores for those in the CP group than those in the NCP group.

The second regression used to test prediction XII employed a similar three-step hierarchical regression with variables reversed for PO and PT. PO pain-related FACS scores were entered as the dependent variable. The variables included in each step and variance accounted for at each step is summarized in Table 15.

All three steps of the model were statistically significant, with the final step accounting for 36% of the total variance, \( F(11, 115) = 5.98, p < .001 \). In step one, 16% of the variance was accounted for by years together, PO age, and PO MC-10, \( F(3, 123) = 8.03, p < .001 \). In Step 2, variance accounted for increased to 31% with the addition of group membership, PT pain-related FACS scores, and PO gender, \( F_{\text{change}}(3, 120) = 8.53, p < .001 \). In Step 3, PCS for PO and PT, as well as interaction terms between PO PCS and group, PT PCS and group, and PO PCS and gender were entered, but did not lead to a statistically significant increase in variance accounted for in the prediction of PO pain-related FACS scores, \( R^2_{\text{change}} = .05, F_{\text{change}} = 1.92, p = .10 \). Only PT pain-related FACS scores (\( \beta = .39, p < .001 \)) was statistically significant in the final model.

Based on the results of the two regressions conducted to examine prediction XII, this prediction was partially confirmed. In PTs, PCS scores predicted pain-related FACS scores; however, this relationship was only observed when examining the moderating effect of group membership. As anticipated, PT PCS scores more strongly predicted PT
Figure 7. Interaction between centred PT PCS score and PT group for the predicted value of PT pain-related FACS score. NCP = No Chronic Pain; CP = Chronic Pain; PO = Pain Observer; FACS = Pain-Related Facial Action Coding System Score; PCS = Pain Catastrophizing Scale (PT PCS)/Pain Catastrophizing Scale – Spouse Version (PO PCS).
Table 15

*Hierarchical Multiple Regression Analysis Predicting PO Pain-Related FACS Scores from Demographic Variables, PT Pain-Related FACS Scores, and PCS Scores*

<table>
<thead>
<tr>
<th>Predictors</th>
<th>$\Delta R^2$</th>
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<th>$t$</th>
</tr>
</thead>
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<tr>
<td>PO MC-10</td>
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<tr>
<td><strong>Model 2</strong></td>
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<td></td>
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<td>PO Years Together</td>
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<td>-.32</td>
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</tr>
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<td>-1.20</td>
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<tr>
<td>Group</td>
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<tr>
<td>PT FACS</td>
<td>.41</td>
<td>5.01***</td>
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<tr>
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<td>-.71</td>
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<td>Group</td>
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<td>PO Gender</td>
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<td>PO PCS x PO Gender</td>
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*Note: $\Delta R^2$ = Change in $R^2$; $\beta$ = Standardized coefficient (Beta); PT = Pain Target; PO =*
Pain Observer; MC-10 = Marlowe-Crowne Social Desirability Scale – Short Form; FACS = Pain-Related Facial Action Coding System Score; PCS = Pain Catastrophizing Scale (PT PCS)/Pain Catastrophizing Scale – Spouse Version (PO PCS). 

*p < .05; **p < .01; ***p < .001
pain-related FACS scores for those in the CP group than those in the NCP group. No relationship was found between PCS scores and PO pain-related facial activity.

**Prediction XIII.** Prediction XIII related to the influence of pain catastrophizing on pain intensity after controlling for the influence of age, years together, group membership, social desirability, and pain-related facial activity. It was predicted that higher scores on the PCS would predict higher NRS scores in both PTs and POs. Further, it was predicted that the relationship between PCS and NRS scores would be stronger in among individuals in the CPs than individuals in the NCPs. Two regressions were once again used to examine this prediction. Multicollinearity was not identified as an issue in either regression.

In the first regression, PT NRS scores were entered as the dependent variable and a three-step model was employed. The variables included at each step are summarized in Table 16. The overall model with all steps included was not statistically significant, nor were any of the individual steps, $R^2 = .116, F(11, 115) = 1.37, p = .20$.

In the second regression, PO NRS scores were entered as the dependent variable. Again, a three-step model was used, but none of the step were statistically significant, $R^2 = .09, F(11, 115) = 1.04, p = .42$. The variables included at each step are summarized in Table 17. Based on the results of the two regression analyses conducted to test prediction XIII, prediction XIII was not confirmed.

**Additional Exploratory Analyses**

Several analyses were conducted for exploratory purposes. Variables of particular interest included PO pain-related facial activity, self-reported empathy, and facial emotions. The linear trend within partners and between groups on pain ratings during the
Table 16

*Hierarchical Multiple Regression Analysis Predicting PT NRS Scores from* Demographic Variables, PO Pain-Related FACS Scores, and PCS Scores

<table>
<thead>
<tr>
<th>Predictors</th>
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<td><strong>Model 2</strong></td>
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</tr>
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<td><strong>Model 3</strong></td>
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*Note: $\Delta R^2$ = Change in $R^2$; $\beta$ = Standardized coefficient (Beta); PT = Pain Target; PO =*
Pain Observer; MC-10 = Marlowe-Crowne Social Desirability Scale – Short Form;
FACS = Pain-Related Facial Action Coding System Score; PCS = Pain Catastrophizing
Scale (PT PCS)/Pain Catastrophizing Scale – Spouse Version (PO PCS).

*p < .05; **p < .01; ***p < .001
Table 17

Hierarchical Multiple Regression Analysis Predicting PO NRS Scores from
Demographic Variables, PT Pain-Related FACS Scores, and PCS Scores

<table>
<thead>
<tr>
<th>Predictors</th>
<th>$\Delta R^2$</th>
<th>$\beta$</th>
<th>$t$</th>
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</tr>
<tr>
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</tr>
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<td>-.09</td>
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<td>.03</td>
<td></td>
</tr>
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<td>PO MC-10</td>
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<td>PT FACS</td>
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<td>.85</td>
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<td>PO PCS x PO Gender</td>
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Note: $\Delta R^2 =$ Change in $R^2$; $\beta =$ Standardized coefficient (Beta); PT = Pain Target; PO =
Pain Observer; MC-10 = Marlowe-Crowne Social Desirability Scale – Short Form;
FACS = Pain-Related Facial Action Coding System Score; PCS = Pain Catastrophizing
Scale (PT PCS)/Pain Catastrophizing Scale – Spouse Version (PO PCS).
*p < .05; **p < .01; ***p < .001
task was also examined.

**Analysis of PO pain-related FACS activity.** A two-by-two between-groups analysis of covariance (ANCOVA) was conducted to garner an understanding of PO pain-related facial expressions during the study. PO pain-related FACS scores were examined to determine whether pain-related facial activity was evident and whether differences existed between individuals in the CP and NCP group. Given that the POs were not undergoing a pain task, it could not be assumed that the pain-related FACS score would account for the most commonly exhibited AUs in POs. Nevertheless, examination of PO pain-related facial activity was of interest given that it could be a marker of pain-related empathy. No specific hypotheses were made regarding which group (i.e., POs in the CP or NCP group) would exhibit more pain-related facial expression.

Group (i.e., CP or NCP) and gender were entered as the independent variables in the ANCOVA. Average pain-related FACS score for the PO was entered as the dependent variable. Age was entered as a covariate as this variable was found to correlate with the dependent variable. After controlling for the influence of age, there was no significant interaction effect, \( F(1,124) = 0.157, p = .692 \), or main effect for group \( F(1,124) = .064, p = .801 \) or gender \( F(1,124) = .257, p = .613 \).

**Role of empathy.** Empathy was not a primary variable of interest in the current study but an exploratory aim was to provide an initial investigation into the influence of this variable on pain responses. The IRI-EC subscale and the IRS-PeT subscale for each partner were correlated with each partner’s average discrepancy (i.e., average difference in NRS ratings between PO and PT), average NRS rating, and average pain-related
FACS score. Correlations for the NCP group and CP group were examined separately. Fisher’s $r$-to-$z$ transformation was used to assess the significance of the difference between correlation coefficients in the CP and NCP group. Fisher’s $r$-to-$z$ transformation was only used in cases where a significant correlation was observed between partners within a group.

In the NCP group, no significant correlations were found between IRI-EC or IRI-PeT variables and any of the pain-related variables. In the CP group, a small negative correlation was identified between PT scores on the IRI-EC subscale and the average discrepancy between partners, $r = -0.26$, $p = 0.04$. When compared to the same correlation in the NCP group (i.e., IRI-EC-PT and average discrepancy), there was not a statistically significant difference between the strength of the correlation in each group, $z = 1.75$, $p = 0.08$. A small negative correlation was also found between PO IRI-EC score and average FACS score for the PT, $r = -0.30$, $p = 0.02$. Despite the statistically significant correlation between partners on these variables, the correlation coefficient in the CP group was not statistically significantly stronger than the correlation in the NCP group, $z = 0.68$, $p = 0.50$. Intercorrelations among variables are presented in Table 18.

**Role of facial expressions of emotion.** Facial expressions of emotion during the pain task were also examined in an exploratory manner to gain a better understanding of what facial expressions of emotion might emerge in the context of couples. No specific hypotheses were proposed. Facial expressions of emotion were examined by correlating the FaceReader data. The observed frequency of primary emotions (i.e., happiness, sadness, anger, surprise, fear, disgust) were correlated between the PO and PT. Additionally, neutral expressions and other facial expressions that the FaceReader
Table 18

*Intercorrelations for *IRI* Scores, with Discrepancy Scores, NRS Scores, and Pain-Related FACS Scores*

<table>
<thead>
<tr>
<th>Variables</th>
<th>PT IRI-EC</th>
<th>PO IRI-EC</th>
<th>PT IRI-PeT</th>
<th>PO IRI-PeT</th>
<th>M Discrepancy</th>
<th>M PT NRS</th>
<th>M PO NRS</th>
<th>M PT FACS</th>
<th>M PO FACS</th>
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<td>-.13</td>
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<td>PO IRI-PeT</td>
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<td>.14</td>
<td>-</td>
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<td>-.05</td>
<td>-.08</td>
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<td>.12</td>
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<td>-.08</td>
<td>.14</td>
<td>-</td>
<td>.44**</td>
<td>.20</td>
<td>.09</td>
<td>.15</td>
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<td>M PT NRS</td>
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<td>.11</td>
<td>-.12</td>
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<td>-</td>
<td>.30*</td>
<td>-.06</td>
<td>-.19</td>
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<td>M PO NRS</td>
<td>.24</td>
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<td>.06</td>
<td>.08</td>
<td>-.25**</td>
<td>.57**</td>
<td>-</td>
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<td>M PT FACS</td>
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<td>.14</td>
<td>-.16</td>
<td>.10</td>
<td>.31*</td>
<td>.11</td>
<td>-</td>
<td>.45**</td>
</tr>
<tr>
<td>M PO FACS</td>
<td>.04</td>
<td>-.02</td>
<td>-.01</td>
<td>-.10</td>
<td>.18</td>
<td>.23</td>
<td>.06</td>
<td>.45**</td>
<td>-</td>
</tr>
</tbody>
</table>

*Note. Intercorrelations for NCP group (N=65) are presented above the diagonal, and intercorrelations for CP group (n = 66) are presented below the diagonal. PT = Pain Observer; PT = Pain Target; IRI-EC = Interpersonal Reactivity Index – Empathic Concern; IRI-PeT = Interpersonal Reactivity Index – Perspective Taking; NRS = Numeric Rating Scale; FACS = Pain-Related Facial Action Coding System Score; Discrepancy = Absolute difference between PO and PT NRS ratings.*

*p < .05; **p < .01
program could not code within the primary emotions (labelled as “other”) or neutral category were correlated across POs and PTs. To examine whether differences occurred across groups, correlations between partners were analysed for the NCP and CP groups separately. Fisher’s r-to-z transformation was used to assess the significance of the difference between correlation coefficients in the CP and NCP group. Fisher’s r-to-z transformation was only used in cases where a significant correlation was observed between partners within a group.

