PAIN'S ECHO:
EMPATHY AND THE SOCIAL COMMUNICATION OF PAIN

by

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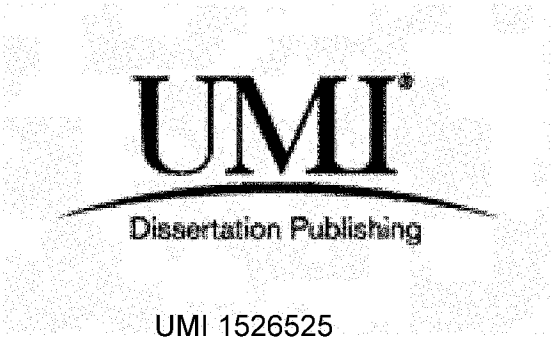

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Abstract

Two judgment studies were conducted to investigate (1) the effect of observer trait empathy on judging pain from facial expression; (2) whether empathic pain facial expression of an intermediary encodes (echoes) pain experienced by a first to a third party.

Experiment 1: High- and low-empathy judges viewed two-second thin-slice videos of models exhibiting pain, no-pain, and neutral facial expressions. Judges' faces were video-recorded while they rated the models' pain. Trait empathy scores were positively correlated with pain ratings: High-empathy judges tended to rate pain more highly than low-empathy judges.

Experiment 2: Participants (receivers) viewed 2-second clips of judges' facial expressions from Experiment 1 (Senders) to estimate Experiment 1 models' pain. Signal detection analyses indicated that receivers detected pain in models to a small, significant degree, suggesting the presence of an empathic pain "echo" in observers of others' suffering. Implications for understanding the social communication of pain are discussed.

Keywords: Pain, empathy, pain facial expression, facial expression, nonverbal communication, judgment study

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Introduction

> And I will use regimens for the benefit of the ill in accordance with my ability and my judgment, but from [what is] to their harm or injustice I will keep [them].
>
> –"The Hippocratic Oath"[1]

Pain is the most common complaint for which adults seek primary and emergency care (Gureje, Von Korff, Simon, & Gater, 1998; Matthias et al., 2010; Pitts, Niska, Xu, & Burt, 2008). Between 15-40% of Canadians and 57% of Americans suffer from chronic pain, compared with 21.5% worldwide (Choinière et al., 2010; Gilron & Johnson, 2010; Gureje et al., 1998; Matthias et al., 2010). The risk of suicide is doubled for sufferers, and the condition costs the Canadian economy an estimated $10 billion per year, while it cost the US $560-$635 billion in 2010 (Reitsma, Tranmer, Buchanan, & Vandenkerkhof, 2011; Tang & Crane, 2006). Pain is underestimated and undertreated in health care, and a negative relationship has been found between compassion for patients and time spent in health care training and professions (Breivik et al., 2009; Choinière et al., 2010; Firth-Cozens & Cornwell, 2009; Prkachin, Solomon, & Ross, 2007). This increases patients' risk for harm, and gives rise to calls for more compassion in care and methods to increase pain assessment accuracy (Brennan, Carr, & Cousins, 2007).

Facial expression is an important dimension of nonverbal communication and socialization in humans, and pain facial expression is present at birth, spontaneous, and measureable as an indicator of pain (Malatesta & Haviland, 1982; Prkachin, 1997; Schiavenato et al., 2008). Ability to judge pain from facial expression is critical for assessment and diagnosis of pain in pre- and nonverbal patients and important for a multidisciplinary, patient-centred

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[1] von Staden, H. (1996). "In a pure and holy way": Personal and professional conduct in the Hippocratic Oath? *Journal of the History of Medicine and Allied Sciences, 51: p. 406.* (Brackets translator's)

approach to accurate pain assessment in general (Choinière et al., 2010; Prkachin, 2009). The studies presented in this thesis investigated effects of observer trait empathy on judging pain facial expression, and conducted a heuristic exploration into whether empathy encodes the pain of the observed on the face of the observer.

The Hippocratic Oath does not include an injunction to minimize pain in patients *per se* (Markel, 2004; Miles, 2005). This is because ancient Greek physicians, "imperfectly separated," (Miles, 2005, p. 76) pain from disease or injury, and were without the pharmacotherapy tools that allow modern doctors to manage pain without treating the underlying malady– that is, to consider pain as treatable in itself, and not merely a symptom of disease (p. 70). Research on pain and pain treatments has borne knowledge of the evolutionary function, neurophysiology, and classifications of pain, as well as advanced analgesics, anaesthetics, and pain management techniques, thereby providing an array of approaches for assisting patients with pain (Brune & Hinz, 2013; Freeman, 2013; Melzack, 1999; Perl, 2007; Thomas, 2014; Turk & Okifuji, 2002). Further, neuroimaging studies have reconceived the "concept of "pain" as a "disease entity" versus a syndrome or symptom," particularly with regards to chronic pain (Doleys, 2010, p. 399; Loeser & Treede, 2008; Tracey & Bushnell, 2009).

Pain assessment is also critical for optimizing pain treatment or management, which can increase patients' resilience to prescribed care regimens, expedite post-operative recuperation, and improve psychological wellbeing and overall quality of life (QoL) (Breivik et al., 2009; Greenstreet, 2001; Puntillo & Weiss, 1994). Accurate pain assessment from pain expression is fundamental in health care for the diagnosis and characterization of injury and disease; those caring for people with congenital insensitivity to pain (CIP) must observe physical harm in order to respond to injury or infection and prevent worsening (Creamer, Lethbridge-Cejku, &

Hochberg, 1998; Escalante, Lichtenstein, Lawrence, Roberson, & Hazuda, 1996; Heckert, 2012). Outside the health care setting, an accurate ability to assess pain is important for governing such critical human affairs as caretaking and altruistic behaviour.

However, research reveals that patient pain is underestimated and undertreated in the health care setting in relation to factors such as the type of pain or disease the patient endures, certain patient characteristics, and the length of time care providers have worked in their practice or specialty (Anderson, Green, & Payne, 2009; Breivik et al., 2009; De Ruddere et al., 2011; Kappesser, Williams, & Prkachin, 2006; Pletcher, Kertesz, Kohn, & Gonzales, 2008). Those living with chronic pain experience what harkens back to the ancient Greek view—pain lacking an empirically detectible malady can be difficult to diagnose, often leaving patients' credibility questioned (Craig, 2009; Dewar, Greggs, White, & Lander, 2009; Toye & Barker, 2010). Chronic pain that is associated with an underlying condition such as cardiovascular disease, cancer, or HIV has also been found to be undertreated (Anderson et al., 2000; Breivik et al., 2009; McGillion et al., 2009; Phillips, Cherry, Moss, & Rice, 2010).

Patients who may be disliked or display their pain in a context of other negative affect, and patients of ethnic and racial minorities, receive suboptimal pain assessment and management (De Ruddere et al., 2011; Kappesser & Williams, 2002; Pletcher et al., 2008). Ironically, patient pain in general is underestimated the longer health care providers practice or train in medicine (Kappesser et al., 2006; Prkachin & Craig, 1995). This places patients at risk for both harm and injustice, and has brought some to consider medicine to be, "[...] at an "inflection point" in which unreasonable failure to treat pain is viewed worldwide as poor medicine, unethical practice, and an abrogation of a fundamental human right," (Brennan et al., 2007, p. 205).

Concern over the increasing evidence of undertreatment of pain has given rise to an overwhelming call in the literature for increased compassion in care (Wear & Zarconi, 2008; Youngson, 2014). That most nurses and doctors enter the care professions with the intention of bettering the lives of patients, yet find their compassion waning the longer they practice, suggests that compassion and its sustainability are complex (Firth-Cozens & Cornwell, 2009; Kappesser et al., 2006; Wear & Zarconi, 2008). A number of mechanisms have been proposed as explanations for diminishing compassion in care. Long term exposure to witnessing extreme levels of pain may cause care providers to extend, "[...] the higher end of the implicit [pain] scale," wherein a patient's self-rating of worst pain experienced is viewed as relative to the highest patient pain seen in the providers' career in care (Kappesser et al., 2006, p. 109). Further, feeling compelled to act upon compassion to bring positive change to the lives of others can be draining when care is not reciprocated, or when providers must at times mitigate against deception by patients with drug seeking behaviours, giving rise to compassion fatigue in the caring professions (Cash, 2007; Kappesser et al., 2006; Portnoy, 2011; Walker, Morin, & Labrie, 2012).

Practitioners of medicine must prescribe with discernment for patients' wellbeing, as per Paracelcus' entreaty, "Solely the dose determines that a thing is not a poison," as well as be concerned for medical liability (Deichmann, Henschler, Holmstedt, & Keil, 1986, p. 210). Patients taking analgesics to treat tonic pain generally do not quickly develop a tolerance for the drug - and this is supported by lab research in mice - the way that those who seek it for mood alteration do (Melzack, 1990; Rittner, Brack, & Stein, 2008). In 1991 to 2007, however, fatalities rose in Ontario by five times due to oxycodone use in correlation with physicians' increased prescription of opioids (Dhalla et al., 2009). In the United States, opioid abuse increased greatly

between 1999 and 2004, and mortality from opioid addiction overtook mortality from non-analgesic drug abuse (Compton & Volkow, 2006; Paulozzi & Xi, 2008).

It is perhaps regard for more objective decision making that compels the argument that compassion is insufficient as a moral guide, and should yield to logic reasoning lest it be cause for ineffective decision making (Bloom, 2014; Shakespeare, 2013). Interestingly, while conceptions of pain have changed greatly, sensibilities with regards to compassionate communication with patients appear to have endured since Hippocrates: "The patient, though conscious that his (sic) condition is perilous, may recover his health simply through his contentment with the goodness of the physician" (Firth-Cozens & Cornwell, 2009, p. 3). Aside from patients considering compassionate care to be more effective, practical evidence suggests that higher empathy improves patient-provider communication, fosters patient-centred practice, and gives rise to more thorough and accurate diagnoses (Firth-Cozens & Cornwell, 2009; Nguyen, Hong, & Prose, 2013; Wear & Zarconi, 2008). Further, higher compassion has been found to be protective for the health of the provider, and compassion for self and self-care are becoming integral to curricula in nursing and medicine (Firth-Cozens & Cornwell, 2009; Lowenstein, 1997; Matthias et al., 2010; Murinson et al., 2011).

A communicative dyad exists between the evolutionary functions of pain expression and empathy that forms the basis of health care: Pain expression functions in part to solicit succour, while empathy is necessary to assess the pain a sufferer is experiencing and respond with the appropriate care (Batson, Fultz, & Schoenrade, 1987; Goubert et al., 2005; Prkachin & Craig, 1995; Saarela et al., 2007). Verbal and nonverbal forms of communication are inextricably intertwined, patients use an array of behaviours to express pain, and nonverbal forms can be accurately encoded and decoded (Craig, Prkachin, & Grunau, 2011; Deyo, Prkachin, & Mercer,

2004; Knapp, Hall, & Horgan, 2013; Roter, Frankel, Hall, & Sluyter, 2006). While rating tools allow patients to quantify their pain for care providers, accurate diagnosis relies greatly on communicative dynamics requiring subjective skills to accurately determine patients' pain levels (Coll, Grégoire, Latimer, Eugène, & Jackson, 2011; Pasero & McCaffery, 2003).

Facial expression has been established as a valid form of nonverbal communication, accurately perceived in minute instances, and critical in situations involving pre- or nonverbal individuals, such as young children, the elderly, and persons with mental disabilities, as well as in situations where respondents may not provide candid or accurate self-report (Buck & Duffy, 1980; Clark, Winkielman, & McIntosh, 2008; Craig et al., 2011; Patrick, Craig, & Prkachin, 1986; Rosenthal, 1987; Whiten & Perner, 1991). Accuracy at judging pain facial expression has been argued to be useful in diagnosis, as well as prescriptive in reducing disparities in pain treatment (Drwecki, Moore, Ward, & Prkachin, 2011; Prkachin, Currie, & Craig, 1983). Others argue that training in pain facial recognition is not useful, because facial expressions of negative affect that are often present during pain (sadness, fear, anger) are not easily distinguished from pain by care providers (Kappesser & Williams, 2002). However, from the patient-centred paradigm, patients' wellbeing is benefitted by providers' capability to achieve a holistic comprehension of a patient's condition, in order to derive the most accurate and effective diagnosis. Empathy as well as pain assessment supported by accurate pain expression recognition are key to improving pain diagnosis and treatment.