In the NCP group, significant correlations were found between fear expressions in the PO and surprise expressions in the PT, \( r = .554, p < .001 \) and fear expressions in PO and fear expressions in PT, \( r = .699, p < .001 \). When comparing the difference in strength of correlations between groups, the NCP correlation between PO fear and PT surprise was significantly stronger than the strength of correlation between PO fear and PT surprise in the CP group, \( z = 3.22, p < .001 \). The correlation between fear expressions in both partners in the NCP group was also significantly stronger than the correlation found in the CP group, \( z = 4.24, p < .001 \).

In the CP group, there was a small significant correlation between happiness in the PT and the PO, \( r = .319, p = .035 \), and between surprise in the PO and anger in the PT, \( r = .299, p = .049 \). The strength of the correlation between happiness in both partners was not significantly stronger in the CP group than the NCP group, despite the significant correlation observed in the CP group, \( z = 1.64, p = .10 \). The correlation between surprise in the PO and anger in the PT was also not significantly stronger in the CP group than in the NCP group, \( z = 1.60, p = .11 \). No other significant correlations were identified across facial expressions of emotion. Intercorrelations of FaceReader variables
are presented in Table 19.

**Analysis of trends in pain intensity ratings.** A final exploratory aim was to examine whether NRS responses changed over the course of the pain task. Of interest was the trend in NRS scores as well as any differences between partners and across groups during the task. A repeated-measures mixed model ANOVA with one between-subjects factor (CP and NCP) and two within-subjects factors (NRS score with 5 levels, reports 1-5; assignment with two levels, PO and PT) was used to assess for the presence of a trend. A “helmert” contrast was performed with which each trial except the last was compared to the mean effect of all subsequent trials. Specifically, trial 1 NRS score was compared to the mean of trials 2 to 5 NRS scores, trial 2 was compared to the mean of trials 3 to 5, and so forth. This contrast method was selected because it allowed for an examination of the trend over time, rather than comparing only consecutive trials (i.e., trial 1 to 2, trial 2 to 3, trial 3 to 4, and trial 4 to 5).

The repeated-measures results indicated a significant main effect for NRS scores, \(F(4, 512) = 70.49, p < .001\), and a significant main effect for assignment, \(F(1, 128) = 30.50, p < .001\). Examination of contrasts and estimated marginal means indicated a significant difference at each level of NRS ratings compared to all remaining ratings. With the exception of trial 2 where mean NRS scores for the total sample were relatively unchanged from trial 1, an increase in mean NRS ratings was observed over the 5 trials. The main effect of assignment highlighted that PT scores on average were significantly higher than PO scores. The interaction effect between the NRS scores across trials and the assignment of participants was statistically significant, \(F(4, 512) = 3.23, p = .01\). This effect suggested that NRS scores provided by PTs and POs while the PT completed the
Table 19

Intercorrelations for FaceReader Frequency of Facial Expressions of Emotion between Partners by Group

<table>
<thead>
<tr>
<th></th>
<th>PO Happiness</th>
<th>PO Sadness</th>
<th>PO Anger</th>
<th>PO Surprise</th>
<th>PO Fear</th>
<th>PO Disgust</th>
<th>PO Neutral</th>
<th>PO Other</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>NCP Intercorrelations</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PT Happiness</td>
<td>- .03</td>
<td>.02</td>
<td>.23</td>
<td>- .03</td>
<td>- .17</td>
<td>- .14</td>
<td>- .13</td>
<td>- .08</td>
</tr>
<tr>
<td>PT Sadness</td>
<td>- .08</td>
<td>- .12</td>
<td>.13</td>
<td>- .15</td>
<td>- .07</td>
<td>.07</td>
<td>.13</td>
<td>- .01</td>
</tr>
<tr>
<td>PT Anger</td>
<td>- .14</td>
<td>.10</td>
<td>.04</td>
<td>- .04</td>
<td>- .15</td>
<td>.20</td>
<td>- .12</td>
<td>.23</td>
</tr>
<tr>
<td>PT Surprise</td>
<td>.10</td>
<td>.13</td>
<td>- .22</td>
<td>.17</td>
<td>.55**</td>
<td>- .06</td>
<td>- .03</td>
<td>- .11</td>
</tr>
<tr>
<td>PT Fear</td>
<td>.04</td>
<td>.02</td>
<td>.10</td>
<td>- .09</td>
<td>.70**</td>
<td>.04</td>
<td>- .14</td>
<td>.10</td>
</tr>
<tr>
<td>PT Disgust</td>
<td>- .15</td>
<td>- .21</td>
<td>- .06</td>
<td>.12</td>
<td>- .05</td>
<td>.05</td>
<td>.21</td>
<td>- .12</td>
</tr>
<tr>
<td>PT Neutral</td>
<td>.16</td>
<td>- .16</td>
<td>- .16</td>
<td>.03</td>
<td>.15</td>
<td>.08</td>
<td>.04</td>
<td>.25</td>
</tr>
<tr>
<td>PT Other</td>
<td>.12</td>
<td>- .19</td>
<td>.04</td>
<td>.09</td>
<td>- .07</td>
<td>- .01</td>
<td>- .02</td>
<td>.09</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>PO Happiness</th>
<th>PO Sadness</th>
<th>PO Anger</th>
<th>PO Surprise</th>
<th>PO Fear</th>
<th>PO Disgust</th>
<th>PO Neutral</th>
<th>PO Other</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>CP Intercorrelations</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PT Happiness</td>
<td>.32*</td>
<td>.04</td>
<td>.05</td>
<td>- .26</td>
<td>- .12</td>
<td>.02</td>
<td>- .27</td>
<td>- .02</td>
</tr>
<tr>
<td>PT Sadness</td>
<td>- .20</td>
<td>- .05</td>
<td>.10</td>
<td>.25</td>
<td>.14</td>
<td>.09</td>
<td>.03</td>
<td>.04</td>
</tr>
<tr>
<td>PT Anger</td>
<td>- .16</td>
<td>.00</td>
<td>- .07</td>
<td>.30*</td>
<td>.26</td>
<td>- .14</td>
<td>.21</td>
<td>.12</td>
</tr>
<tr>
<td>PT Surprise</td>
<td>- .01</td>
<td>.19</td>
<td>- .10</td>
<td>.04</td>
<td>- .09</td>
<td>- .16</td>
<td>.08</td>
<td>.07</td>
</tr>
<tr>
<td>PT Fear</td>
<td>.08</td>
<td>- .21</td>
<td>- .01</td>
<td>- .12</td>
<td>- .07</td>
<td>.16</td>
<td>.04</td>
<td>.19</td>
</tr>
<tr>
<td>PT Disgust</td>
<td>- .02</td>
<td>- .17</td>
<td>- .15</td>
<td>.00</td>
<td>.02</td>
<td>- .10</td>
<td>.13</td>
<td>.13</td>
</tr>
<tr>
<td></td>
<td>PT Neutral</td>
<td></td>
<td></td>
<td></td>
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<td></td>
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<tr>
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<td>---</td>
</tr>
<tr>
<td>PT Neutral</td>
<td>-0.02</td>
<td>0.09</td>
<td>0.19</td>
<td>-0.02</td>
<td>0.06</td>
<td>0.16</td>
<td>-0.08</td>
<td>0.16</td>
</tr>
<tr>
<td>PT Other</td>
<td>0.06</td>
<td>-0.10</td>
<td>0.06</td>
<td>0.01</td>
<td>-0.18</td>
<td>-0.10</td>
<td>0.14</td>
<td>-0.23</td>
</tr>
</tbody>
</table>

Note. NCP = No Chronic Pain Group; CP = Chronic Pain Group; PO = Pain Observer; PT= Pain Target

*p < .05; **p < .01
pain task were significantly different. To better understand this interaction, contrasts were examined across trials comparing PT and PO NRS scores. These contrasts revealed a significant interaction effect of assignment on NRS scores when comparing the 2nd trial compared to all subsequent trials, $F(1, 128) = 8.28, p < .01$. No other contrasts were significant when comparing the interaction between PTs and POs and NRS scores. Figure 8 demonstrates the interaction between assignment and NRS scores. The graph shows that PT and PO ratings increased over time; however, PTs consistently reported higher levels of pain at all time points. PO scores drop much more that PT scores at trial 2, creating more divergence between partners on this rating, particularly when compared to all subsequent ratings. There were no significant interaction effects for NRS x Group, $F(4, 512) = .78, p = .54$, Assignment x Group, $F(1,128) = .28, p = .60$ or NRS x Group x Assignment, $F(4, 512) = 1.14, p = .34$.

**Predictive role of pain-related FACS scores.** A final consideration was given to the role that one partner’s pain-related facial expression might have on the other partner’s pain-related facial activity. The potential reciprocal influences between partners could be drawn from the regression results. The inclusion of pain-related FACS scores in the regressions used for predictions VIII through XIII provided information about whether facial activity in one partner influenced facial activity in the other partner. As observed in Tables 6, 7, 10, 11, 14, and 15, pain-related FACS scores in the PO significantly and positively predicted pain-related FACS scores in the PT and vice versa. More pain-related facial activity in one partner during the pain task was related to more pain-related facial activity in the other partner.
Figure 8. Average NRS scores for PTs and POs across the 5 trials of the pain task. NRS = Numeric Rating Scale; PT = Pain Target; PO = Pain Task.
Discussion

Pain is conceptualized as a biopsychosocial process (Turk & Monarch, 2002); however, it is only recently that the “social” influences of pain have gained increasing recognition (Fordyce, 1976; Hadjistavropoulos et al., 2011; Thorn, Ward, Sullivan, & Boothby, 2003). The interactions that occur between an individual in pain and those in his or her environment play an integral role in how that person experiences pain and responds to future pain-related situations. In the context of intimate partners, the “social” component is an essential facet given the dyadic nature of interactions. This study is an innovative investigation of pain communication in couples.

A unique feature of this investigation is the direct observation of couples’ behaviour during the pain task. The systematic focus on facial expressions of pain and emotion also represents a novel component of this research. Additional strengths are the inclusion of a control group of couples without CP and observation of both partners of the dyad. Seldom have researchers considered whether differences in pain communication (e.g., facial expressions or experienced/perceived pain intensity ratings) occur between couples where neither partner has CP and couples where one partner suffers from CP. Moreover, when conducting research in couples with an individual with CP, only a few researchers have examined responses from both members of the dyad rather than focusing solely on the partner experiencing CP (e.g., Leonard et al., 2013; Sullivan et al., 2006).

Consistent with the communications model of pain, the findings support the importance of relationship variables in pain responses. Relationship satisfaction interacted with PT gender to influence the manner in which pain was expressed and
experienced. Specifically, in both men and women PTs, lower relationship satisfaction was associated with more pain-related facial activity during the pain task. Among men with high relationship satisfaction, less pain-related facial activity was observed during the pain task, but this was not the case for women with higher relationship satisfaction.

Relationship satisfaction and perceived support also interacted with the presence or absence of CP in the relationship to influence responses to pain in observing partners. In particular, lower relationship satisfaction and lower perceived support were associated with reduced pain-related facial activity among POs without a CP partner. In couples with a partner with CP, however, lower relationship satisfaction and lower perceived support was associated with increased pain-related facial activity among POs.

Gender differences were similarly important. Women reported and non-verbally expressed more pain during the task. Male observers, however, did not perceive a greater degree of pain in their partner compared to female observers.

Individual difference variables were also found to be influential in predicting pain-related facial activity during the pain task. That is, a stronger positive relationship was observed between pain catastrophizing and pain-related non-verbal expressions among individuals with CP than individuals without CP. The same pattern of results was not observed with self-reported pain. This is not surprising given that non-verbal and self-reported indices of pain do not always correspond (Craig & Patrick, 1985; Horgas, Elliott, & Marsiske, 2009; Labus et al., 2003), as they each tap different dimensions of the pain experience. As specified in the communications model of pain, non-verbal expressions tap the more reflexive and immediate aspects of pain. Self-reported pain is more likely to be cognitively mediated and thereby moderated by social variables (T.
Importantly, this study supports a transactional process between partners during the communication of pain as specified in the communications model of pain. This transactional process was observed in the analyses of self-reported pain, facial expressions of pain, and facial expressions of emotion in both partners. Specifically, in terms of self-reported pain, examination of the trend in pain intensity ratings throughout the task demonstrated that PTs (i.e., the pain encoders) were sending messages that appeared to impact pain intensity reported by POs (i.e., the pain decoders). In terms of facial expressions of pain, the transactional process was observed in the manner through which PTs and POs mutually influenced each other’s non-verbal responses. Pain-related facial expression in PTs was predictive of pain-related facial expression in POs and vice versa. In terms of facial expressions of emotions, correlations between facial expressions of emotions were observed between partners during the task. Among couples with CP, significant associations were observed between expressions of happiness in the PT and the PO, as well as between expressions of surprise in the PO and anger in the PT. Among couples without CP, significant associations were observed between expressions of fear in the PT and the PO, as well as between expressions of fear in the PO and surprise in the PT. These results suggest that different patterns of interaction may be developing as a result of the couples’ social context. Table 20 summarizes the extent to which the various predictions/hypotheses of this study were supported.

**Detailed Discussion of Findings**

**Gender differences in pain encoding and decoding.** As anticipated, gender differences emerged when comparing men and women PTs during the pain task.
Table 20

**Summary of Study Predictions and Associated Conclusions**

<table>
<thead>
<tr>
<th>Study Predictions</th>
<th>Conclusion</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Prediction I</strong></td>
<td></td>
</tr>
<tr>
<td>▪ Couples in which one partner has CP will demonstrate more discrepancy in their pain intensity ratings than couples where neither partner has CP.</td>
<td>Not supported</td>
</tr>
<tr>
<td><strong>Prediction II</strong></td>
<td></td>
</tr>
<tr>
<td>▪ PTs with CP will provide higher pain intensity ratings than PTs without CP.</td>
<td>Not supported</td>
</tr>
<tr>
<td><strong>Prediction III</strong></td>
<td></td>
</tr>
<tr>
<td>▪ In PTs, women will provide higher pain intensity ratings than men.</td>
<td>Supported</td>
</tr>
<tr>
<td>▪ In PTs, women with CP will provide higher pain intensity ratings than women without CP.</td>
<td>Not supported</td>
</tr>
<tr>
<td><strong>Prediction IV</strong></td>
<td></td>
</tr>
<tr>
<td>▪ POs in the CP group will perceive lower pain intensity than POs in the NCP group.</td>
<td>Not supported</td>
</tr>
<tr>
<td><strong>Prediction V</strong></td>
<td></td>
</tr>
<tr>
<td>▪ In POs, men will perceive lower pain intensity than women.</td>
<td>Not supported</td>
</tr>
<tr>
<td>▪ In POs, men in the CP group will perceive lower pain intensity than men in the NCP group.</td>
<td>Not supported</td>
</tr>
</tbody>
</table>
Prediction VI

- PTs with CP will exhibit more pain-related facial activity than PTs without CP.  
  Not supported

Prediction VII

- In PTs, women will exhibit more pain-related facial activity than men.  
  Supported
- In PTs, women with CP will exhibit more pain-related facial activity than women without CP.  
  Not supported

Prediction VIII

- Pain-related facial activity will be negatively predicted by relationship satisfaction in PTs. The  
  association between variables will be stronger in PTs in the CP group than in the NCP group.  
  Not supported
- Pain-related facial activity will be positively predicted by relationship satisfaction in POs. The  
  association between these variables will be stronger in POs in the NCP group than in the CP group.  
  Partially supported (positively predicted in NCP group, negatively predicted in CP group)

Prediction IX

- Pain intensity ratings will be negatively predicted by relationship satisfaction in PTs. The  
  association between these variables will be stronger in PTs in the CP group than in the NCP group.  
  Not supported
- Pain intensity ratings will be positively predicted by relationship satisfaction in POs. The  
  Not supported
association between these variables will be stronger in POs in the NCP group than in the CP group.

Prediction X

- Pain-related facial activity will be negatively predicted by perceived support in PTs. The association between these variables will be stronger in PTs in the CP group than in the NCP group.  
  Not supported

- Pain-related facial activity will be positively predicted by perceived support in POs. The association between these variables will be stronger in POs in the NCP group than in the CP group.  
  Partially supported (positively predicted in NCP group, negatively predicted in CP group)

Prediction XI

- Pain intensity ratings will be negatively predicted by perceived relationship support in PTs. The association between these variables will be stronger in PTs in the CP group than in the NCP group.  
  Not supported

- Pain intensity ratings will be positively predicted by perceived relationship support in POs. The association between these variables will be stronger in POs in the NCP group than in the CP group.  
  Not supported

Prediction XII

- Pain-related facial expression will be positively predicted by pain catastrophizing in PTs. The association between these variables will be stronger in PTs in the CP group than in the NCP group.  
  Supported
• Pain-related facial expression will be positively predicted by pain catastrophizing in POs. The association between these variables will be stronger in POs in the CP group than in the NCP group.

Prediction XIII

• Pain intensity ratings will be positively predicted by pain catastrophizing in PTs. The association between these variables will be stronger in PTs in the CP group than in the NCP group.

• Pain intensity ratings will be positively predicted by pain catastrophizing in POs. The association between these variables will be stronger in POs in the CP group than in the NCP group.

Note. PT = Pain Target; PO = Pain Observer; CP = Chronic Pain Group; NCP = No Chronic Pain Group.
Consistent with what was predicted, women self-reported greater pain than men and had higher pain-related FACS scores. In contrast with what was expected, the presence of CP did not lead to greater pain responses among women with CP as compared to women without CP. Heightened pain sensitivity and higher pain intensity ratings in women are well documented in the literature (Bulls et al., 2015; Mogil & Bailey, 2010). It has been suggested that women are more sensitive to pain due to biological mechanisms, over and above any social learning factors (Melchior, Poisbeau, Gaumand, & Marchand, in press; Wiesenfeld-Hallin, 2005). In the current investigation, women appeared to experience higher levels of pain than men, consistent with previous research. However, gender differences in pain-related facial expression during laboratory-based pain tasks are generally not found (Kunz, Gruber, & Lautenbacher, 2006; Prkachin, 1992).

One potential explanation for the inconsistencies between the current findings and previous research could be that the presence of the partner observing the pain task contributed to higher pain ratings among women. The presence of a partner has previously been found to lead to increased facial expression among individuals completing a pain induction task when compared to being in the presence of a stranger or being alone (Gallant & Hadjistavropoulos, 2016; Karmann et al., 2015). Partners with CP who are women are also more likely to exaggerate pain than partners with CP who are men (Keefe et al., 2000; Wise et al., 2002). Consequently, increased pain-related facial expression observed among women in this investigation may have been a function of the presence of the partner. Although such an explanation would not negate biological differences (i.e., sex differences) in the pain experience, it expands the notion that social factors are integral in pain responses. Additional controlled investigations of different
pain responses in varying social context – particularly with and without the presence of a partner – are required to confirm this explanation.

In contrast to what was expected, no significant differences were observed in POs between women and men on NRS ratings. If accurate perception of pain was occurring, it would be expected that POs who were men would have higher ratings than POs who were women to reflect the higher level of pain reported by their partner. Consequently, the findings add support to the existing literature that pain is decoded less accurately when the decoder is a man (Ickes et al., 2000; Newton-John & Williams, 2006; Vigil & Coulombe, 2011) and the pain encoder is a woman (Riva et al., 2011). One explanation may be a better sensitivity to facial cues and better aptitude for decoding among women, a position supported by previous research (Ickes et al., 2000; Newton-John & Williams, 2006; Prkachin et al., 2004). Alternatively, men may be more likely to underestimate pain in others, regardless of the cues provided or the encoder’s gender, a position also supported by previous research (Vigil & Coulombe, 2011). Clarification of decoder processes can be pursued in future research.