In recent years there has been a resurgence in interest in both empathy and compassion, particularly as they relate to the responses that observers, whether professionals or laity, have to people suffering from pain (Hein & Singer, 2010; Irving & Dickson, 2004; Matthias et al., 2010; Mazzola et al., 2010; Mercer & Reynolds, 2002; Murinson et al., 2011; Perry, Bentin, Bartal,

Lamm, & Decety, 2010; Walter, 2012). This resurgence has been driven by a number of factors, some having to do with the kinds of documented shortcomings in the treatment of pain sufferers described above, some arising from empirical studies of the perception of pain in others, and some arising from methodological and conceptual advances in other related areas that have provided new insights into the processes that support or inhibit empathic and compassionate behaviour.

The studies that comprise this thesis have been informed by this literature and represent attempts to explore psychological and behavioural elements of the responses that observers have to evidence of suffering in others. Two connected judgment study experiments were conducted to examine (1) the influence of self-rated empathic characteristics on participants' perception of the pain of other people in varyingly painful conditions and (2) the novel possibility that perceiving pain in others is, in turn, perceptible *to* others. The studies were performed using a combination of judgment study methodology and "thin slices" of behaviour (Ambady, Bernieri, & Richeson, 2000; Ambady & Rosenthal, 1997). Below is a literature review of core concepts and findings in the study of pain expression, social perception of pain and pain-related empathy, which provides the base justification for the research questions to be addressed. This is followed by a review of the judgment study and thin-slice methods and concepts

Literature Review

Pain

The feeling of pain cannot be categorized solely as a physical sensation. "From the perspective of emotion, pain is a state of the individual that has as its primary defining feature awareness of and homeostatic adjustment to tissue trauma," (Chapman, 2004, p. 63). 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," (IASP, 2014; IASP Task Force on Taxonomy, 1994; Loeser & Treede, 2008; Singer et al., 2004). After a meeting in Kyoto by the IASP Task Force on Taxonomy in 2007, it was decided that the above suitably described chronic pain, and no changes were made to the definition (Loeser & Treede, 2008). However, notation on the IASP webpage provides more comprehensive language:

> The inability to communicate verbally does not negate the possibility that an individual is experiencing pain and is in need of appropriate pain-relieving treatment. Pain is always subjective. [...] Biologists recognize that those stimuli which cause pain are liable to damage tissue. [...] There is usually no way to distinguish [peoples'] experience from that due to tissue damage if we take the subjective report. If they regard their experience as pain, and if they report it in the same ways as pain caused by tissue damage, it should be accepted as pain. This definition avoids tying pain to the stimulus. (IASP, 2014)

Of import in the IASP definition of pain, and its attendant note, is its emphasis on pain as subjective, and its lack of emphasis on verbal report. It does not preclude the pre- or nonverbal from being perceived as experiencing pain and requiring treatment (Anand & Craig, 1996; Schiavenato & Craig, 2010), and it separates the experience of pain from disease and injury. These assertions work against the continued underassessment and undertreatment of pain in the care industry. Patients enduring chronic or neuropathic pain may express pain that eludes the

empirical detection of tissue damage, as well as curative treatments, and this definition of pain denounces dismissing the credibility of individuals who report pain under such circumstances.

The most direct method of assessing pain is empirical observation of tissue damage or inflammation; indeed, this is the remaining mode of assessment left for those who provide care to patients with CIP, since lacking the experience of pain precludes pain's expression (Learoyd, 2011; Nagasako, Oaklander, & Dworkin, 2003). CIP is very rare, however, and much suffering and injury would go without notice were it not for the ability of patients to experience and express pain. Support for the sufferer's perspective has led to verbal self-report to be considered highly reliable – thought of as the 'gold standard,' to some, but as 'fool's gold' to others – for pain assessment (Anand & Craig, 1996; Schiavenato & Craig, 2010). While patient self-report should provide a very accurate form of assessment since it comes from personal perspective, self-report can be unreliable and subject to distortion (Hadjistavropoulos et al., 2011). Further, overemphasis on self-report can diminish the perceived validity of nonverbal expressions of pain (Hadjistavropoulos, Hunter, & Dever Fitzgerald, 2009). It has been established that nonverbal behaviour, including facial expression, can be accurately encoded and decoded and is reliable and valid as a source of data in psychological research that is not redundant with verbal self-report (Ambady & Rosenthal, 1997; Craig, 1992; Patrick et al., 1986; Rosenthal, 1987). This development has import in behavioural research when participants are not expected to be accurate in verbal self-report, or are pre-linguistic or unable to communicate verbally, including young children and infants, those with communicative or intellectual disabilities, and animals (LaChapelle, Hadjistavropoulos, & Craig, 1999; Langford et al., 2010; Whiten & Perner, 1991).

This study takes as its basis evolutionary psychology, and the social communication model of pain. The social communication model focuses on the encoding and decoding of

observable pain behaviours in social (i.e. interpersonal) interactions, and assumes the functions of pain and pain behaviours to be explainable by evolutionary theory (Craig, 2009; Williams, 2002). Still, this review includes a basic neurophysiological (i.e. intrapersonal) background of pain for the purpose of demonstrating the involuntary nature of pain behaviours including, and the potential accuracy of estimation of pain from, pain facial expression (Craig, 2009).

Evolutionary function. Acute pain functions for the detection of noxious stimuli; in order to, "prioritise escape, recovery, and healing," it demands the attention of the injured and makes it challenging to engage with innocuous cues (Eccleston & Crombez, 1999; Williams, 2002, p. 439). The affective dimension of pain plays a role in momentary avoidance as well as future aversion to negative and noxious stimuli (Chapman, 1995; Shackman et al., 2011), increases vigilance to threat, which in turn incites attention to pain (Williams, 2002, p. 440), and is instrumental in the interpersonal communication of pain (Saarela et al., 2007). The complexity of pain in relation to health and healing is revealed in part by chronic pain, which endures past its adaptive usefulness for indicating threat at the moment of injury (Eccleston & Crombez, 1999; Wall, 2000). Aside from the protective function of pain to inhibit actions that may further stress damaged tissue, research has discovered that pain may play a role in initializing and directing immunological and analgesic processes within the organism to promote healing and a return to homeostasis (Rittner et al., 2008). The benefit of the capacity to experience pain for survival and adaptation is emphasized by the fact that life expectancy is reduced among people born with the congenital inability to experience the pain of injury (Nagasako et al., 2003).

Chronic pain. An experience as ubiquitous to humanity as pain cannot be without its mysterious anomalies. Pain functions to warn the organism of tissue damage, and yet, people having severed their own caught limb in order to escape entrapment often report the surprise of

having felt little pain during their self-dismemberment (Learoyd, 2011; Wall, 2000). This capability of pain to oddly switch off when its persistence would hinder survival evidences its adaptability for survival. However, pain has an equally counterintuitive, but less useful, tendency to persist, and to be extant where nociception is not. Chronic pain is considered to be any pain that continues past the period of tissue damage, and can be all the more troubling if it is of unknown aetiology (Loeser, 1991).

While the IASP webpage on Taxonomy does not include a definition of chronic pain in itself, a subset, neuropathic pain, is defined as, "Pain caused by a lesion or disease of the somatosensory nervous system," (IASP, 2014; IASP Task Force on Taxonomy, 1994), and is accompanied by the following note:

> Neuropathic pain is a clinical description (and not a diagnosis) which requires a demonstrable lesion or a disease that satisfies established neurological diagnostic criteria. [...] *Somatosensory* refers to information about the body per se including visceral organs, rather than information about the external world (e.g., vision, hearing, or olfaction). [...] It is common when investigating neuropathic pain that diagnostic testing may yield inconclusive or even inconsistent data. *In such instances, clinical judgment is required to reduce the totality of findings in a patient into one putative diagnosis or concise group of diagnoses.* (IASP, 2014) (Emphasis added.)

Loeser (1991) states that "all pain is in the brain" – because the, "brain is the organ responsible for all pain," (p. 215). It is therefore understandable that pain can exist centrally without having a peripheral source. He goes on to distinguish acute from chronic pain, emphasizing that the two are distinct except for both being forms of pain: Prescriptions for acute pain are contraindicated for chronic pain, moreover, chronic pain defies adaptive principles, causing suffering for which there is no conceivable benefit to the organism (Loeser, 1991).

While persistent tonic pain can be caused by an underlying chronic condition such as cancer or arthritis, chronic pain with unknown aetiology has come to be seen not as treatable as a

symptom of an underlying malady, but as a disease in its own right (Cohen, 1991; Doleys, 2010; Tracey & Bushnell, 2009). However, while the pain of another may be empathized with, the experience cannot really be known – only inferred by perceiving another's tissue damage or pain expression (Danziger, Prkachin, & Willer, 2006). Therefore, Loeser argues that, "Challenging the validity of the complaint is, by the IASP definition, denying the patient's honesty" (1991, p. 215), and he recommends that a total pain approach is required to obtain as thorough and accurate a diagnosis as possible (Greenstreet, 2001). Further, pain facial expression was found to be moderately correlated with chronic pain patient self-report, attempts by patients to fake pain faces produced, "intensified caricature of the genuine expression," and inhibition of the pain face was not convincing (Craig, Hyde, & Patrick, 1991, p. 169). Facial expression should therefore remain useful in the toolkit of, "clinical judgment [...] required to reduce the totality of findings in a patient into one putative diagnosis or concise group of diagnoses" for the pain assessment of chronic pain sufferers (IASP, 2014).

Concepts and models. The concept referred to by Loeser's "all pain is in the brain" (1991, p. 215) was relatively new, as before the 1960's, pain was still seen in a light reminiscent of the ancient Greek view (Miles, 2005): Pain was considered a symptom of tissue damage, i.e. a sensory response to peripheral nociception. The Melzack-Wall Gate Control Theory (1965) provided the breakthrough that perception of pain lies in the central nervous system (CNS), which integrated bottom-up processes of nociception with brain-side, top-down modulation (Loeser & Melzack, 1999; Melzack & Wall, 1967). In turn, pain perception became conceivable as separate from nociception, and the experience of chronic pain could be considered valid without evidence of tissue damage. Further, the modulation of pain by the CNS in this model

explains affective-motivational processes which connect memory, past experience, values, anticipation, and emotional states with the experience of pain (Williams, 2002).

Melzack and Loeser (1977), dissatisfied that the Gate Control Theory could not explain the phantom limb phenomenon, published a major development to the model (Melzack & Loeser, 1977). The proposal, considered by some to be revolutionary, was for the existence of a Neuromatrix, a matrix of neurons genetically formed and environmentally moulded that cause patterns of nerve-impulses and somatosensory experiences in the body by linking thalamic, cortical and limbic regions, and that produce a neurosignature, or output pattern, specific to the organism (Keefe, Lefebvre, & Starr, 1996; Melzack, 1999). This Hebbian neurophysiological model effectively provides pathways for extending knowledge of chronic pain, and takes account of intra- and inter-individual variations (Wolff, 1996). Neuroanatomical and neuroimaging studies have since expanded the basis for understanding that pain entails sensory-discriminative as well as affective dimensions (Melzack & Casey, 1968; Rainville, Duncan, Price, Carrier, & Bushnell, 1997). Centripetal and centrifugal sensory and motor pathways allow for stimulus discrimination and produce pain behaviours that function for the avoidance or removal of noxious stimuli, and for mitigation and healing from attendant tissue damage (Craig & Prkachin, 1983; Eccleston & Crombez, 1999; Loeser & Melzack, 1999). The hypothalamus and limbic structures are activated in tissue trauma, giving rise to negative emotion states and communicative pain behaviours that are adaptive in soliciting succour and for warning conspecifics (Chapman, 1995; Prkachin et al., 1983).