**Relationship variables and pain encoding and decoding.** Several important findings were observed when examining the impact of relationship variables on the prediction of pain responses. First, it was expected that relationship satisfaction would predict non-verbal expressions in PTs. Contrary to expectations, an association was observed between relationship satisfaction and non-verbal expressions in PTs, but only when considering the moderating influence of the gender of the PT. Across genders, higher satisfaction scores were related to reduced non-verbal pain expressiveness, but the relationship between these variables was markedly stronger for men than for women.
Second, consistent with expectations for POs, better relationship outcomes (i.e., relationship satisfaction or perceived relationship support) were associated with more pain-related facial expressions in POs, and the relationship between these variables was moderated by the presence or absence of a partner with CP in the relationship. Lower scores on relationship measures led to fewer non-verbal pain expressions in POs in the NCP group, and an increase in non-verbal pain expressions in the CP group.

Taken together, these findings provide further evidence that pain responses (both by encoders and decoders) are related to the social context. For encoders – particularly encoders who were men – the findings might suggest that when relationship satisfaction is high fewer pain-related behaviours are required for them to feel that their partner is effectively understanding their pain. If non-verbal expressions are serving a communicative purpose, as proposed in this investigation, then the findings could suggest that the more men experiencing pain feel that their relationship needs are being met, the less they need to exaggerate pain behaviours to receive the desired response from their partner. An alternative explanation could be that men with higher relationship satisfaction show fewer pain-related behaviours in order to protect their partner from seeing them in pain. Further research is needed to clarify the reasons why relationship satisfaction may influence pain-related behaviours.

Although researchers investigating couples have considered factors (e.g., individual and relationship variables) that predict pain behaviours in the partner with CP, the experience of the partner without CP is less frequently examined. Among POs, higher scores on relationship measures led to higher pain-related FACS scores in the NCP group, but the opposite was true in the CP group. CP has been found to
significantly and negatively affect relationship satisfaction (Flor, Turk et al., 1987). The findings of the current investigation, however, extend beyond this to highlight that the relationship context will influence the pain decoder response. Additionally, given that a different pain response was observed in couples with and without CP, the results suggest that there may be patterns of responsiveness to pain that have developed over time, as a consequence of living with CP.

For couples in which pain is a less frequent experience (i.e., the NCP group) a supportive response to an encoder’s pain may be a demonstration of concern (e.g., facial expression of empathy). This could provide one explanation for the increased non-verbal pain expressions among POs satisfied with their relationship. In couples where CP is a persistent and daily experience, this level of responsiveness is not required when in a satisfied relationship. Solicitous responses and better empathic accuracy have been found to augment pain behaviours and correlate with poorer pain outcomes in the person with CP (Romano et al., 2000). In the context of this investigation, these previous findings may point to POs having learned that decreased responsiveness to pain leads to a better outcome.

An alternative explanation for the decreased pain-related facial activity among observers with more relationship satisfaction could be that they were engaging in another facial behaviour. In particular, observers may have been talking to their partner during the task. Observers engaging in verbal communication would not have received an elevated pain-related facial activity score. It is possible that observers more satisfied in their relationship were engaging in verbal communication to support their partner throughout the pain task. This explanation is consistent with previous research where a
positive association between frequency of pain-related talk and marital satisfaction has been found (Newton-John & Williams, 2006). Nevertheless, examination of verbal communication was not included in the current investigation, but would be an important area of focus for future research. Although further clarification of PO responses is needed, relationship satisfaction in POs is associated with pain-related facial expression, and it is noteworthy that a process is occurring in the partners in the NCP group that differs from partners in the CP group.

It should be noted that, although these relationship variables appeared to play a role for POs, across both partners the most significant predictor of pain-related facial expression for one partner was the pain-related facial expression of the other partner. Higher PT pain-related facial expression was associated with higher PO pain-related facial expression and vice versa. In each regression model predicting pain-related facial expression in one partner where a significant interaction was observed between a relationship variable and gender or the presence of CP, the pain-related facial expression of the opposite partner consistently remained a significant predictor.

Surprisingly and in contrast to expectations, although an interaction was observed between relationship variables (i.e., relationship satisfaction and perceived relationship support) and the presence of CP in predicting non-verbal pain expressions for POs, an interaction was not observed between relationship variables and the presence of CP in predicting non-verbal pain expressions for PTs. This indicates that the factors influencing pain responses are not identical for the two members of the dyad. The manner through which relationship variables predict pain responses differs based on the presence or absence of CP in the relationship and member of the dyad being examined.
(i.e., partner experiencing or observing pain). Additional contextual or relationship variables not considered (e.g., relationship expectations, perception of empathic responses, division of household responsibilities, history of CP or illness in the partner without CP, etc.) may account better for pain responses in the PT than the relationship variables examined in this investigation. Future research should continue to explore variables that influence pain responses with particular focus on how variables may lead to different pain responses based on the presence of CP in the relationship and the role of the partner (i.e., individual with CP or partner of individual with CP) in the dyad.

**Catastrophizing and pain encoding and decoding.** In addition to examining relationship variables, pain catastrophizing about the PT’s pain was assessed. Contrary to expectations, pain catastrophizing alone was not associated with increased facial expressions of pain for either partner. Consistent with expectations, however, a relationship emerged when the moderating role of CP in the PT was considered. Among PTs with CP, increased catastrophizing led to increased PT non-verbal pain expressions, a relationship that was not observed to the same degree among those without CP.

Pain catastrophizing is a well-researched variable and, in the context of couples, pain catastrophizing interacts with a number of factors to predict pain outcomes. The communal coping perspective proposes that partners catastrophize as a means of garnering intimacy and support (Sullivan et al., 2004; Thorn et al., 2003). Research is mixed as to whether catastrophizing leads to increases in positive responses such as solicitousness and social support (Buenaver et al., 2007; L. R. Gauthier et al., 2012; Giardino, Jensen, Turner, Ehde, & Cardenas, 2003) or increases in punishing or negative responses (Thorn et al., 2003; Waxman, Tripp, & Flamenbaum, 2008) from the partner.
without CP. Nevertheless, people who catastrophize have been identified as being more expressive when experiencing pain around others than alone (Sullivan et al., 2004). This suggests a communicative purpose to behaviours exhibited by those who are high in pain catastrophizing.

In contrast to expectations, PO catastrophizing about the PT’s pain was not associated with either partner’s facial expressions of pain. The significant other version of the Pain Catastrophizing Scale (Cano et al., 2005) has only been used in a limited number of investigations and has never been associated with facial expressions in the context of couples. The lack of association between PO catastrophizing about the PT’s pain and pain responses in either partner suggests that the decoder’s level of catastrophizing about his or her partner’s pain does not have a direct impact on the encoder’s or the decoder’s behavioural responses.

**Behavioural and self-report measures of pain.** An important finding of this study was the distinct outcomes for facial expressions of pain and self-report (i.e., NRS) indices. Throughout the models examining individual variables (i.e., pain catastrophizing) and relationship variables (i.e., perceived support, relationship satisfaction) in the prediction of pain intensity ratings and non-verbal pain expressions, it was anticipated that similar patterns would be observed. Although there was evidence that relationship and individual variables interacted with either gender or group membership in POs and PTs to predict facial expressions of pain, none of the models predicting NRS scores were significant.

It is noteworthy that non-verbal pain expressions and pain intensity ratings appear to operate through different processes. The existing research demonstrating that
pain catastrophizing and relationship variables influence non-verbal and self-reported pain responses (Burns et al., 2015; Cano et al., 2009; Lefebvre et al., 1995; McClelland & McCubbin, 2008; Sullivan et al., 2002) led to the expectation that similar patterns would be observed across both types of pain responses. Rather, the findings are more in line with research demonstrating that non-verbal pain expressions and self-reported ratings do not always correlate (Labus, Keefe, & Jensen, 2003; Vachon-Presseau et al., 2016). In fact, distinct patterns of brain activity have been found when comparing activity associated with facial expression to activity associated with subjective pain ratings (Vachon-Presseau et al., 2016). These discrete patterns suggest separate neural processes for each type of pain response.

The examination of both types of pain response during the same task in this examination provides further evidence that non-verbal responses and self-report are distinct expressions of pain influenced by separate variables. Non-verbal pain responses tap the more immediate aspects of the pain experience whereas self-reported pain responses are more subject to voluntary control and social desirability (Craig & Patrick, 1985; Horgas et al., 2009; Labus et al., 2003). Pain intensity ratings from PTs remained the same regardless of contextual variables, while non-verbal responses changed as a function of various contextual influences. This finding is consistent with the communications model of pain and highlights that, although the internal pain experience may be influenced by contextual variables, PTs were choosing not to change their self-reported expressions. Meanwhile, the automatic responses – in the form of facial expressions – were more likely to reflect changes occurring in the pain experience as a result of contextual influences. Notably, a similar process was observed in the POs.
Perceived pain intensity ratings remained the same, regardless of contextual variables, while non-verbal responses changed as a function of various contextual variables.

Although the lack of factors predicting self-reported pain intensity scores makes sense from a theoretical perspective, it is surprising given previous research findings, particularly for PTs. Pain intensity ratings have been demonstrated to be influenced by a number of variables, including social support in the individual experiencing pain (McClelland & McCubbin, 2008) or responses to pain, such as solicitous or negative responses (Newton-John, 2002; Weiss & Kerns, 1995).

A contributor to the inconsistency of the current results with previous research findings may be the procedure used in the current study. Directly requesting pain ratings from an observing partner while the partner completes a pain task has not been a commonly used approach in previous studies. Researchers frequently elicit pain or pain-related talk and code behaviours (Cano et al., 2008; Leonard et al., 2013), or ask for self-reported pain ratings separate from a pain task (Cano et al., 2004; Flor et al., 1987). Self-reports of pain when pain is not occurring rely on accurate recall of recent pain situations. Consequently, pain ratings obtained during painful situations may differ from those collected during recall. Eliciting pain ratings while pain is occurring provides an important indication of whether self-reported pain is influenced by contextual variables.

The findings from this investigation suggest that contextual variables do not have a consistent influence on pain responses. As researchers continue to investigate factors that influence the way in which couples respond when one person experiences pain, it cannot be assumed that all types of pain responses (e.g., verbal expression, non-verbal facial expression, self-report) will be influenced in a consistent manner. Rather, different
types of pain responses (e.g., self-report and non-verbal facial expressions) may be influenced in distinct ways by various contextual influences (e.g., relationship factors). Further examination of the manner in which different types of pain responses are influenced by various contextual factors in couples is warranted.

**The role of CP in the relationship.** Several predictions that proposed group differences were not confirmed. Contrary to expectations, couples in which one partner had CP did not provide more inconsistent ratings of the PT’s pain than couples in the NCP group. Rather, across couples and regardless of whether or not CP was present, the PT generally reported higher levels of pain than the PO, pointing to a slight underestimation of pain by the individuals observing pain in his or her partner. Similarly, groups did not differ with regard to pain-related facial expressions or pain ratings in either partner during the task. Moreover, although PO pain-related facial activity was influenced by an interaction between relationship variables and group (i.e., CP or NCP), this was not the case for pain intensity ratings in either partner or PT non-verbal pain expressions.

Nonetheless, there were many findings supporting group differences that highlight that the social context affects pain communication. That is, relationship satisfaction and perceived support were important predictors of non-verbal responses in POs when interacting with the presence of CP in the relationship. Similarly, catastrophizing interacted with the presence of CP to influence pain-related facial expression in PTs. These findings highlight that the impact of relationship and contextual variables on pain responses is different for individuals or partners of individuals with CP when compared to individuals or partners of individuals without CP. The role of CP as a
variable that interacts with other factors in the prediction of pain-related facial expressions is suggestive of communication patterns developing within couples with a partner with CP that do not develop in couples without a partner with CP. For instance, a pattern of responding develops over time among individuals with CP who score high on catastrophizing as a means of garnering ongoing support from their partner.

The notion that distinct patterns of responding to pain develop in individuals with CP has been examined in neuroimaging research (Vachon-Presseau et al., 2016). When comparing brain activity in individuals with CP to healthy controls during a pain induction task, additional activity in brain regions associated with reward processing and social cognition is observed in individuals with CP, but not in the healthy control group participants. Moreover, increased brain activity is observed in individuals with CP during facial expressions of pain that is not observed during self-report (Vachon-Presseau et al., 2016).

Vachon-Presseau and colleagues (2016) proposed that the distinct patterns of responding to pain in individuals with CP develop based on social exchanges that occurs during painful situations as a product of living with CP. This explanation is consistent with the results of the current investigation. The results point to individual and relationship influences that contribute to discrete patterns of pain-related facial expression in couples with a partner with CP. Investigation of brain activity in pain observers who are accustomed to viewing CP would be a relevant next step in brain imaging research to establish whether patterns of responding occur in partners of individuals with CP that are distinct from partners of individuals without CP.

On the whole, the results suggest that the relationship between the presence or
absence of CP and pain responses is nuanced. Examining differences in pain responses alone may not clarify how couples with and without CP differ. Rather, it is through the examination of individual and contextual variables that the group differences appear to emerge. It is clear from the findings that individual and contextual variables are integral to the understanding of distinct pain responses between couples with and without CP. These findings highlight the relevance and necessity of including a comparison group in pain research.

**Facial expressions of emotion and empathy.** The results of this investigation indicated that facial expressions of emotion are occurring during painful situations with distinct patterns of emotion occurring in couples with and without CP. In couples without a partner with CP, the pain task elicited a relationship between surprise in the PT and fear in the PO and a relationship between fear in the PT and fear in the PO. Conversely, in individuals with CP, happiness in one partner was associated with happiness in the other, and PO surprise was associated with PT anger. The correlation between self-reported measures of empathy and pain-related facial activity was also examined. A significant negative correlation was observed in the couples with CP between empathic concern in POs and pain-related facial activity in PTs.

Although further investigation is needed, these findings further suggest a pattern of responding that emerges as a result of having a partner with CP in the relationship. Other-oriented emotions (e.g., showing support/reassurance) towards an individual experiencing pain can only occur after self-oriented emotions (e.g., fear for one’s own safety) have been regulated. However, if self-oriented emotions are not regulated, then the observer may not be able to provide the appropriate empathic response to the person.
in pain (Goubert et al., 2005; Goubert et al., 2008). In couples without a partner with CP, there is less frequent exposure to pain. As a result, observers may be experiencing a higher level of distress and more self-oriented emotions when watching their partner in pain. The relationship between PO and PT fear, and PO fear and PT surprise observed in the NCP group would coincide with this higher degree of self-oriented emotions.

Partners who frequently see the individual with CP in pain (i.e., observers in the CP group) experience less self-oriented distress and are more quickly able to engage in other-oriented emotions. Such an interpretation could explain the stronger association between happiness in partners in the CP group as observers are engaging in responses to reduce PT distress (e.g., distraction).

Similarly, it is possible that other-oriented responses not emerging in the NCP group account for the lack of relationship between PT pain-related facial activity and PO empathic concern. PT pain-related facial activity and PO empathic concern were related in couples with an individual with CP. POs in the CP group observe pain in their partner on a regular basis and may have grown accustomed to seeing their partner experience pain. As a result, the POs in the CP group may be less distressed during the pain task. This lower level of distress permits the POs who would generally show empathy (i.e., those with higher empathic concern) to demonstrate other-oriented responses. As they receive a more empathic response, PTs in turn show fewer pain-related facial expressions.

**Theoretical implications.** The results of this investigation provide increased specificity for the communications model of pain in the context of couples. The variables investigated allow for a better understanding of specific factors that influence pain
communication in couples. Consistent with the model, the basic tenets of the pain communication process occur in the dyadic context. Participants experiencing the internal experience (A; the pain stimulus), encoded their pain through facial expressions and self-report (B), which led to responses in the pain decoders (C). Cultural, situational intrapersonal, interpersonal, and social determinants are proposed to influence each stage of the process. Additionally, the attitudes, abilities, and characteristics of the observer influence pain decoding (T. Hadjistavropoulos & Craig, 2002; T. Hadjistavropoulos et al., 2004). These influences, particularly interpersonal characteristics and social context, were found to affect the communication within couples. The individual difference characteristics of gender and pain catastrophizing were found to have an influence on encoding and decoding processes. Contextual variables, including the presence of pain in the relationship, relationship satisfaction, and perceived support also influenced the dyadic pain experience.

Although many of the findings are consistent with the pain communications model, the model does not provide sufficient specificity to explain some of the findings. Specifically, contextual variables tended to have more of an influence on pain-related facial expressions in the decoder (i.e., the observing partner) than the encoder (i.e., the partner experiencing pain). Relationship variables did not predict pain responses in the encoder, but consistently were a predictor of pain-related facial activity in decoders. Catastrophizing, the primary individual variable examined in this study, played a role in the encoders’ pain-related facial expression but not the decoders’ pain-related facial expression. Specifically, catastrophizing about the PT’s pain did not predict pain responses in the decoder, but interacted with the presence of CP to predict pain-related
facial activity in the encoder. Although these findings were not what were expected within the pain communications context, they highlight that distinct individual and contextual factors need to be considered when examining predictors of pain responses in encoders and decoders.

The communications model of pain not only recognizes the step-by-step influence from internal experience to decoder response, but also acknowledges the transactional processes occurring in which encoders and decoders mutually influence each other’s subsequent reactions. This transaction was observed in the current examination through the analysis of pain intensity scores at each time point. Results highlighted that the encoder was sending messages during the pain task that influenced the NRS ratings for decoders at each time point. Although POs were perceiving significantly less pain than PTs were reporting, as pain intensity ratings increased in PTs across the five trials of the pain task, so did perceived pain intensity ratings provided by POs. Additional support for the transaction between couples was observed in the relationships between partners’ facial expressions of emotion. These findings further support the validity of the pain communications model within the dyadic context.

Although the pain communications model was generally supported and a transactional process was observed, further research will help clarify the intricacies of the model, such as the transactional processes. In particular, the findings highlight that a transaction occurred over the course of the pain task such that PT behaviours influenced PO ratings. The pain task in the current investigation was of relatively short length (4 minutes) and participants were not engaged in other activities during the task. Further clarification of the transactional process would be brought by examining couples over
longer time periods to determine whether rating accuracy in decoders remains when the
duration of the pain is extended. Additionally, examining the transaction between
partners when there are different demands (e.g., situations with more distractions, not as
focused on the partner experiencing pain), or with different types of pain tasks (e.g.,
tasks involving movement, tasks that activate the site of CP in individuals with CP)
would clarify how context influences pain rating accuracy in decoders and influences the
transactional process between partners.

This study also aimed to examine what automatic and controlled processes were
occurring in individuals experiencing pain and whether these processes differed in those
with and without CP. Controlled processes, or processes that are cognitively-mediated,
were examined through the pain intensity ratings which showed evidence of pain in the
PT. Self-report relies on higher mental processes and are not a reflexive, automatic
response to the pain stimulus (T. Hadjistavropoulos & Craig, 2002). Anecdotally, during
the task the PTs frequently expressed uncertainty about how to rate their pain or worried
that they were not accurately rating their experience. These concerns highlight the
cognitive nature of providing a pain rating.

Automatic processes in PTs were more difficult to decipher. Facial expressions
are often conceptualized as automatic (A. C. Williams, 2002), but their automaticity can
be overridden to a certain extent for various reasons, including context or social learning
(Craig et al., 1991; Craig, Standford, Fairbairn, & Chambers, 2006; Hill & Craig, 2002).
One of the reasons for which the automaticity of facial expressions is overridden is to
alter the communicated message (T. Hadjistavropoulos et al., 2011). Conceivably, the
presence of the partner influenced the facial expressions of pain and emotion. This
influence was noted in the correlations across facial expressions of emotion in POs and PTs, as well as in the regression analyses findings that pain-related facial activity in one partner was predictive of pain-related facial activity in the other.

The manner through which partners appear to mutually influence one another’s facial expression suggests that a transaction is occurring between the couples regarding the pain experience. It is likely that each partner’s individual motivations, goals, thoughts, beliefs, and previous experiences influence their behaviour in the transaction. If this is the case, the facial expressions have an initial level of automaticity, but over time and with repeated exposure to pain shift to being cognitively-mediated. Therefore, although this research question could be partially explored in the current investigation, further examination of the automatic and controlled nature of facial expressions in the context of pain is indicated. In particular, pain duration may have an important function in automatic and controlled processes among couples where one partner has CP.