Through neuroimaging research, the concept of a Pain Matrix has been derived from the Neuromatrix (Derbyshire, 2000; Iannetti & Mouraux, 2010). The components of the Pain Matrix are identified as the primary somatosensory cortex (SI), the secondary somatosensory cortex

(SII), bilateral anterior insula (AI), anterior cingulate cortex (ACC), the cerebellum, and the thalamus. Proponents of the Pain Matrix concept assert that this neural conglomeration functions specifically for the perception of pain (Davis, 2000; Singer et al., 2004; Stern, Jeanmonod, & Sarnthein, 2006). However, researchers critical of this derivation highlight that the Neuromatrix as proposed by Melzack operates more generally (for non-nociceptive processes also), and although it was theorized as a source for pain outputs, it was never described as having separate cortical regions limited in function to pain perception (Davis, 2000). By comparing functional magnetic resonance images (fMRI), Mouraux and colleagues concluded that subcomponents of the Pain Matrix also responded to non-nociceptive inputs, providing confirmation that the constituents identified as the Pain Matrix are in fact multimodal (Mouraux, Diukova, Lee, Wise, & Iannetti, 2011). Still, neuroimaging work pursued under the concept of the Pain Matrix has revealed some information about the relationship of empathy, pain, and pain affect in interpersonal communication which may be valid despite the critique of the specificity of the Pain Matrix, and will be explored in greater detail in a later section of this review (Botvinick et al., 2005; Saarela et al., 2007; Singer et al., 2004).

Fordyce et al. (1968) proposed a cognitive-behavioural model of pain derived from Skinnerian behaviourism that treats pain as unknowable and pain behaviours as the way to understanding the brain (Fordyce, Fowler, & DeLateur, 1968; Williams, 2002). However, this Operant Model of pain also assumes pain behaviours are operant controlled, despite much research that demonstrates many pain behaviours are reflexive or involuntary (Williams, 2002). While the Gate Control and Neuromatrix theories account for intra- and interpersonal processes from a neurophysiological perspective a, counterpart that focuses on the, "interactions between biological, psychological and social features of pain," is necessary, and is found in the Social

Communication model proposed by Craig (2009). While the intrapersonal and socio-environmental context of the person experiencing pain is a focal point, this model uniquely considers the judgment, psychology, and socio-environmental context of persons other than the sufferer, and caregivers in particular. The basic unit of research in this model is a sequence of experiences and behaviours in which the state of the pain sufferer is experienced, then expressed, their behaviour is perceived by (an)other(s), and the caregiver or other in question interprets and/or reacts to the sufferer's behaviour (Craig, 2009). Methods under this model investigate the communicative dyad between pain expression and empathy, and make derivations about altruism, caregiving, and also phenomena where empathy may be lacking or insufficient, and in so doing, can identify issues in empathy or pain estimation along the continuum of care (Craig, 2009).

Pain facial expression. Pain elicits behaviours that do not appear to play a direct role in escaping or mitigating aversion or injury. Instead, these behaviours are adapted specifically for the communication to others of features of the experience of the sufferer, specifically to broadcast warning and solicit succour (Prkachin & Craig, 1995; Prkachin et al., 1983). There are several examples of this type of pain-related behaviour, but the most prominent and most extensively studied are the changes in facial expression that frequently accompany pain, which are useful in evoking empathy and related helping behaviours from others to relieve distress or suffering (Deyo et al., 2004; Prkachin & Craig, 1995).

In *The Expression of the Emotions in Man and Animals*, Darwin (1872/2006) theorized that facial muscles have distinct uses, and sought evidence in infants and the elderly, individuals with cognitive impairments, varying ethnicities, and across human and non-human species, to support his postulate of the universality of expression based on evolution. In the debate over the relative cultural specificity or universality of facial expression, Ekman and Friesen (and

colleagues) evinced through research in "visually isolated" Papua New Guinean communities, and a number of literate cultures, that facial expressions for particular emotions are universal across cultures (Ekman, 1989; Ekman & Friesen, 1971). Ekman and Friesen formulated the Facial Action Coding System (FACS), which attributes specific Action Units (AU) to facial muscles contracted during expression (Ekman & Friesen, 1978).

Darwin described the human pain face as displayed with contracted brows, dilated nostrils, retracted (or compressed) lips, clenched teeth, and wildly staring eyes (Darwin, 1872/2006). While some elements of Darwin's portrayal may correspond with the pain face described with FACS (e.g. contracted brows; retracted lips), the overall semblance is off the mark from the set of facial AUs now identified as the core pain face (Williams, 2002). Studies based on photographs of pain faces, actors modeling facial expressions of pain, and spontaneous pain stimulus models, have narrowed down the adult pain face in humans to four main facial actions: Brow lowering (AU4/corrugator), orbit tightening and cheek raise (AU6/orbicularis oculi), brow lowering and eyelid tightening (AU7/orbicularis oculi), upper lip raise (AU10/levator contraction) and eyelid closing (AU43/relaxation of levator palpebrae superioris) (Ekman, Friesen, & Hager, 2002; LeResche, 1982; Prkachin, 1992; Williams, 2002). While other facial actions arise in diverse participant samples, such as mouth opening/lips parting (AU25) or jaw drop (AU26), the four mentioned above were found to be consistent across varying modes of pain (electric shock, cold, pressure, muscle ischemia) (Prkachin, 1992; Williams, 2002). The pain face, as described by the FACS, is consistent enough to be detected using automated pain recognition software (Ashraf et al., 2009).

The facial expression of pain, therefore, is considered in humans to be genetically predisposed, but moderated by environment and learning during life. Schiavenato et al. (2008)

used computational point-pair comparison to evaluate the primal face of pain (PFP) in infants, and found neonates to have a distinguishable pain face consistent across sex and ethnicity. At the opposite end of the human lifespan, while the ability to self-report verbally and by using pain rating tools wanes with age and/or mental disability, the ability to express pain facially is sustained (Hadjistavropoulos et al., 2009; LaChapelle et al., 1999). The pain face has not been researched in cross-cultural studies to the level of Ekman's studies of basic facial expressions, although he did provide personal communication to LeResche that preliterate Papua New Guinean participants in his research posed pain faces that were similar to the pain face described above using facial AUs (Ekman & Friesen, 1971; LeResche, 1982). Although the pain literature supports the universality of the pain face in humans, further research using cross-cultural designs is needed.

Empathy

Definition. This study takes the definition of empathy as proposed by Preston and de Waal (2002): "[A]ny process where the attended perception of the object's state generates a state in the subject that is more applicable to the object's state or situation than to the subject's own prior state or situation" (p. 4). Discourse regarding the nature and definition of empathy has been explored in a great variety of fields (philosophy, history, ethology, psychology, etc.), but understanding the proximate and ultimate causes of the phenomenon adds clarity to a widely debated definition. The Perception-Action Model (PAM) describes empathy from the basis of evolutionary theory, wherein ultimate causes of behaviour affect the DNA of a population over generations, and proximate motivators refer to the reaction of an individual to its immediate environment. Empathy is regarded as adaptive in furthering survival, particularly in pro-social species such as humans.

The term "empathy" was translated by Titchener from the German *Einfühlung* (lit.: feeling into) via the Greek *empathia* (lit.: in suffering or passion) (Nowak, 2011; Preston & deWaal, 2002; Wispé, 1990; Wispé, 1991). Theorized as having a neural basis in mirror neurons and imitation, empathy is considered to be a 'shared-state' or 'shared manifold' phenomenon, requiring a level of 'state matching,' whereby subjective experiences are partially congruous between self and other (Gallese, 2003; Iacoboni, 2005; Preston & deWaal, 2002). In the literature on empathy, there has been longstanding dialogue over definitions and terminology of the phenomenon. Areas of debate involve the level to which empathy and related concepts are relatively immediate/reflexive or latent/conscious in response to stimuli (Preston & deWaal, 2002). For example, many explain that states may be shared with some immediacy by way of emotional contagion, the mechanism by which a neonate begins to cry upon exposure to the crying of other infants, and exchanges/shares emotional states with their mother, but which, "requires neither perspective taking nor an explicit self–other distinction" (Hatfield, Cacioppo, & Rapson, 1992; Hsee, Hatfield, & Chemtob, 1992; Walter, 2012, p. 10). Conversely, while cognitive empathy requires the empathizer to have a clear sense of difference from other, it does not by definition require them to share the state of the other (Walter, 2012). Rather, one can imagine or mentally understand what another might be experiencing (Danziger et al., 2006; Walter, 2012).

The PAM provides a unifying theory of empathy that demonstrates that all forms of empathic response are unitary portions of a larger construct. Preston and de Waal (2002) take the perception-action organization of the nervous system as preceding the PAM of empathy, meaning that the survival of organisms would have been benefitted by an ability to react with a spectrum of responses to their environment, and this would have evolved in species living in

larger social groups to behaviours for responding to conspecifics. However, factors such as familiarity and interdependence, and age and experience, affect the activation of empathy and empathic behaviours, meaning that empathy is a construct of both nature and nurture.

According to Preston and de Waal's (2002) PAM, when a person observes another's behaviour, neural representations of that behaviour are automatically activated in the observer forming what is called a "shared representation." This shared representation automatically primes regions of the observer's brain that are linked to the representation of the behavioural state being displayed. The shared representation allows the observer to understand the mental state of the other and to share features of the observed person's internal experience associated with the behaviour. Although they do not state it in their original conception of the PAM, Preston and de Waal's formulation is also consistent with the expectation that actual behavioural features of the shared state would also be activated, such as in the phenomenon of emotional contagion. The search for evidence of such a shared behavioural response, or "echo" is a main goal of the studies described in this thesis.

Empathy and the assessment of pain from facial expression. Two independent studies conducted with functional magnetic resonance imaging (fMRI) demonstrate that the observation of pain in others activates the affective dimensions of pain related neurological regions (considered the Pain Matrix by the authors) in the observer (Botvinick et al., 2005; Saarela et al., 2007; Singer et al., 2004). Singer et al. (2004) compared brain activity in sixteen female participants when a noxious stimulus was applied to their own hand, or to their male partner's hand (2004. Botvinick et al. (2005) compared the neural activity of participants as they underwent thermal noxious stimuli to the hand, and when they observed the facial expressions of shoulder pain patients undergoing manipulations of the affected joint. Both studies found that the

anterior cingulate cortex (ACC) and bilateral anterior insula (AI) were activated, as they are in the neural substrate of a person experiencing pain, and these areas are associated with subjectivity and the feeling of the physical self (Botvinick et al., 2005; Singer et al., 2004).

Neuroimaging studies that mapped brain activity of participants viewing the facial expressions of others enduring pain evinced that the affective, but not the sensorimotor, brain regions related to pain were activated (Botvinick et al., 2005; Saarela et al., 2007; Singer et al., 2004). These results provide neural evidence for the mirroring or shared-state nature of the empathic reaction to pain, as well as a basis for the theory of mindreading, or the ability to construct a theory of mind about an 'other' (Iacoboni, 2005; Singer et al., 2004; Whiten, 1991). This reflective nature of empathy prevents it from being defined as a singular emotion: It is in essence always a reaction to and a sharing with another's internal state, and no core facial expression has been described that can be said to be representative of empathy. This leads to the question of whether the facial expression of empathy encodes, accurately, for the expression with which an observer is empathizing - in this case, pain.

Pain's Echo: A Heuristic Framework

The recognition that pain experiences involve both sensory and affective components and that these components subserve complex behaviours responsible not only for modulating the experience itself but also for influencing the social context in which pain occurs has stimulated the development of heuristic frameworks that attempt to capture elements of the pain process from instigation to social response (Craig, 2009; Hadjistavropoulos & Craig, 2002; Hadjistavropoulos et al., 2011; Prkachin & Craig, 1995; Prkachin, Kaseweter, & Browne, 2015). All are based in Rosenthal's 1982 A→B→C framework for understanding the communication of internal states, such as emotions (Rosenthal, 1982). They conceive of pain in the context of a

social communication process that begins with the internal experience (A). Features of the internal experience are correlated with changes in behaviour that are observable to others. The correlated behaviours are said to encode the internal experience into a signal (B) which is broadcast into the social world where it impinges on the sensory receptors of others, who then perceive the behaviour and decode it (C).