Repeated exposure to pain may shift the degree to which responses are automatic versus cognitively-mediated. Comparisons of automatic and controlled processes in response to pain across couples in which pain duration is varied in the partner with CP is needed. Such investigations would add important clarification to whether the transactions between partners shift over time and to the impact this shift has on the automatic and controlled responses to pain.

Automatic and controlled responses were also examined in individuals who witnessed pain in their partner. An aim of this investigation was to identify whether partners of individuals with CP demonstrated distinct automatic and controlled responses to their partners’ pain compared to partners of individuals without CP. Once again,
evidence of a response from POs could be observed through pain intensity ratings, pain-related FACS scores, and facial expressions of emotion, all of which suggested that processes were occurring in the POs during the task in response to the PTs’ pain. As with the PTs, it is challenging to determine the extent to which the automaticity of facial expressions of pain and emotion was overridden by a cognitively-mediated response in the context of this study. Nevertheless, these processes were influenced by the presence of the partner experiencing pain.

As a whole, these findings support the transactional features of the communications model of pain in the dyadic context. Further, the communications model of pain recognizes the influence that the decoder’s response can have on the internal stimulus (e.g., reduction, no change, or increase in pain). This feedback from the decoder’s response to the ongoing or future internal experience highlights how patterns of responding can develop over time with repeated exposure to pain. The differences that emerged between the two study groups, in particular with regard to non-verbal behaviours, may be indicative of communication patterns that develop in couples with a CP partner as the couple continually moves through the steps of the model.

**Clinical implications.** This study may serve as a springboard for clinical research. Results advance that the dyadic context influences the pain experience. Gender differences, relationship variables, and partner’s facial expressions were of notable influence on the encoder and decoders responses to pain. As dyadic factors become better understood, modifications to mainstream intervention approaches could be evaluated to determine whether consideration of these factors leads to better pain, disability, and relationship outcomes. For instance, current treatment practices do not
differentiate between the experiences of men and women or consider how the gender of the person in pain influences the dyad’s responses to pain (e.g., Cano & Leonard, 2006; Ehde, Dillworth, & Turner, 2014). In this study, men provided lower perceived pain intensity ratings than women, despite women showing more pain-related facial expressions and reporting higher pain intensity ratings while completing the pain task than men. These results suggest discordance in the communication occurring within the dyad. With further research, these results could point to a need for therapeutic interventions that include a focus on communication in the dyad around painful experiences.

The evidence emerging from this investigation points to important mutual influences from partners in a couple. Relationship variables and individual variables play an important role in pain responses. Initial evidence for dyadic treatments for CP exists (Cano & Leonard, 2006) but has not been extensively examined. Moreover, dyadic research examining couples with an individual with CP is only in its infancy. There is ongoing identification of factors that influence pain responses. Further research that integrates both partners’ responses to pain and examines the ways in which having an individual with CP in the couple affects both partners is needed. As research progresses, treatment approaches that include both partners and that help couples address important relationship aspects that may influence pain (e.g., perceived relationship support), may prove beneficial.

**Limitations**

Several limitations must be taken into consideration when interpreting the findings of this investigation. One limitation results from the presence of the primary
researcher in the laboratory while couples completed the experimental pain task. The presence of a researcher can influence pain intensity ratings. For instance, men and women report lower pain sensitivity scores when in the presence of a researcher who is a man compared to a researcher who is a woman (Vigil, Rowell, Alcock, & Maestes, 2014). Pain tolerance is higher in individuals who are being tested by a researcher of the opposite gender (Kallai, Barke, & Voss, 2004), and men report lower pain intensity when in the presence of a woman (Vigil & Coulombe, 2011). Although efforts were made to limit interactions between the researcher and participating couples throughout the experimental pain task, it is nevertheless possible that the presence of the researcher influenced the participants’ pain responses. Replication of this investigation in a laboratory context where the pain task can be conducted without the experimenter present would help clarify the results of this study.

A second limitation of this study is the socio-demographic and relationship characteristics of the participating couples. The couples were primarily middle class (with more than 50% with annual income greater than $90,000 per year), White, heterosexual, and generally reported themselves to be in satisfied relationships. Ethnic differences in the pain experience have been observed in previous research (C. L. Edwards, Fillingim, & Keefe, 2001) and it is important to consider that the results of this study may not be generalizable to all couples. As well, only heterosexual couples were included in this study and the findings are likely not generalizable to same sex relationships. Further research involving same sex couples should be conducted. Additionally, Hagerdoorn et al. (2015) identified that when conducting research with couples in which one partner has an illness, participating couples tend to report less
negative affect and higher relationship satisfaction, and the partner without the illness typically demonstrates more engagement towards the partner with the illness. Based on the high degree of relationship satisfaction across couples in the CP and NCP group, participating couples may not be representative of couples at large. Future research with couples from a wider range of ethnic and socio-demographic backgrounds and with varying levels of relationship satisfaction would be important to pursue.

Selection bias is also a concern given the topic of this research and the nature of the experimental task. Pain tasks may be intimidating as a research method, and anecdotally, many initially interested couples did not participate because one of the members of the couple did not wish to experience the pain stimulus. Those who self-selected to participate may have differed from those who chose not to participate on important characteristics (e.g., pain anxiety). Although challenging in investigations involving pain induction, future research should be aimed to minimize the influence of self-selection.

**Recommendations and Future Directions**

In addition to the recommendations listed above to address the limitations of this study, several additional recommendations for ongoing research in pain in couples are indicated. First, an important strength of this research was the inclusion of both partners during the pain task. Although this structure allowed for some conclusions to be made regarding the automatic and cognitively-mediated nature of facial expression, it did not allow for a complete examination of the issue. Future research should consider whether pain responses different based on who is present while pain is experienced. Experimental procedures that include multiple conditions (e.g., alone versus with a partner) would
elucidate whether the presence of a partner influences encoding and decoding processes. PT facial expressions and pain ratings collected while completing the task alone should be compared to when completing the task in the presence of a partner. PO facial expressions and pain ratings could be gathered when the PO is observing the PT on video or through a one-way mirror and compared to facial expressions and pain ratings gathered when the PO directly observes the PT.

Second, the findings of the current study highlight that it is imperative to include a comparison group in pain investigations. Further research is needed that clarifies the manner through which pain responses differ in couples with and without CP, and how these responses may be affected by individual and contextual variables. Of particular interest in future research would be the temporal pattern of the association between relationship outcomes and the presence of pain. In the current investigation, relationship variables interacted with the presence of CP to influence non-verbal facial expression in observers. The pattern observed in the CP group was distinct from that observed in the NCP group. This raises the question of whether partners of individuals with CP are more likely to report lower relationship satisfaction and perceived support, resulting in greater pain-related facial expressions. Alternatively, poor relationship outcomes could be playing a negative role on the pain experience, thus leading to the increased pain behaviours in observers. Clarification of this pattern would provide relevant information for researchers and clinicians.

Similarly, as previously discussed, consideration of pain duration in individuals with CP, in addition to a comparison group with no pain, would clarify whether transactional communicative patterns develop over time. Of interest would be the
investigation of automatic and controlled processes occurring in couples where neither partner has pain, as compared to several groups of couples in which one partner has CP and the duration of pain across varied by groups. Comparisons of responses across groups would elucidate whether differences in the transactional patterns are a function of time.

The generalization of the findings in day-to-day contexts should also be examined further. The pain experienced in the laboratory setting may differ from the day-to-day experiences of couples with a partner with CP. In addition to pain induction investigations, researchers should consider ways of examining the influence of CP in the daily lives of couples, while still allowing for comparisons to couples where neither partner has CP. One potential avenue for future research may be the examination of pain communications in couples wherein one partner has had a recent injury. Examination of facial expressions and pain ratings/perceived pain ratings (in the partner with and without the injury) at several time points throughout recovery would allow for pain communication patterns to be examined over time. Additionally, among individuals with recent injuries (who are also in a relationship), identification of those with existing CP and those with no previous pain would allow for the exploration of several research questions. In particular, researchers could examine whether differences in pain ratings, pain-related facial expression, and facial expressions of emotion emerge between individuals with and without pre-existing CP. In the uninjured partner, perceived pain ratings, pain-related facial expressions, and facial expressions of emotions in response to the injured partner’s pain could be evaluated and compared between those with and without a partner with pre-existing CP.
Lastly, although the study of non-verbal pain expressions is often integrated into pain research, the examination of facial expressions of specific emotions is a nascent focus. Results from examination of facial expressions of emotion in this study suggest that different emotions are expressed between partners during painful interactions when the partner experiencing pain has a CP condition. Clarification of the patterns of facial expression of emotions and of factors that contribute to different expressions of emotions in couples with and without CP is warranted. Further, facial expressions of emotions have largely been examined using pain induction research (Gallant & Hadjistavropoulos, 2016). Extension of the research on facial expressions of emotions to various pain-related situations is needed. Facial expressions of emotion show promise as critical variables in the communication of pain and require further attention within dyadic pain research.

**Conclusion**

The goal of this study was to examine pain communication, using the conceptual framework of the communications model of pain (Craig, 2009; Craig et al., 2011; T. Hadjistavropoulos et al., 2011), in the dyadic context. The findings of this investigation support the application of the communications model of pain in the context of couples. Consistent with the model, one partner perceived an internal experience and encoded their pain through facial expressions and self-report, which led to responses (i.e., facial expression, adjustment of pain intensity ratings) in the observing partner. Also consistent with the communications model of pain, interpersonal characteristics and social context were found to affect the communication within couples.

The inclusion of both partners during the pain task allowed for direct examination
of the communication processes emerging during a painful experience. Unique processes that occur within the context of couples were identified, particularly with regard to the influences of partner facial expressions, gender, catastrophizing, and relationship and support variables. Moreover, differences in couples’ communication were observed as a function of the presence of an individual with CP in the relationship. This research supports the need for consideration of the social context in pain.

Overall, this study offers a significant contribution to the literature on pain in couples. It is evident that both partners in a couple influence the pain experience. Further research that includes both partners of the couple and examines verbal and non-verbal responses to pain is needed. This will ensure a more comprehensive understanding of the transaction occurring between partners when one member of the dyad experiences pain. As researchers further elucidate the patterns of pain communication that occur in couples, clinical implications can emerge that will assist couples in relationships where one partner has a CP condition.
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Appendix A

Research Ethics Board Approval

Research Ethics Board
Certificate of Approval

PRINCIPAL INVESTIGATOR
Michelle Gagnon

DEPARTMENT
Psychology

SUPERVISOR
Dr. Thomas Hadjistavropoulos

FUNDER(S)
Innovation Fund, Dean of Arts Research Award, CFI, CIHR

TITLE
Pain Communication in Couples

APPROVAL OF
Appendix A – Poster and Newspaper Advertisements
Appendix B – E-mail Template for Student Observers
Appendix C – Informed Consent Form – Participant
– Informed Consent Form Observer
Appendix D – Phone Screen for Couples
Appendix E – Demographics Information Sheet – Couples
Appendix F – Couple Satisfaction Index
Appendix G – Source Specific – Social Provision Scale
Appendix H – Pain Catastrophizing Scale (Individual and Significant Other Versions)
Appendix I – Interpersonal Reactivity Scale
Appendix J – Marlowe-Crowne Social Desirability Scale – Short Form
Appendix K – Post-Procedural Questionnaire
Appendix L – Post-Procedural Interview Questions
Appendix M – Demographic Sheet – Student Observer
Appendix N – Untrained Observer Visual Analog Scales
Appendix O – Instruction Scripts for Couples

APPROVED ON
November 14, 2013
CURRENT EXPIRY DATE
November 14, 2014
(And renewable to
November 14, 2018)

Delegated Review

CERTIFICATION
The University of Regina Research Ethics Board has reviewed the above-named research project. The proposal was found to be acceptable on ethical grounds. The principal investigator has the responsibility for any other administrative or regulatory approvals that may pertain to this research project, and for ensuring that the authorized research is carried out according to the conditions outlined in the original protocol submitted for ethics review. This Certificate of Approval is valid for the above time period provided there is no change in experimental protocol, consent process or documents.

Any significant changes to your proposed method, or your consent and recruitment procedures should be reported to the Chair for Research Ethics Board consideration in advance of its implementation.

ONGOING REVIEW REQUIREMENTS
In order to receive annual renewal, a status report must be submitted to the REB Chair for Board consideration within one month of the current expiry date each year the study remains open, and upon study completion.
Please refer to the following website for further instructions: http://www.uregina.ca/research/REB/main.shtml

Dr. Larena Hoeber, Chair
University of Regina Research Ethics Board

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December 5, 2014

Dr. Thomas Hadjistavropoulos
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Dear Dr. Hadjistavropoulos,

RE: REB-14-154, REB #2351314
Title: Pain Communication in Couples

Your application for research ethics review has undergone a harmonized review by the Regina Qu’Appelle Health Region (RQHR) and University of Regina (U of R) Research Ethics Boards (REBs). In accordance with the Research Ethics Review Reciprocity Agreement signed by the University of Saskatchewan, University of Regina, and Regina Qu’Appelle Health Region, the RQHR REB accepts the Certificate of Approval issued by U of R REB. This letter is issued to you in lieu of a Certificate of Approval by the RQHR REB. This letter permits you to conduct research activities as approved by the U of R REB, provided that you maintain a valid and up-to-date Certificate of Approval.

All continuing ethics review will be conducted by the U of R REB. The U of R is authorized to share all communications pertaining to this file with the RQHR REB at their discretion. The RQHR REB may provide input into continuing ethical review activities, as agreed upon by both REBs.

The RQHR REB reserves the right to revoke the privileges described in this letter at any time in order to conduct their own independent research ethics review of your project. Such a decision would be communicated to you and the U of R REB in writing.

If at any time you will require resources, participants, or data from any additional departments, you must provide the RQHR REB with the required signatures before proceeding.

Best wishes for your continuing research endeavours.

Sincerely,

[Signature]

Dr. Michelle McCarron, Chair
Research Ethics Board
Regina Qu’Appelle Health Region

cc. University of Regina Research Ethics Board
Appendix B

Telephone Screen

“Thank you for your interest in this study. Prior to coming into the lab, we need to ensure that both you and your partner are eligible for this study. We will need to speak to you and to your partner individually over the phone.”

Pre-Screen Questions:
1. Are you and your partner younger than 19 years of age?
   [ ] Yes   [ ] No

2. Have you and your partner been co-habiting for fewer than 6 months?
   [ ] Yes   [ ] No

3. Are you or your partner currently experiencing any serious psychiatric conditions?
   [ ] Yes   [ ] No

4. Are you or your partner currently suffering from a terminal illness or cancer?
   [ ] Yes   [ ] No

5. Are you and your partner currently expecting a child?
   [ ] Yes   [ ] No

6. Do you or your partner have sensitive skin?
   [ ] Yes   [ ] No

7. Do you or your partner have internal electrical devices (e.g., pacemaker)?
   [ ] Yes   [ ] No

If no to all questions, then criteria met for inclusion

If criteria not met:
“Unfortunately you do not meet criteria for our study at this time. We appreciate your interest and hope that you will consider participating in our studies in the future.” [end call]

If criteria met:
“Thank you for your time. I now need to ask you a few demographic questions. Before asking these questions, I will require verbal consent that you agree to my asking these questions. All responses will remain confidential. Do you provide consent to answering a few demographic questions?

Verbal Consent Provided? :   [ ] Yes   [ ] No
*(only continue with demographic questions is verbal consent provided by participant).
Appendix C

Demographic Information Sheet

1. Age: _______

2. Sex:  □ MALE  □ FEMALE

3. How many years of education do you have (include all levels including elementary school, high school, and post-secondary/post-graduate education)?
   __________________________

4. Average Household Annual Income:  □ < $20,000
   □ $20,000-$39,999
   □ $40,000-$69,999
   □ $70,000-$89,999
   □ $90,000 +
   □ do not wish to disclose

5. What is your ethnic background?______________________________________________

6. How long have you been with your spouse/partner (in years): _________________

7. How long have you been living with your spouse/partner (in years): ____________
Demographic Information Sheet– Pain Questions CP-PT

These questions are about your demographic information. These items are very important for our research. Responses are confidential. Please answer honestly.

1. Please indicate if any of the following apply to you? (Please circle YES or NO for every item):
   a. Do you have sensitive skin? YES NO
   b. Living with partner fewer than 6 months YES NO
   c. Currently experiencing psychosis YES NO
   d. Currently diagnosed with a terminal illness YES NO
   e. Currently expecting a child YES NO

2. Please describe your injury or pain: ____________________________________________

3. Please list the cause of your injury or pain: _______________________________________

4. How long have you been experiencing this pain (in months): ________________

5. Please rate your pain by circling the one number that best describes your pain at its worst in the last week:
   
   0 1 2 3 4 5 6 7 8 9 10
   No Pain  Pain as bad as you can imagine

6. Please rate your pain by circling the one number that best describes your pain at its least in the last week:
   
   0 1 2 3 4 5 6 7 8 9 10
   No Pain  Pain as bad as you can imagine

7. Please rate your pain by circling the one number that best describes your pain on average:
   
   0 1 2 3 4 5 6 7 8 9 10
8. Please rate your pain by circling the one number that tells how much pain you have right now:

0 1 2 3 4 5 6 7 8 9 10
No Pain  Pain as bad as you can imagine

9. Please colour on the diagram below the areas in which you experience pain:
Demographic Information Sheet – Pain Questions CP-PO

These questions are about your demographic information. These items are very important for our research. Responses are confidential. Please answer honestly.

1. Please indicate if any of the following apply to you? (Please circle YES or NO for every item):
   f. Do you have sensitive skin? YES NO
   g. Living with partner for fewer than 6 months YES NO
   h. Currently experiencing psychosis YES NO
   i. Currently diagnosed with a terminal illness YES NO
   j. Currently expecting a child YES NO

2. Please list any past injuries or chronic pain that you have experienced:__________________________________________________________
   __________________________________________________________________________________________
   ________________________________________________________________

3. Would you currently consider yourself to have a chronic pain condition?
   □ Yes □ No

If you answered “Yes” to question 3, please answer the following question. If you answered “No” to question 3, please skip to question 9.

4. Please describe your injury or pain:__________________________________________________________
   __________________________________________________________________________________________
   ________________________________________________________________

5. Please list the cause of your injury or pain:________________________________________________
   __________________________________________________________________________________________
   ________________________________________________________________

6. How long have you been experiencing this pain (in months): ____________________________

7. Please rate your pain by circling the one number that best describes your pain on average:
   0 1 2 3 4 5 6 7 8 9 10
   No Pain Pain as bad as you can imagine
8. Please rate your pain by circling the one number that tells how much pain you have right now:

   0  1  2  3  4  5  6  7  8  9  10
   No Pain  Pain as bad as you can imagine

For the following questions, please think about your partner’s pain or injury:

9. Please describe your partner’s injury or pain: ________________________________
    ________________________________________________________________
    ________________________________________________________________

10. Please list the cause of your partner’s injury or pain: _______________________
    ________________________________________________________________
    ________________________________________________________________

11. How long has your partner been experiencing this pain (in months): __________

12. Please colour on the diagram below the areas in which your partner experiences pain:
Demographic Information Sheet – Pain Questions NCP-PT and NCP-PO

These questions are about your demographic information. These items are very important for our research. Responses are confidential. Please answer honestly.

1. Please indicate if any of the following apply to you? (Please circle YES or NO for every item):
   k. Do you have sensitive skin? YES NO
   l. Living with partner for fewer than 6 months YES NO
   m. Currently experiencing psychosis YES NO
   n. Currently diagnosed with a terminal illness YES NO
   o. Currently expecting a child YES NO

2. Please list any past injuries or chronic pain that you have experienced: ___________
   ____________________________________________________________________________
   ____________________________________________________________________________

3. Would you currently consider yourself to have a chronic pain condition?
   □ Yes  □ No

If you answered “Yes” to question 3, please advise the researcher before continuing.
### Appendix D

**Numeric Rating Scale**

<table>
<thead>
<tr>
<th>0</th>
<th>50</th>
<th>100</th>
</tr>
</thead>
<tbody>
<tr>
<td>No Pain</td>
<td>Pain as bad as it could be</td>
<td></td>
</tr>
</tbody>
</table>

Report 1: ____________________________

Report 2: ____________________________

Report 3: ____________________________

Report 4: ____________________________

Report 5: ____________________________

Report 6: ____________________________

Report 7: ____________________________
Appendix E

Participant Consent Form

**Project Title:** Pain Communication in Couples

**Researcher(s):**
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University of Regina
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(306) 337-2537

**Supervisor:**
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Research Associate, Regina Qu’Appelle Health Region
Department of Psychology
University of Regina
hadjistt@uregina.ca
(306) 585-4457

**Purpose(s) and Objective(s) of the Research:**
- The purpose of this study is to explore the effects that pain experienced in one person in a couple has on both members of the couple.