The most recent of these heuristic frameworks is presented below. It summarizes available empirical evidence concerning the components of pain encoding and decoding. Of central importance to the present thesis are two aspects of the framework. First, it points out that decoding pain involves processes of detection (discriminating the presence of pain cues) and of evaluation (judgments of the meaning of the pain cues in relation to underlying pain dimensions and in relation to the circumstances in which the pain episode is taking place). Second, it points out that the behavioural response to evidence of pain in others is potentially multimodal, ranging from succour and assistance to potentially antisocial reactions. Among the processes that are given a role both in detection and evaluation is empathy. Empathy is located in this component of the model based on empirical evidence (see Prkachin et al., 2015, for a review). With respect to the behavioural response to evidence of pain in others, the list of alternatives is not comprehensive. One potential behavioural response that is not considered in the model is suggested by recent literature on empathy. Based on the Perception-Action Model of Preston and de Waal (2002) and the related concept of emotional contagion, it is plausible to speculate that one of the behavioural reactions to the pain of others would be a pain response in the observer; a phenomenon that might be termed an "echo" of pain (Preston & deWaal, 2002). The present studies were designed to examine the role of empathy in the perception of others pain and, importantly, to seek evidence for the existence of a behavioural pain "echo."

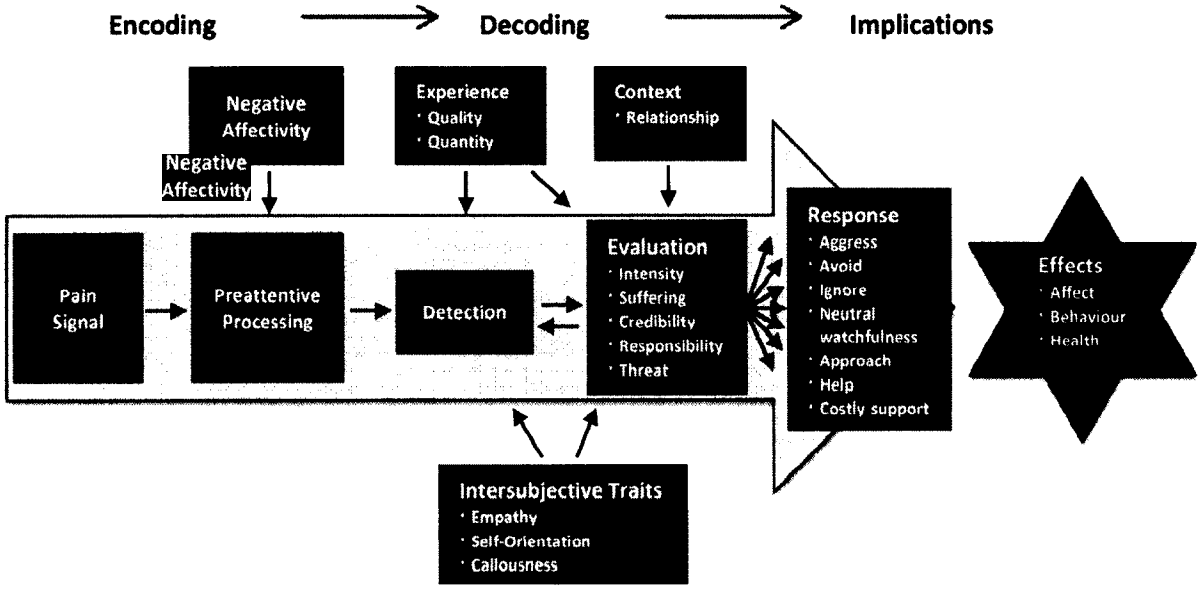

Figure 1. Heuristic framework for understanding third-person pain[2]

Review of Methods

Studies of the social communication of pain, like studies of social communication of other motivational and emotional states, are built on a variety of methodologies. The present studies made extensive use of judgment study methods; in particular, the technique that has come to be known as "thin slicing" (Ambady, LaPlante, & Johnson, 2001). To understand the design and capabilities of the methodology, a review of important features of the judgment study approach and thin-slicing is in order.

Judgment studies. Charles Darwin was one of the first to use judgment studies, which he applied to the investigation of the universality of facial expression in humankind in *The Expression of Emotions in Man and Animals* (Darwin, 1872/2006). He showed images of facial

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[2] From Prkachin, K. M., Kaseweter, K. A., & Browne, M. E. (2015). Understanding the suffering of others: The sources and consequences of third-person pain. In G. Pickering & S. Gibson (Eds.), *Pain, emotion and cognition: A complex nexus*. New York: Springer.

expressions, captured by Duchenne through the application of electrodes to particular muscle groups in the models' faces, to members of the public and asked them if they could correctly identify the emotion being expressed (Darwin, 1872/2006; Duchenne, 1862/1990). Paul Ekman (1971) followed up approximately 100 years later by taking a similar form of judgment study to people of the Fore cultural and linguistic group in the South East Highlands of Papua New Guinea, who had either minimal exposure to Western facial imagery or who had been somewhat Westernized. There, he told an emotion story about a situation that should end with the protagonist feeling one of 6 emotion states (anger, sadness, fear, happiness, surprise, disgust), and asked adult participants to select one of 3 (out of 1 correct, two incorrect) photographs (2 for children, 1 correct, 1 incorrect) which depicted facial expression (Ekman & Friesen, 1971).

Judgment studies were designed specifically for the purpose of elucidating nonverbal behaviour and communication (Buck & VanLear, 2002; Rosenthal, 1987). Rosenthal conceptualized methods to draw out the influences and expectations that he suspected could be communicated nonverbally from a sender to a receiver, usually unbeknownst to both (Rosenthal, 1987). Judgment studies are based upon the states and nonverbal behaviours of encoders (senders) and decoders (receivers/judges), and Rosenthal provides a composite model (Figure 2) that delineates basic components that can be used to devise various judgment studies according to the variables and dimensions under analysis (Rosenthal, 1987, p. 4).

Thin Slices

Nalini Ambady sought to discover how minute a glimpse of behaviour was required to form an accurate impression, considering the frequency of decision-making based on molecular nonverbal exchanges that occurs in daily interaction (Ambady & Rosenthal, 1997). To do this, she had clips edited from footage of stimulus persons, omitting extraneous stimuli, down to

durations of 10, five and two second 'thin slices' (Ambady & Rosenthal, 1992; Ambady & Rosenthal, 1997). Ambady found first that judges were able to estimate with considerable accuracy the properties of behaviour being displayed by the stimulus persons in the clips and, second, that there were no significant differences in the accuracy of judges' estimates from thin slice clips lasting 10, five or two seconds (Ambady & Rosenthal, 1997). The importance of being able to conduct judgment studies based on thin slices of behaviour is that reliable and sensitive intuitive, spontaneous, and involuntary responses can be elicited from judges (Ambady & Rosenthal, 1997; Buck & VanLear, 2002). The affective, neurological and expressive components that link experienced and observed pain behaviour is the focus here, and as such, capturing the immediate involuntary response is key (Botvinick et al., 2005; Saarela et al., 2007; Singer et al., 2004). This study uses thin-slice clips edited from footage of patients undergoing a test of range of motion of their shoulders in the UNBC-McMaster Shoulder Pain Expression Archive Database, wherein patients undergoing manipulation of an affected shoulder experience and express instances of acute pain (Lucey, Cohn, Prkachin, Solomon, & Matthews, 2011).

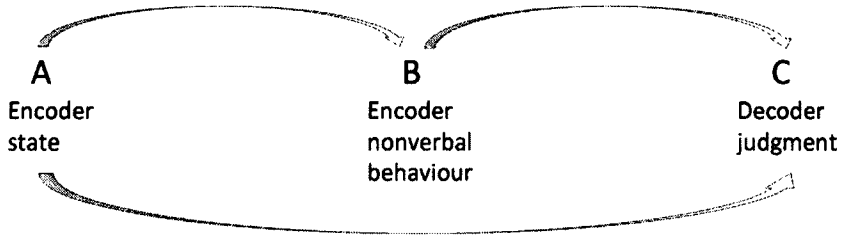

Figure 2. The basic judgment study model as proposed by Rosenthal (1987)

Participants in the judgment study design are senders, who exhibit or encode nonverbal behaviour, and receivers, or judges, who decode sender behaviour (Figure 2). In Rosenthal's proposed basic judgment study model, the encoder's state (A), encoder's nonverbal behaviour (B), and decoder judgment (C) can be ascribed as dependent and independent variables in

differing ways to formulate various judgment studies. The AB, BC, and ABC links can all be explored. For a study using the encoder state (A) as a dependent variable, participants may be exposed to a stimulus, with resulting data on the encoder's state coming from a self-report or physiological measure (Rosenthal, 1987). A study focusing on the encoder's nonverbal behaviour (B) might be concerned with facial expression or vocal tone of participants with a particular state or trait (e.g. warm teachers; doctors with malpractice suits) (Ambady et al., 2002; Rosenthal, 1987). When decoder judgment (C) is the key dependent variable, the goal is to establish that nonverbal behaviour can accurately be decoded (Rosenthal, 1987). Each of these types of studies may be used as groundwork upon which to build judgment studies of higher complexity that investigate the relationships between encoders' and decoders' states, traits, and nonverbal behaviours.

An AB study would then be concerned with encoder behaviours as elicited by certain encoder states (Rosenthal, 1987). An examples of this would be the studies that established the UNBC-McMaster Shoulder Pain Expression Archive, in which a pain stimulus was applied to encoders, and the encoders' pain states were measured by experts using a pain scale to assess the encoders' facial expressions (Lucey et al., 2011). In these examples, decoder judgment was not the focus. A study such as that by Prkachin, Berzins and Mercer (1994) on encoding and decoding pain expression would use an ABC judgment design, wherein the encoder's state is influenced via stimuli and exhibited in their behaviour, decoders are tasked with interpreting encoder behaviour.

The present study used a thin slice judgment design to investigate the effects of state and trait empathy levels on the judgments of pain by observers of human models (Ambady &

Rosenthal, 1997; Rosenthal, 1987). A focal interest was the ability for an empathic response to encode observed pain.

Experiment 1. The Effects of Trait Empathy on Pain Estimation from Facial Expression

Introduction

In order to pursue the ultimate goal of this work—testing evidence that observing pain results in a pain "echo" in the observer—it was first necessary to perform a study in which a group of observers were exposed to pain behaviours and behaviours not related to pain of others. This afforded an opportunity to investigate the relationship between measureable features of observers' empathy and their own perception of the pain of the sufferers they were observing.

Curiously, although there has been much speculation about the role of empathy in the perception of others' pain, there have been relatively few studies in which measures of an observer's empathy have been related to their perception of others' pain. Neuroimaging studies, which do not directly examine perception but, rather, examine patterns of neural activation, have shown that self-report measures of empathy are occasionally correlated with the degree of activation in empathy-related regions in a manner consistent with the conclusion that self-reported empathy is associated with increased activation (Singer et al., 2004). Interestingly, Danziger et al. (2006) were able to show that a measure of dispositional empathy was correlated with judgments of pain facial expressions and painful events, but only among a group of patients suffering from congenital insensitivity to pain. Green, Tripp, Sullivan, and Davidson (2009) found that high-empathy observers of pain faces significantly overestimated pain, in comparison with stimulus model self-reports.

The literature on empathy implies strongly that people who are high in trait features of empathy would be highly sensitive and responsive to evidence of pain and suffering in others.

Accordingly, the present study, while serving primarily as a vehicle for testing the pain echo hypothesis, also examined the following hypothesis:

Hypothesis 1: Observers with high levels of empathy who view patients displaying pain will evaluate their pain to be greater than observers with lower levels of empathy.