**Procedures:**
- The experiment will take approximately 1 hour to complete.
- You will be assigned an ID number to ensure confidentiality of your responses. We will determine who will complete the pain induction procedure. In couples where one partner has chronic pain, the individual with chronic pain will complete the task. This partner will be referred to as the *Task-partner*. In couples where neither partner has chronic pain, the person completing the task will be randomly determined by the researcher. This partner will be referred to as the *Observer-partner*.
- You and your partner will be asked to complete a number of self-report questionnaires.
- A demonstration of the procedure and the pain rating scale will be provided.
- You and your partner will be asked to sit facing each other. The thermal stimulator (small rectangular surface that produces heat) will be placed on the forearm of the partner completing the task.
- Video recording devices will be set up to record facial reactions throughout the task.  
  - We also ask that you grant permission to have the video footage shown to untrained observers (students) who will rate pain and/or emotional expression in both partners.
o Untrained observers will be explicitly asked not to disclose any identifiable information regarding the individuals in the video recordings and to employ the strictest rules of confidentiality.

- The Task-partner will then be asked to complete a pain threshold and tolerance task. For the threshold task, stimulus intensity will be slowly increased until you indicate that it starts to become painful. For the tolerance task, thermal stimulation will slowly increase (but will not exceed approved safety limits) until you tell us that your level of tolerance has been reached.
- Next, you will complete 5 trials of thermal stimulation.
  o For the Task-partner, this will cause some pain or discomfort. You may discontinue the task or withdraw from the study at any time by indicating to the researcher that you would like to withdraw.
  o The Observer-Partner will observe the Task-partner throughout the trials. You may discontinue the task or withdraw from the study at any time by either saying “stop” or otherwise informing the researcher of your willingness to withdraw.
  o At the end of each trial, the researcher will say “report.” At this time, the Task-partner should rate the level of pain he/she experienced and the Observer-partner should rate the level of pain he/she thinks the Task-partner was experiencing.
- Following this, you will both be asked to complete a post-procedure questionnaire. Individually with the researcher, each partner will complete an interview lasting up to 5 minutes.
- An audio recording device will be set up to record the interview.
- Following the interviews, the study will be completed. You are encouraged to ask any questions regarding the procedures and goals of the study or your role.

**Exclusion Criteria:**
- Please check if you meet any of the following criteria:
  □ Currently experiencing psychosis
  □ Diagnosed with a terminal illness
  □ Pregnant
  □ Sensitive skin

**Potential Risks:**
- Although no negative effects are anticipated with the protocols, there is the possibility that you may experience some reddening and sensitivity to the skin on the small area of the skin where the thermal stimulator (small rectangular surface that produces heat) will be placed during and after the study. In the overwhelming majority of cases, the redness disappears within 1 to 2 hours.
- In extremely rare circumstances, it is possible that the pain stimuli may cause a minor small burn or minor small blister to the skin.
In the unlikely event of a negative reaction following the study, we recommend you consult your physician and request that you inform us of any such event.

**Potential Benefits:**
- Your participation will assist in furthering the understanding of how pain affects couples – both the partner experiencing pain and the partner who is not experiencing pain.
- Results may provide direction for the development of future programs designed to help couples with chronic pain.
- Furthermore, results will enhance the conceptualization of pain communication.

**Compensation:**
- You and your partner will each receive $20 for your participation in this study (i.e., as a couple you will receive $40).
- Even if you choose to withdraw, you will be compensated for your time.

**Confidentiality:**
- Although the data from this research project will be published and presented at conferences, the data will be reported in aggregate form, so it will not be possible to identify individuals.
- Consent forms will be stored separately from the questionnaires, so that it will not be possible to associate a name with any given set of responses.
- Please do not put your name or other identifying information on the questionnaires.
- The video segments and audio recordings will be viewed or heard by the primary researcher and research assistants who will employ the strictest rules of confidentiality.
- Untrained observers (e.g., university students) will also watch the videos. They will be explicitly asked not to disclose any identifiable information regarding the individuals in the video recordings. However, we cannot control what the participants do with the information presented.

**Storage of Data:**
- Only the researchers and research assistants will have access to the data.
- All original data (hard copies) and video/audio recordings will be securely kept.
- Informed consent and identifying information will be kept in a separate locked cabinet.
- Electronic data will be kept in password protected databases and on password protected computers.
- Data will be stored for a minimum of 7 years following publication.
- Subsequent to this period, all data will be shredded and deleted.
Right to Withdraw:
- Your participation is voluntary, and you may choose to answer only those questions with which you feel comfortable providing a response.
- You may withdraw from the research project for any reason at any time without explanation or penalty of any sort.
- Should you wish to withdraw, please notify the researcher, and he or she will immediately end the experiment and all data will be permanently deleted.
- Your right to withdraw data from the study will apply until November 1, 2014. After this date, it is possible that some form of research dissemination will have already occurred and it may not be possible to withdraw your data or your video footage may have already been viewed.

Follow up:
- The goal is to have results from this study available early in 2015.
- To obtain results from the study, please contact the Health Psychology Laboratory at:
  Phone: (306) 585-4428; Email: gagnonmi@uregina.ca

Questions or Concerns:
- Contact the researcher(s) using the information at the top of page 1.
- This project has been approved on ethical grounds by the University of Regina Research Ethics Board on November 14, 2013. Any questions regarding your rights as a participant may be addressed to the committee at (585-4775 or research.ethics@uregina.ca). Out of town participants may call collect.

Your signature below indicates that you:
- Consent to participate in this research study and understand your participation is voluntary.
- Understand that, although unlikely, in rare cases minor negative consequences (e.g., a minor burn to a small area of the skin as a result of the thermal stimuli) may occur. You agree to inform the primary researchers if you experience an aversive consequence.
- Consent to being video recorded and to have this footage showed to untrained observers who will make ratings based on facial expressions.
- Consent to being audio recorded.

Your signature below indicates that you have read, understand the description provided, and agree with the following statement:

I have had an opportunity to ask questions and my/our questions have been answered. I consent to participate in the research project. A copy of this Consent Form has been given to me for my records.
<table>
<thead>
<tr>
<th>Name of Participant</th>
<th>Signature</th>
<th>Date</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Name of Researcher</th>
<th>Signature</th>
<th>Date</th>
</tr>
</thead>
</table>

*A copy of this consent will be left with you, and a copy will be kept by the researcher.*
Appendix F

Numeric Rating Scale Instructions

“For the next few portions of the study, I will need you to use the following measure. This measure allows you to rate pain from 0 to 100, where 0 means “no pain” and 100 means “pain as bad as it can be.” For example, if you were to experience the worst pain you’ve ever felt, where would you place it? [wait for response]. And if you were feeling no pain at all, where would you place it? [wait for response; provide corrected feedback if needed]

While you are completing the next few tasks, [Name of Task-Partner], I want you to be rating the pain that you are experiencing. [Name of Observer-Partner], while you are completing the next few tasks, I would like you to observe [Name of Task-Partner]. When you provide ratings, I would like you to be reporting the intensity of the pain you think that your partner is experiencing while completing these tasks. You are not reporting your own pain, but rather your partner’s pain.

At various points throughout the next few parts of this study, I will say the word ‘report,’ followed by a number. When I say the word ‘report’ followed by a number, I want you to provide a rating next to the appropriate number on the sheet beside you. For example, if I say “report 1” please complete the line next to “report 1.” [Name of Task-Partner] provide a pain rating of the pain you might be experiencing on your arm. [Name of Task-Observer], provide a rating of the pain intensity that you think [Name of Task-Partner] might be experiencing on his/her arm. Remember, this scale ranges from 0 to 100, where 0 means ‘no pain’ and 100 means ‘pain as bad as it can be’. Any questions?”
Appendix G

Baseline Task Instructions

“Now we’re going to have a resting period. Just relax and look into the camera. For this part, try not to interact with each other or distract each other. Just relax and look into the camera until I tell you that you may stop. I will ask you to provide a report at the end of the task.”

[Time 4 minutes]

“‘Report 2’ provide a rating next to this number on the sheet beside you. [Name of Task-Partner], provide a pain rating of the pain you are experiencing on your arm. [Name of Task-Observer], provide a rating of the pain intensity that you think [Name of Task-Partner] is experiencing on his/her arm. If you look down to provide your rating, please remember to look back towards your partner once it is noted.”
Appendix H

Pain Threshold Instructions

“[Name of Task-Partner], in this next task, the thermode will begin to slowly produce heat. I would like you to discontinue the task by pressing this green button [provide stop button] as soon as you begin to feel any pain stimulus. In other words, as soon as you begin to feel pain, press the green button.

[Name of Task-Observer], your job is just to watch your partner.”
Appendix I

Pain Tolerance Instructions

“[Name of Task-Partner], in this task, I will once again increase the temperature. I want you to push the green button when it becomes too painful to handle. The temperature will immediately decrease. In this task, stimulus safety limits will not be exceeded. So, as soon as you can no longer tolerate the pain, press the green button.

[Name of Task-Observer], your job is just to watch your partner.”
Appendix J

Pain Trial Task Instructions

“In this last portion, you will both be playing a role. Please feel free to interact as you normally would during this task. That means you can talk about what is happening or talk about things unrelated to what is happening, or even sit in silence. It is up to you. I only ask that you don’t share your specific pain ratings. [Name of Task-Partner], now we will complete the trial task. You will feel the thermode heat up and cool down a series of times. While you are completing the task, please try to look forward instead of down. Throughout the task, you will hear the word ‘report’ followed by a number, as we previously discussed. When I say the word ‘report’ I want you to provide a pain rating on the appropriately numbered line on the sheet beside you. This report should be of the worst pain you experienced since your last report. Remember, this scale ranges from 0 to 100, where 0 means ‘no pain’ and 100 means ‘pain as bad as it can be.’ You will provide a rating of the worst intensity of pain you have felt on your arm since you last heard to word ‘report’. So, although the pain will likely have started to decrease at the point I say ‘report,’ please think of how intense the pain has just been. If you look down to provide your rating, please remember to look back towards your partner once it is noted.

[Name of Observer-Partner], while your partner is completing these tasks, I would like you to observe him/her. When I say the word ‘report,’ I want you to provide a pain rating on the appropriately numbered line on the sheet next to you. Remember, you will be reporting the intensity of the pain you think that your partner is experiencing while completing this task. Please report the number reflecting the worst pain you think your partner experienced since your last report. If you look down to provide your rating,
please remember to look back towards your partner once you have provided a rating.”