To examine this hypothesis, observers completed a recently developed self-report measure of dispositional empathy, the Toronto Empathy Questionnaire (Spreng, McKinnon, Mar, & Levine, 2009).

A second reason for measuring observers' dispositional empathy was to anticipate a question linked to the second experiment in this series, in which evidence for a pain echo was tested. In brief, it is natural to expect that, if there is a pain echo in the behaviour of an observer of pain, then it would be more likely to be observed among people who are high in empathy. Accordingly, observers' self-reported empathy levels were measured in the present study in order to be able to investigate a link between their dispositional empathy and the degree to which they would display a pain echo in the following study.

Method

Participants.

Selection. Undergraduate participants were recruited from the Psychology Student Research Participation Pool using the Sona online system at the University of Northern British Columbia (UNBC), and awarded course credits for their time. Students wishing to participate in this study completed an online screening survey that collected demographic information, and excluded those who had previously participated in pain or empathy judgment studies.

Groups. Students who passed screening also completed the Toronto Empathy Questionnaire (TEQ) on Sona (Spreng et al., 2009). The students' total TEQ scores were compared to the mean obtained from the original normative study by Spreng et al. (2009), and students scoring at or higher than a half standard deviation above the mean, and those scoring at or lower than a half standard deviation below the mean were selected for the study. Judges were blind to their TEQ scores and empathy categorization during participation.

Apparatus and materials. Participants viewed a specially-prepared sequence of video clips on a Dell Optiplex 990 desktop and Dell monitor. Video clips were presented using Superlab 4.5. The video clips presented "stimulus models" selected as described below. Sony Vegas Movie Studio Platinum 8.0 video editing software was used to prepare video clips, as described below. The participants' facial expressions were recorded using a Sony Handycam (HDR-XR260), which was hidden during the experiment.

Stimulus models.

Pain and no-pain. Twenty video clips of patients, ten experiencing pain and ten experiencing no-pain were taken from the UNBC-McMaster Shoulder Pain Expression Archive Database (Lucey et al., 2011). Pain levels of patients in the shoulder pain archive were self-reported on a 10cm Visual Analog Scale. Behavioural measurement of their facial expressions was performed using a variation of the FACS in which the four facial movements that have been empirically associated with pain were measured by expert coders (Ekman & Friesen, 1978; Prkachin & Solomon, 2008). This measure yields a score ranging from 0-15. The pain clips selected for this study were edited from videos of patients with facial expressions coded with pain scores between 10 and 15 points, and all no-pain clips were of patients with a pain score of zero.

Neutral controls. Ten video recordings were taken of individuals undergoing an interview from the Waterloo Longitudinal Reactivity Study database (Prkachin & Silverman, 2002). The interview was unrelated to pain and no recordings contained evidence of pain behaviour.

Thin slices of pain, no-pain and neutral facial expressions. Thirty silent, two-second, video clips of stimulus model facial expressions were compiled, 10 each exhibiting pain, no-pain, and neutral facial expressions, with five male and five female models in each group (Table 3). Clips focused on stimulus models' faces, and were edited with Sony Vegas Movie Studio Platinum 8.0 video editing software. The cookie cutter tool was used to place an oval around the models' faces to black out the background and exclude all extraneous stimuli.

Measures.

Toronto Empathy Questionnaire. The Toronto Empathy Questionnaire (TEQ) is a 16-item unidimensional measure of emotional empathy (Spreng et al., 2009). It was derived through factor analysis of select questions from the major heterogeneous multifactorial scales of empathy currently in use, including The Empathy Scale, the Questionnaire Measure of Emotional Empathy (QMEE) and the Davis Interpersonal Reactivity Index (IRI) (Davis, 1983; Hogan, 1969; Spreng et al., 2009). The questionnaire contains an equal number of positively and negatively worded items rated on a four point scale, and total scores may range from 0 to 64. The reported mean scores of the TEQ in three studies of undergraduate populations was 44.54 (SEM = .54), 47.27 (SEM = .84), and 46.95 (SEM = .93) (Spreng et al., 2009). The internal consistency of the TEQ is good, $\alpha = .87$, with a high test–retest reliability, $r = .81$, $p < .001$ (Spreng et al., 2009). This scale is intended to provide a single tool to assess empathy at its broadest level and was

selected for this study due to its brevity and reported robustness and generalizability as assessed by statistical methods.

Empathic Concern Scale. The Empathic Concern Scale (ECS) differs from most empathy scales in that it measures state empathy as an immediate reaction to the experience of another, as opposed to trait empathy that is characteristic of an individual (Batson, 1987; Batson et al., 1988; Drwecki et al., 2011). High levels of internal reliability were measured across 3 tests of the ECS ($\alpha_{\text{Experiment 1}} = .96$; $\alpha_{\text{Experiment 2}} = .96$, $\alpha_{\text{Experiment 3}} = .90$) (Drwecki et al., 2011). For each human stimulus model observed, participants rated the degree to which they felt tender, softhearted, warm, compassionate, moved, concerned, and sympathetic towards the model they had viewed on a scale from 1 (not at all) to 7 (extremely). The ECS is an effective measure that may explain anomalies in pain estimates that are inconsistent with trait empathy levels.

Pain rating scale. Judges rated stimulus model facial expression on an 11-point scale ranging from 0-10.

Procedure. The experiment was conducted in a laboratory room in which the computer, video camera and tables were located. Upon reporting to participate, participants underwent the informed consent process. They were then oriented to the study, informed that they would be viewing and rating a series of video clips, some of which would be showing people in pain, others not. The nature of the pain and empathy ratings was then explained and any questions about procedure were answered.

Superlab v4.5 was used to run the experiment. The 30 thin-slice clips were presented in random order. Judges viewed each clip, following which they entered their pain ratings of, and scores of state empathy for, each stimulus model, using the computer keyboard. Judges' ratings

were stored automatically in Superlab. Experiment 1 was completed in durations ranging from 20-45 minutes.

As per ethics requirements, once data collection was complete, the participants were debriefed about being video recorded and signed a disclosure and release form (Appendix 2D) to allow their footage to be used in Experiment 2.

Study Design. Experiment 1 utilized a basic judgment study formulation, as demonstrated in Figure 3. Stimulus models (encoders) were shoulder pain patients and interviewees who were experiencing painful, painless, and neutral states (A). Video clips displayed the stimulus models' states as encoded in their facial expressions (B). Judges (decoders) viewed and rated the thin slice video clips of stimulus model facial expressions (C).

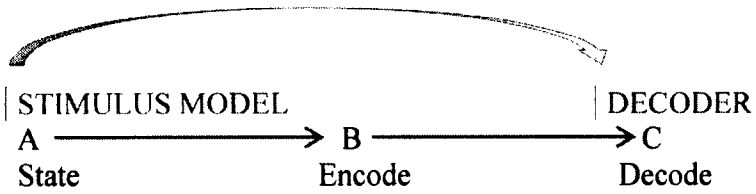

Figure 3. Judgment study design for Experiment 1

Results

A simple linear regression was conducted to calculate whether judges' trait empathy was positively correlated with their ratings of model pain. Fifty-three undergraduate students who met screening and TEQ score criteria participated in the study, and after data were cleaned and 5 outliers who rated pain at above 2 SD from the mean were removed, $N = 46$. A significant positive relationship was found with an R^2 of .18 and a correlation coefficient of .43 ($p = .002$, $F = 10.26$). This demonstrates that judges displaying higher trait empathy provided higher pain

ratings, and vice versa. A single 2 (high empathy vs. low empathy) x 2 (sex) ANOVA was conducted, where a significant effect of empathy was found (F (1, 42) = 9.41, $p < .01$), $\eta_p^2 = .18$. This analysis confirmed higher average pain ratings by high empathy participants (M = 2.80, SEM = .14) than by low empathy participants (M = 2.25; SEM = .11). No difference by sex or interaction between sex and empathy was found.

Discussion

Consistent with the main hypothesis of this study, dispositional empathy, as measured by the TEQ was positively correlated with observers' pain ratings. Observers high in dispositional empathy used higher ends of the pain scale when rating the pain displays of the pain stimulus models. In other words, high empathy participants in Experiment 1 tended to rate stimulus model pain higher than participants with low empathy, which supports the first hypothesis, and is in agreement with results found by Green et al. (2009). In addition to supporting the main hypothesis, this finding provides evidence for the construct validity of the TEQ. Some studies use wholly female samples in psychological research relating to empathy; there also exists an assumption that females tend to be more highly empathic than males (Ambady & Rosenthal, 1992; Eisenberg & Lennon, 1983). However, a study by Eisenberge and Lennon (1983) demonstrated that empathy ratings that differed by sex were affected by the form of empathy test administered. Self-rated empathy found females to be higher in empathy, however, when they tested and observed physiological and nonverbal reactions to another's emotional state, no difference by sex was found (Eisenberg & Lennon, 1983). In this study, samples included equal numbers of males and females. Interestingly, there was no evidence to suggest differences in pain ratings in relation to sex. Nor was there reason to believe that there was a different relationship between empathy and pain judgments between men and women, as evidenced by the

absence of a statistical interaction in the ANOVA, which supports results from the preceding studies on empathy in relation to sex.

Support for the first hypothesis suggests that in the health care settings where compassion fatigue may have set in, empathy for patients is waning, and underestimation of pain in patients is observed, that methods to increase empathy may reduce underestimation. However, the positive correlation between observer trait empathy and average pain scores also suggests that empathy is not an overall panacea for inaccurate pain estimation from facial expression: Empathy that is very high gives rise to higher pain ratings and inaccuracy of pain estimation may result off the other end of the spectrum. Accurate pain estimation is necessary as under or overestimation can be a disadvantage for patients' recuperation, and overall health and wellness (Craig, 2009).

It is important to emphasize that, although the present findings suggest an overall difference between people high in empathy and people low in empathy with respect to how they judge pain in others, they say nothing about differences in the accuracy of those judgments. Recall that the pain ratings that observers were applying were to video recordings of people displaying pain, people not displaying pain, and people responding in a completely non-pain-related context. Consequently, on some occasions, high empathy judges were undoubtedly making higher pain ratings of models that were not in pain at all. Thus, the relationship documented in this study must be interpreted as identifying differences in a response bias associated with dispositional empathy and not as identifying differences in perceptual accuracy.

Experiment 2. The face of empathy: Does empathy echo the affect of observed facial expression?

Introduction

Experiment 2 examined the central question addressed in this thesis: When people observe someone else displaying pain, is there a change in their facial expression that carries information about the fact that they are observing pain? As noted above, the literature on emotional contagion has shown that there are circumstances in which exposure to the affective displays of one person elicits evidence of comparable displays on the part of the observer. For example, neonates who are exposed to other neonates' cries will themselves begin to cry, although they will not do so to recordings of their own crying or the cries of other species (Martin & Clark, 1982). Similarly Preston and de Waal (2002) emphasize in their PAM the idea that observing another's emotional state automatically elicits the observer's own internal representation of a comparable state, and there is reason to believe that such a resonating internal representation would be accompanied by an overt behavioural representation. In this literature review, I did not encounter previous studies investigating the encoding of behaviour in the outward expression of observers that echo the states of sufferers.

There are good reasons to explain why the possibility of a behavioural pain echo has not been tested. The principal one is that testing of the idea presents formidable methodological challenges. The main behavioural expression of pain that has been examined empirically is facial expression. Although the structure of the pain expression has been well described, if one is to study the natural response to pain expression it would seem to be necessary to employ as stimuli naturally-occurring and ecologically valid expressions. Naturally occurring pain expressions, unlike posed or acted expressions, are small, brief and subtle. If they generate a behavioural echo

on the part of the observer, that response may be even smaller, subtler and briefer. Measurement with commonly used systems such as the FACS is unlikely to be sufficiently sensitive to identify a behavioural echo because whatever behavioural signal there is likely to be embedded within measurement error. The problem is one of deciding whether a signal is present in the presence of a high level of ambiguity.

The problem of measuring perceptual sensitivity to very weak stimuli has been addressed by psychophysicists since the middle of the past century. Methods derived from the theory of signal detection have been applied to many perceptual tasks involving decision making under uncertainty (Swets, 1996). In the classic signal detection paradigm, an observer is presented repeatedly with two stimuli: A very weak signal and no signal at all. The latter is referred to as a "noise" trial. When presented with either type of stimulus, the observer is required to indicate whether a signal was or was not presented. Under such conditions, observers' complete performance can be represented in terms of the probability of making a "hit" (indicating that a signal was present when it was) and the probability of making a "false affirmative" or "false alarm" (indicating that a signal was present when it was not). To the extent that the probability of a hit exceeds that of a false alarm, the observer can be said to be more or less sensitive to the presence of the weak signal.

Signal detection methods provide a sensitive means of measuring the ability to discriminate two states of the world. For the purposes of the present study, recordings of the facial expressions of observers from Experiment 1 watching videos of the behaviour of other people were used as signal and noise. The behaviour of the people they watched fell into three categories: Pain expressions, neutral expressions and non-pain expressions. The observers from Experiment 1 were, in turn, watched by other observers, who made a simple judgment: Whether

the person was watching someone in pain or not. If observing a person in pain is associated with a discrete change in facial behaviour that differs from the behaviour that occurs when not observing a person in pain, and if other observers are sensitive to that signal, then there should be evidence that the observers can detect the act of observing another in pain at a level greater than chance. Accordingly, Experiment 2 tested the following hypotheses:

Hypothesis 2: Observers who view patients displaying pain will register the patient's pain in their own facial behaviour, consistent with the concept of a pain echo.

Hypothesis 3: The "pain echo" effect will be greater among observers who score high in empathy.

Method

Participants. Graduate students were recruited by e-mail listserv and the Northern British Columbia Graduate Student Society Facebook page at the University of Northern British Columbia (UNBC). Volunteers were offered gift cards for a local coffee vendor in appreciation for their time. Students wishing to participate in this study completed a paper screening survey that collected demographic information. Recruits who had previously participated in pain or empathy judgment studies were excluded. Three female and 3 male students were selected, and participated as Receivers in this experiment.

Apparatus and materials. Participants observed specially edited videos taken of stimulus models from Experiment 1. The videos were displayed on an Acer monitor and computer and were compiled using Sony Vegas Movie Studio Platinum 8.0. Video presentation and data collection were controlled by Superlab 5.0.

Stimulus models.

Senders: Thin slices of facial expressions from experiment 1 judges. In Experiment 1, the twenty-four participants observed thirty thin slices of facial expressions, twenty of patients experiencing pain and no-pain from the UNBC-McMaster Shoulder Pain Expression Archive (Lucey et al., 2011; Prkachin & Solomon, 2008), and ten of participants from the Waterloo Longitudinal Reactivity Study database (Lucey et al., 2011; Prkachin & Silverman, 2002) displaying neutral expressions.

A total of 720 (30 thin-slices x 24 participants in Experiment 1) video clips of the facial expressions of judges viewing stimulus model facial expressions was edited and compiled using Sony Vegas Movie Studio Platinum 8.0 video editing software. The software's "cookie cutter" tool was used to place an oval around the models' faces to black out the background and exclude all extraneous stimuli, leaving only a view of the facial expression. Each clip was 2 sec in length. This study investigated whether these participants encoded, or sent, the facial expression they observed in stimulus models. In Experiment 2, the undergraduate judges were therefore termed "Senders."

Presentation of stimuli and recording of responses was accomplished with SuperLab v4.5 software. Each thin-slice clip was displayed in real-time for 2 sec. After the clip was displayed, a screen appeared prompting the participant to enter a rating. When the rating was entered, there was a 1 sec delay before the next clip appeared. The selected thin slice clips of each Sender were randomized, although each Sender appeared in a fixed order. After watching all thin-slice facial expressions of each Sender, the Receiver responded to the ECS prompts relating to that Sender.

Table 1

Total Number of Thin Slice Clips Edited from Footage of Sender Facial Expressions while Viewing Model Facial Expressions

	Senders				
Stimulus Models	6 HM	6 LM	6 HF	6 LF	
10P	60	60	60	60	
10NP	60	60	60	60	
10N	60	60	60	60	
($N = 30$)		($N = 24$)			720 Sender Thin Slices

Note. Film clips of thirty stimulus models were selected and categorized into 3 groups of ten, pain (P), no pain (NP), and neutral (N), each comprising 5 males and 5 females. Footage was taken of twenty-four undergraduate judges from Experiment 1 (Senders) in 4 groups (6 high empathy males (HM), 6 low empathy males (LM), 6 high empathy females (HF), and 6 low empathy females (LF)) as they viewed each of the stimulus model facial expressions, to create 720 thin slices of Sender facial expressions for Experiment 2.

Measures. Participants in Experiment 2 also completed the TEQ and the ECS.

Pain rating. The graduate student participants, or "Receivers," rated Sender facial expressions with a 'yes' for pain (y) or 'no' (n) for no pain by pressing the corresponding keys on the computer keyboard.

Procedure. Receivers responded by pressing 'y' or 'n' keys after viewing each Sender facial expression. Correct responses constituted a hit (responding 'y' to a clip displaying a Sender watching someone in pain) or a correct rejection (responding 'n' when the Sender was not watching someone in pain). Incorrect responses included a miss (responding 'n' when the Sender was watching someone displaying pain), or false alarm (responding 'y' when the Sender was not watching someone displaying pain) (Nevin, 1969). After watching the entire 30 clips of each Sender, participants were prompted to complete the Empathic Concern Scale (ECS) regarding the Sender they had just viewed. Experiment 2 was completed by most participants within 45 minutes.

Study Design

Experiment 2 built upon Experiment 1 to form two linked judgment studies, as demonstrated in Figure 4. In Experiment 2, encoders were Senders whose facial expressions were taken while they were observing pain, no-pain, and neutral stimulus models in Experiment 1. Provided that Senders experienced a shared state with the stimulus model (2A), and then encoded that state in a facial expression (2B), Receivers might be able to judge the state of the stimulus model (1A) with some accuracy by decoding the facial expression of the Senders (2B). Therefore, for each Sender thin slice facial expression viewed (2B), the Receivers were asked to judge whether the model being viewed by the Sender was experiencing pain (1A)—the Receivers were tasked with decoding the Senders' facial expressions in order to judge the encoded states of stimulus models (Link III). Receivers were not privy to visual information from the stimulus models observed by the Senders.

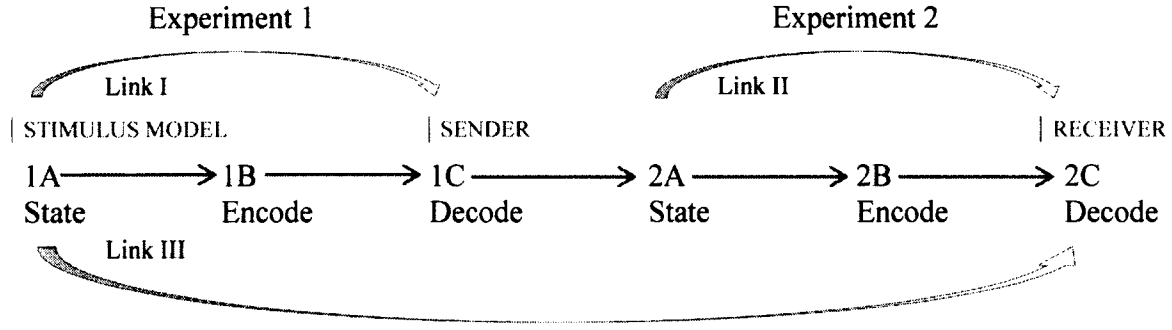

Figure 4. Judgment study design for Experiments 1 and 2

Two ABC links (Links I-II) were explored in order to ascertain the accuracy with which Receivers can judge stimulus model states by decoding Sender facial expressions (Link III).

Data reduction

The task employed in Experiment 2 is a classical signal detection task in which the Receiver attempts to detect the presence of a small signal in the context of noise. Nonparametric signal detection theory (SDT) measures were employed to measure Receivers' performance. Hit and false alarm probabilities were calculated from each Receiver's performance. The nonparametric parameter, A' (Snodgrass & Corwin, 1988), was used to measure Receivers' ability to discriminate clips in which the Sender was watching someone displaying pain from clips in which the Sender was not watching someone in pain. A' is defined as: For pH $\geq$ pFA, $A' = .5 + [(pH - pFA) + pH - pFA)]/[(4pH(1 - pFA)]$. When pFA > pH, $A' = .5 - [(pFA - pH)(1 + pFA - pH)]/[4pFA(1 - pH)]$. Values of A' can vary between 0 and 1. A value of .5 represents chance performance or guessing. Values exceeding .5 represent increasing ability to distinguish signals (in this case Senders watching people displaying pain) from noise (watching people not displaying pain). Accordingly, a simple test of whether Senders encoded something in their facial expression distinguishing the fact that they were watching someone in pain is whether Receivers' A' values reliably exceed a value of .5.

SDT methods were developed in order to separate sensory sensitivity from decisional processes in judgment tasks. A' is a nonparametric measure of sensitivity or the ability of the observer to discriminate between two states of the world. It is theoretically independent of response bias, which is the tendency to make either liberal or conservative judgments in the perceptual task. In the present case a liberal bias would be a general tendency to say "yes" when presented with a Sender observing either a stimulus model displaying pain or when presented with a Sender observing a stimulus model not displaying pain. A conservative bias would be a general tendency to say "no." Bias can be measured with the nonparametric index, B''. When pH

$\geq$ pFA, B'' is defined as B'' = [pH(1 – pH) – pFA(1 – pFA)]/[pH (1 – pH) + pFA(1 – FA)]. When pFA > pH, B'' = [pFA(1 – pFA) – pH(1 – pH)]/[pFA(1 – pFA) + pH(1 – pH)].

Results

A' and B''_H were calculated separately for each Receiver-Sender dyad. They were then averaged for each Sender. This provided overall measures of the discriminability of that Sender's behaviour when watching someone in pain and when watching someone not in pain and of Receivers' overall tendencies to be liberal or conservative when making judgments of individual Senders. Separate A' and B'' values were calculated for the two types of discriminations Receivers were required to make. Recall that Receivers judged clips of Senders in three conditions: Observing someone else in pain (a patient undergoing a range-of-motion test and showing pain), observing someone else not in pain but in a pain context (a patient undergoing a range-of motion test and not in pain) and observing someone else not in pain and not in a pain context (a non-patient in an interview context and not in pain). Measures based on the first discrimination—pain vs. no-pain/pain context—were given the subscript pvnp; measures based on the second discrimination—pain vs. no-pain/no-pain context—were given the subscript pvnn.

Descriptive statistics for these outcome variables are presented in Table 2. The main analysis questions focused on the discriminability of pain and no-pain conditions. Since chance performance at discriminating pain from no-pain conditions would result in an A' value of .5, a precise test of whether Receivers could discriminate when a patient was experiencing pain by watching someone watching them is a test of whether Receivers' A' values differed significantly from .5. Accordingly, A'_{pvnp} and A'_{pvnn} values were entered into one-sample t-tests, evaluating average discriminability values against the chance level of .5. Since the hypothesis that

Receivers would be able to discriminate pain from no-pain conditions is directional, a one-tailed test was deemed appropriate.

Table 2

Descriptive Statistics Outcome Variables Calculated for the Discriminations Pain vs. No-pain/Pain Context and Pain vs. No-pain/No-pain Context

	A'_{pvnp}	A'_{pvnn}	B''_{pvnp}	B''_{pvnn}
Mean	.5277	.5419	.1473	.1661
Standard deviation	.0793	.0930	.1276	.1048

Both tests were statistically significant. For A'_{pvnp}, t (23) = 1.71, one-tailed p =.05. Similarly, for A'_{pvnn} t (23) = 2.21, one-tailed p = .02.

Another way of evaluating whether Receivers could tell the difference between pain and no-pain trials was also employed. A value of .5 was subtracted from A'_{pvnp} and A'_{pvnn}. The resulting transformed values were then entered into a repeated measures ANOVA testing two effects: Whether A'_{pvnp} and A'_{pvnn} values differed and whether the intercept (the mean of all scores) differed significantly from 0 (the transformed value for chance performance). The test of differences between A'_{pvnp} and A'_{pvnn} was not significant, p = .3. By contrast the test of the intercept was statistically significant, F (1, 23) = 4.62, p = .04. Since A'_{pvnn} and A'_{pvnn} did not differ and, collectively, they differed significantly from 0, the hypothesis that Receivers could tell the difference between pain and no pain in both conditions received support. The Pearson correlation between A'_{pvnn} and A'_{pvnn} was also statistically significant, r (24) = .69; p < .001,

which also supports the inference that both parameters indicate that Receivers were sensitive to the difference between pain and no pain trials.

The parameter, B'', has a value of 0 when observers have a neutral bias; that is, when the probability of a hit is equal to the probability of a false alarm. Positive values indicate a liberal criterion. Consequently, B'' values were also entered into one-sample t-tests, evaluating them against a comparison value of 0. Both tests were significant; for B''_{pvnp}, t (23) = 5.66, $p < .001$; for B''_{pvnn}, t (23) = 7.76, $p < .001$, indicating that, overall, Receivers displayed a liberal bias; in other words, they inclined toward reporting the presence of pain. A repeated measures ANOVA parallel to that performed for A' values also indicated no significant bias differences between both parameters, but that they did differ significantly from 0 altogether, F (1, 23) = 62.70, $p < .001$.

A natural question arises as to whether the discriminability of Senders' behaviour when watching others in pain is related to the relevant characteristic of empathy as measured by the TEQ. To address this question, Pearson correlations were calculated between Senders' TEQ scores and the two respective discriminability and bias parameters. None of the correlations were significant (all $p > .2$).

Discussion

Hypothesis 2 asserted that the pain facial expression of stimulus models would be encoded on the observers' faces, and was tested in Experiment 2 by having a second set of participants (Receivers) estimate pain in the models by viewing the observers' (Senders') facial expressions. Receivers' judgments were reduced into measures of the ability to discriminate trials on which Senders had observed someone in pain from trials on which they had not observed someone in pain. Signal detection methods allow the calculation of a nonparametric

measure, A′, that has a known metric for chance performance and thus it is possible to determine whether the group of observers, on average, is able to tell the difference at a level that is greater than chance. In the present study, two sets of statistical tests were performed to evaluate whether Receivers were able to detect Senders observing pain at a greater than chance level: Single sample t-tests, evaluating whether the parameter A′ differed significantly from the chance value of .5 and an ANOVA test of the intercept parameter associated with a chance-corrected transformation of A′. Receivers were slightly but significantly able to estimate which Senders had viewed models that were experiencing pain. The note of caution that needs to be emphasized is that, in the case of the discrimination between pain and no pain in a pain context, A′ values only achieved a *p* value of .05 with a one-tailed test. Nevertheless, the study was framed with an explicit, directional *a priori* hypothesis, which does justify the use of a one-tailed test. All other statistical tests of pain vs. no pain discriminability parameters met more stringent criteria for statistical significance. Considering, in addition, that the sample of Receivers was very small which would contribute to diminished power, it seems there is sufficient evidence to conclude that, overall, Receivers were able to detect a weak signal that Senders were watching someone in pain at a level that was greater than chance.

Consequently, the findings were consistent in general with Hypothesis 2. In turn, this suggests that, among some people, observation of pain in others produces a facial response that is consistent with the idea of a behavioural pain echo. Given the fact that Receivers' performance exceeded chance only slightly, it is possible that this effect may have been largely attributable to a subset of the Senders. It is a natural expectation, as articulated in Hypothesis 3, that people who self-report as highly empathic would be more likely to display the pain echo effect than those who do not. However, the direct test of that idea, the correlation between Senders' empathy

scores and the discriminability of their pain echo responses was not significant. This absence of an effect may be a true null finding, or it may reflect methodological shortcomings, of which two are quite plausible.

The first is that there may again be a power issue arising out of the relatively small sample of Senders and Receivers that covers up any true effect that may be there. The second is that the particular trait empathy measure selected for this study was insufficiently reliable or valid as an indicator of trait empathy. Although the TEQ was developed ostensibly as a trait empathy measure that has superior psychometric qualities to other empathy measures, it is a recent and relatively untested measure. Additionally, it is unidimensional, as contrasted with other more commonly employed empathy measures, such as Davis' Interpersonal Response Inventory (IRI) (Davis, 1983). In being a unidimensional measure, the possibility offered by other techniques, of relating the outcome variable to subcomponents of empathy, such as personal distress or perspective-taking, is obviated.

It remains possible that the failure to find a significant relationship between trait empathy and the pain echo is, in fact, a true null effect. If so, that would reinforce the traditional concerns that have been expressed about over-reliance on self-report for building a model of empathy or for uncovering the underlying principles governing affectively-charged behaviour. Empathic and pain-communication processes may very well take place in the absence of personal insight into them.

With respect to the measures of response bias employed in the present study, overall, the present findings revealed that Receivers did have a liberal bias, tending to attribute pain more so than not.

Since this is novel research, there are no other studies with which to compare these results. The findings do seem to indicate the presence of a real pain-echo phenomenon. Further research will be necessary to validate the pain echo effect and to evaluate its determinants and consequences.

Limitations and Suggestions for Future Research

The limitations of Experiment 1 have mainly been discussed in the associated results section. A key limitation is that the eleven point (0-10) pain rating scale that was used did not match up to the sixteen point (0-15) pain rating scale used by those who coded the shoulder pain models' facial expressions, or the 10cm Visual Analog Scale that was used by the models as a patient pain self-rating at the time of their shoulder manipulations. As a result, while a positive correlation was found between participants' TEQ scores and the pain ratings they estimated, it was not possible to clearly assess the relationship between participants' trait empathy and the accuracy with which they judged pain relative to or ratings by facial coders models' self-ratings. A similar study conducted using a similar pain rating scale between either the models' own ratings or the coders' ratings and the participants' might allow for (1) a more close analysis of the relationship between trait empathy and accuracy of pain estimation from facial expression, and (2) inquiry in the second experiment as to whether judges who over- or underestimate pain, or more accurate judges, tend to encode observed pain more readily or intensely.

The participant sample in Experiment 1 was composed entirely of undergraduate students enrolled in the psychology program or courses, or in health science courses at UNBC. While this provided a captive recruitment pool who were willing to participate in part for course credits awarded for participation in psychology research at UNBC, there has been recent critique of this

practice with regards to the generalizability of samples from Western, Educated, Industrialized, Rich, and Democratic (WEIRD) to humans overall (Heinrich, Heine, & Norenzayan, 2010; Nature Neuroscience, 2010). In this study, students with an ethnic background other than Caucasian were in the minority in the sample. While participants in this study did respond to questions on ethnicity and cultural identity on the intake questionnaire (Appendix 2C and 3C), the sample was too small to conduct any analysis on effects of culture on empathy or pain estimation.

Some studies on the judgment of affect have used only female participants, based on the assumption that females are statistically higher in empathy and therefore tend to volunteer, express facially, and respond to facial cues more readily (Ambady & Rosenthal, 1997; Singer et al., 2004). This effect was observed in this study in that the high empathy female group was the group of participants to be filled most rapidly. However, in this study, sex was not found to have an effect on pain expression estimation, nor was there an interaction between empathy and sex. For students in a population that is somewhat diverse, but who subscribe to similar values and experiences both generationally and in terms of academic and social experiences, variations in some responses based on sex may be levelled. This may be particularly true for populations attending institutions of higher learning where gender equality is aspired to. Similarly, without significant variability in age, this factor was not included in data analysis.

A more diverse sample might yield sufficient variation to test for effects. While the benefits to graduate students of recruiting undergraduates in research of accessibility and time are not outweighed by the limitations of using this population, research might benefit by having more diverse participant pools – perhaps a research relationship with the populations of

university towns and communities may allow for efficacious ethics approval and sample recruitment procedures.

In Experiment 2, only 6 participants were recruited, per design. While this does not take away from the validity of Signal Detection Analysis, a larger sample might have been helpful. Hypothesis 3, that Senders higher in dispositional empathy would encode the observed pain facial expression more intensely than low empathy participants was not supported. In Experiment 2, participants completed the TEQ after completing the study tasks. This was to avoid biasing their responses, and because Receivers were expected to be representative of the general population, as opposed to a specific subset selected by TEQ scores (as with Senders). Given the nature of the effect of empathy on willingness to volunteer, all 6 of the participants were above average in empathy according to the TEQ. With more participants in the sample, it might be possible to detect more of a variation in trait empathy from which to derive an effect on facial encoding of observed facial expression. The power of the sample would also be increased, which would apply more robust testing to Hypothesis 2 and might put ambiguity regarding the .05 *p* value to rest.

Also, increasing the sample size of Experiment 2 might allow for more power with which to assess any interaction between (1) Sender trait empathy scores, and (2) Receiver trait empathy scores, and the accuracy with which Receivers decoded models' pain via Sender facial expressions. Investigating the difference in accuracy of Receivers' estimations of model pain between high empathy Senders → high empathy Receivers versus low empathy Senders → low empathy Receivers, and the various combinations in between might reveal more about how the communication of pain potentially intensifies or attenuates in communicative chains dependent

on Sender/receiver dispositional empathy. A larger sample size would certainly be desired for an experiment of this complexity.

Summary and Conclusion

The findings from the two experiments in this thesis confirmed Hypotheses 1 and 2, that participants' dispositional empathy (TEQ) scores would be positively correlated with their pain ratings of models, and that the participants would project, or echo, an encoding of the painful stimulus they observed upon their own faces that was perceivable to the second set of judges. However, the results of this study did not confirm Hypothesis 3, in that no significant relationship was found between Sender trait empathy scores and the intensity with which Senders (Experiment 1 judges) encoded the pain they observed in the models' faces upon their own, as perceived and rated by Receivers.

The results of Experiment 1 are congruent with the results found by Green et al. (2009) in demonstrating a positive correlation between observer dispositional empathy and pain ratings estimated from facial expression. This suggests that empathy is somewhat of a double-edged sword – like medicine, too much or too little can fail to optimize the accuracy of pain estimation in patients and in turn render less effective the prescription of pharmacological or therapeutic treatments, be they curative or for pain management. Studies in the literature have demonstrated the ability of research to reveal issues of pain underestimation in certain segments or contexts of health care; (Burgmann, 2011; Coll et al., 2011; Drwecki et al., 2011; Kappesser et al., 2006; Prkachin et al., 2007) perhaps this should be considered as part of an assessment procedure for the industry. Where underestimation is occurring and is found to be related to empathy among care providers, understanding whether compassion fatigue or other factors may be at play, as

well as understanding the wellbeing and mental state of practitioners, can aid in creating curricula or programs related to provider, for which a body of literature is already growing (Murinson et al., 2011; Portnoy, 2011; Sabo, 2006; Schwam, 1998; Walker et al., 2012; Wear & Zarconi, 2008). To avoid placing too much pressure on providers to be perfectly compassionate, the question remains open whether it would be possible to disambiguate empathy from accuracy of pain assessment, in part by providing training in pain expression recognition alongside self-care and compassion in curricula.

A key and novel finding in this study is the possibility of pain being "echoed" or encoded on the face of those who observe others' suffering. The ingot found in this thesis of a significant level of accuracy of estimating pain in a third party by viewing the face of an intermediary would suggest that the innumerable subtle, minute, non-verbal exchanges that occur in dyads, chains, and groups in social communication are worthy of investigation. Although this took the form of a heuristic inquiry, further study may shed more light on how the communication suffering may be affected by dispositional empathy as it is transmitted in clinical, as well as other care settings.

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Appendices

Appendix 1. Tools and Measures

A. Toronto Empathy Questionnaire (TEQ)

Below is a list of statements. Please read each statement *carefully* and rate how frequently you feel or act in the manner described. Check your answer in the response field. There are no right or wrong answers or trick questions. Please answer each question as honestly as you can.

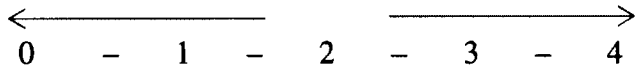
	Never	Rarely	Sometimes	Often	Always
1. When someone else is feeling excited, I tend to get excited too	☐	☐	☐	☐	☐
2. Other people's misfortunes do not disturb me a great deal	☐	☐	☐	☐	☐
3. It upsets me to see someone being treated disrespectfully	☐	☐	☐	☐	☐
4. I remain unaffected when someone close to me is happy	☐	☐	☐	☐	☐
5. I enjoy making other people feel better	☐	☐	☐	☐	☐
6. I have tender, concerned feelings for people less fortunate than me	☐	☐	☐	☐	☐
7. When a friend starts to talk about his/her problems, I try to steer the conversation towards something else	☐	☐	☐	☐	☐
8. I can tell when others are sad even when they do not say anything	☐	☐	☐	☐	☐
9. I find that I am "in tune" with other people's moods	☐	☐	☐	☐	☐
10. I do not feel sympathy for people who cause their own serious illnesses	☐	☐	☐	☐	☐
11. I become irritated when someone cries	☐	☐	☐	☐	☐
12. I am not really interested in how other people feel	☐	☐	☐	☐	☐
13. I get a strong urge to help when I see someone who is upset	☐	☐	☐	☐	☐
14. When I see someone being treated unfairly, I do not feel very much pity for them	☐	☐	☐	☐	☐
15. I find it silly for people to cry out of happiness	☐	☐	☐	☐	☐
16. When I see someone being taken advantage of, I feel kind of protective towards him/her	☐	☐	☐	☐	☐

Scoring: Item responses are scored according to the following scale for positively worded Items 1, 3, 5, 6, 8, 9, 13, 16. Never = 0; Rarely = 1; Sometimes = 2; Often = 3; Always = 4. The following negatively worded items are reverse scored: 2, 4, 7, 10, 11, 12, 14, 15. Scores are summed to derive total for the Toronto Empathy Questionnaire.

B. Empathic Concern Scale (ECS)

After each video clip, please indicate your level of agreement with the following statements about the individual you just viewed.

Scale: Does not describe me well Describes me very well



1. I have tender, concerned feelings toward him/her.
2. I don't feel very sorry for him/her.
3. I feel kind of protective towards him/her.
4. His/her misfortune or suffering does not disturb me a great deal.
5. I don't feel very much pity for him/her.
6. I was quite touched by what I saw happen.
7. I would describe myself as a pretty soft-hearted person.

Appendix 2. Experiment 1 Forms

A. Screening Questionnaire

1. What year were you born in? _____

2. Sex: ☐ Male ☐ Female

3. Is English your first language?

   ☐ Yes ☐ No

4. If no, do you require a foreign language translator or interpreter?

   ☐ Yes ☐ No

5. In the past five years, have you had previous experience as a participant in other empathy, pain, or facial expression judgment studies?

   ☐ Yes ☐ No

6. Do you have any of the following physical or neurological impairments?

   ☐ Visual impairment requiring the use of Braille to read

   ☐ Auditory impairment requiring sign language or lip reading for verbal communication

   ☐ Neurological impairment that affects facial expression

7. Do you require a reader, scribe (amanuensis), and/or sign language interpreter to assist you in daily communication, or with your courses and coursework?

   ☐ Yes ☐ No

B. Consent Form

EFFECTS OF STATE AND TRAIT EMPATHY ON THE ACCURACY OF ENCODING OF OBSERVED PAIN FACIAL EXPRESSION, AND ON THE ACCURACY OF JUDGMENTS OF PAIN IN HUMANS

Participant Consent Form

Purpose of the Study
This research will investigate the relationship between observer empathy and the accuracy of pain judgment of the facial expression observed in others.

Purpose of Consent Form
This form is to provide you with information about the study you are considering participating in, and about your rights with regards to confidentiality, anonymity and consent as a participant. Contact information is also provided on this sheet in case you have questions, complaints, or would like to obtain results.

Participant Selection and Compensation
This study has recruited undergraduate students from the online recruitment system of the UNBC Undergraduate Psychology Student Research Participation Pool. Research participants are integral to research in the health sciences at UNBC, and by choosing to participate in this study you are taking part in the larger project of advancement of knowledge at this institution. As a benefit of participation, you will be awarded *bonus* credits toward your course grade at a rate of 1% per hour or portion thereof of research participation.

Your Participation
In this study, you will be asked to view a compilation of two-second video clips of human facial expressions. After each clip, you will be given time to rate each facial expression you observe on whether or not you think the model has experienced pain, and on how much you have empathized with, or felt concern for, each model you have viewed. These instructions will be made available to you again before and during your task.

Confidentiality
All of the information you provide will be kept confidential and your anonymity maintained. Data received from you during this study will be kept separately from any identifying information you have provided; identifying information has been requested only for the purposes of obtaining consent. All data will be stored securely and indefinitely in Dr. Prkachin's Affect and Health Science Laboratories at the University of Northern British Columbia. Only the graduate student conducting the research, Brooke Boswell, and the professor supervising the research, Dr. Ken Prkachin, will have access to the data and consent information you provide.

C. Intake Questionnaire

Demographics

1. What year were you born in?_____

2. Sex: ☐ Male ☐ Female

3. Ethnic and cultural background
   a. What is your ethnicity?

      _____

      ☐ Prefer not to answer

   b. With which culture do you identify most?
      (If more than one, please list in descending order, the first being the one you identify with most.)

      _____

      ☐ Prefer not to answer

Educational and Professional Background

4. Have you spent any time receiving education or training in health care service provision (e.g. nursing school, medical school, emergency medical service training (EMS), etc.)?

   ☐ Yes ☐ No

   a. If yes, what form of health care education or training did you receive?

      _____

   b. How long did you receive health care education or training for?

      _____

   c. And was this within the last 5 years?

      ☐ Yes ☐ No

5. Have you had experience in health care service provision (e.g. nursing, EMS, physical therapy, etc.)?

   ☐ Yes ☐ No

   a. If yes, in what capacity?

      _____

   b. How long were you in health care provision for?

      _____

   c. And was this within the last 5 years?
      ☐ Yes ☐ No

D. Disclosure and Release Form

EFFECTS OF STATE AND TRAIT EMPATHY ON THE ACCURACY OF ENCODING OF OBSERVED PAIN FACIAL EXPRESSION, AND ON THE ACCURACY OF JUDGMENTS OF PAIN IN HUMANS

Research Disclosure and Video Release Form

Thank you for your participation in this study.

This sheet is to debrief you about aspects of your participation in this research that were not revealed to you at the outset of your involvement. Once you have read this sheet, and thereby received complete disclosure about the project, this form provides you with the opportunity to reconsider your consent to participate and to have your data and media used for the purposes of this research. Once again, you do have the option to withdraw from the study after receiving disclosure.

Toronto Empathy Questionnaire (TEQ)
During the online participant recruitment portion of the project, you were asked to take a 16 point questionnaire about your personality. This statement-response series is known as the Toronto Empathy Questionnaire (TEQ), and it assesses the relative empathy levels of respondents. This study investigates the relationship between a person's empathy levels and their ability to accurately judge whether another person is experiencing pain based on their facial expression. For this reason, participants were selected for this study that scored either slightly higher, or slightly lower, than average on the TEQ. Although you may have scored above or below average, the degree of deviation from average required for participation in this portion of the study is not outside of what can be considered the statistical norm for trait empathy on this questionnaire.

Participant Facial Expression Footage
Another question under investigation in this study is whether a person observing the facial expression of others experiencing pain will demonstrate empathetic pain facial expressions in response. For this reason, your facial expressions were being video recorded while you were viewing the facial expression video clips. As a necessity of this research, your immediate, visceral reactions to the facial expressions you observed were required, and for this reason, you were not informed that you would be filmed prior to your participation in this study. Should you consent to the use of video recordings of your facial expressions in this study, your footage will be stored indefinitely in the Affect and Health Science Laboratories of Dr. Ken Prkachin, faculty supervisor of this project. Your footage may be used in future human social perception studies, but <u>will not</u> be published or released for public viewing or on the internet without your prior consent. If you do not grant permission for its use in this study, your film footage and other data you have provided during your participation will be destroyed.

Appendix 3. Experiment 2 Forms

A. Screening Questionnaire

1. What is your sex?

   ☐ Male ☐ Female

2. Is English your first language?

   ☐ Yes ☐ No

3. If no, do you require a foreign language translator or interpreter?

   ☐ Yes ☐ No

4. In the past five years, have you had previous experience as a participant in other empathy, pain, or facial expression judgment studies?

   ☐ Yes ☐ No

5. Do you have any of the following physical or neurological impairments?

   ☐ Visual impairment requiring the use of Braille or the assistance of a reader

   ☐ Auditory impairment requiring sign language or lip reading for verbal communication

   ☐ Neurological impairment that affects facial expression, recognition or perception

6. Do you require a reader, scribe (amanuensis), and/or sign language interpreter to assist you in daily communication, or with your courses and coursework?

   ☐ Yes ☐ No

B. Consent Form

EFFECTS OF STATE AND TRAIT EMPATHY ON THE ACCURACY OF ENCODING OF OBSERVED PAIN FACIAL EXPRESSION, AND ON THE ACCURACY OF JUDGMENTS OF PAIN IN HUMANS

Participant Consent Form

Purpose of the Study
This research will investigate the relationship between observer empathy and the accuracy of pain judgment of the facial expression observed in others.

Purpose of Consent Form
This form is to provide you with information about the study you are considering participating in, and about your rights with regards to confidentiality, anonymity and consent as a participant. Contact information is also provided on this sheet in case you have questions, complaints, or would like to obtain results.

Participant Selection and Compensation
Graduate students from the Health Sciences and Psychology departments at UNBC have been randomly selected and screened for participation in this study. By choosing to participate in this study you are contributing not only to the completion of the research component of a graduate degree, but also to the larger project of advancement of knowledge at UNBC. Participants will be given a gift card from a coffee and tea establishment in compensation for their time.

Your Participation
In this study, you will be asked to view, separately, two compilations of two-second video clips of facial expressions. After each two-second facial expression clip, you will be given time to rate the model you have just viewed on pain, and for the human models, on the level of empathic concern you feel towards them. The total time required to view the videos (not including administrative tasks, e.g. reading and signing consent forms) will be 2 hours and 30 minutes. Instructions will be made available to you again before and during your task.

Confidentiality
All of the information you provide will be kept confidential and your anonymity maintained. Data received from you during this study will be kept separately from any identifying information you have provided; identifying information has been requested only for the purposes of obtaining consent. All data will be stored securely and indefinitely in Dr. Ken Prkachin's Affect and Health Science Laboratories at the University of Northern British Columbia. Only the graduate student conducting the research, Brooke Boswell, and the professor supervising the research, Dr. Prkachin, will have access to the data and consent information you provide.

C. Intake Questionnaire

Demographics

1. What year were you born in? _____

2. Sex: ☐ Male ☐ Female

3. Ethnic and cultural background
   a. What is your ethnicity?

      _____

      ☐ Prefer not to answer

   b. With which culture do you identify most?
      (If more than one, please list in descending order, the first being the one you identify with most.)

      _____

      ☐ Prefer not to answer

Educational and Professional Background

4. Have you spent any time receiving education or training in health care service provision (e.g. nursing school, medical school, emergency medical service training (EMS), etc.)?

   ☐ Yes ☐ No

   a. If yes, what form of health care education or training did you receive?

      _____

   b. How long did you receive health care education or training for?

      _____

   c. And was this within the last 5 years?

      ☐ Yes ☐ No

5. Have you had experience in health care service provision (e.g. nursing, EMS, physical therapy, etc.)?

   ☐ Yes ☐ No

   a. If yes, in what capacity?

      _____

   b. How long were you in health care provision for?

      _____

   c. And was this within the last 5 years?

      ☐ Yes ☐ No