PAIN EXPRESSION IN MILD COGNITIVE IMPAIRMENT: ITS RELATION TO FRONTAL LOBE INVOLVEMENT IN NON-VERBAL PAIN EXPRESSION

by

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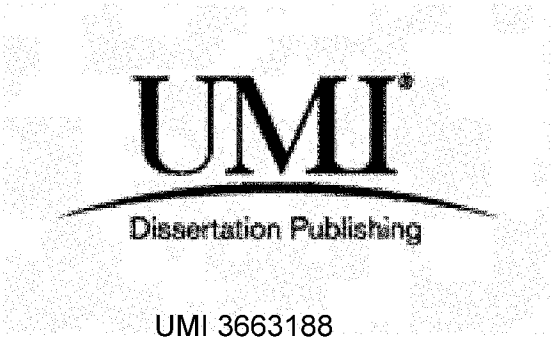

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Abstract

Background/Purpose: Pain is prevalent and often undertreated in elderly individuals suffering from cognitive impairments. Interestingly, such individuals may actually show an increase in facial expressions of pain. The reasons for this are unclear, but may possibly relate to disinhibition due to frontal lobe impairment. It was hypothesized that elderly individuals who suffer from mild cognitive impairments (MCI) would display higher levels of pain expression than normal controls, particularly if they have deficits in frontal lobe functioning.

Methods: A sample of elderly individuals were recruited from the community and labeled as "MCI" if they scored <26 on the Montreal Cognitive Assessment Task (MoCA). A comparison sample (control group) consisted of individuals scoring ≥26 on this test. Facial expressions were videotaped and then rated and scored for pain intensity at the time of an influenza vaccination and participants were subsequently questioned regarding their subjective experience of the painful stimulus. They also underwent neuropsychological testing of frontal lobe functions (in particular, executive functioning) including the Wisconsin Card Sorting Test (WCST), Stroop Test, and verbal fluency testing. Social inhibition was assessed through a self-disclosure interview.

Results: There were 58 participants ranging in age from 56 to 92 yrs (M=69.7; SD=8.3). Of this group, 34 met criteria for MCI based on MoCA scores (i.e., MCI group) while 24 did not (control group). There were no significant differences between the two groups with respect to facial expressions of pain, subjective reports of pain, nor social inhibition scores. While executive functioning was relatively impaired in the MCI group, the degree of impairment did not correlate with facial expressions of pain nor with social inhibition scores.

Conclusions: Contrary to expectations, no significant differences were found between participants identified as having MCI and normal controls in their facial expressions of pain post-immunization and executive functioning scores did not significantly predict observed facial expressions of pain in this sample. If such differences do indeed exist, they may be too mild at this stage of cognitive impairment to be demonstrated with such a small sample size. Further investigations, utilizing a larger sample size and/or participants with a more moderate degree of cognitive impairment may be warranted.

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Pain is prevalent and often undertreated among elderly individuals, especially among those suffering from cognitive impairments (Gabre & Sjoquist, 2002). Of great concern is the potential for caregivers and health care providers to misinterpret or not recognize pain signals in a population that may have difficulty verbally expressing physical discomfort. Researchers have made great strides in understanding pain in this population; however, a conflicting pattern has emerged. Recent research has shown that elderly individuals with cognitive impairments are likely to express higher levels of pain through facial movement than cognitively intact elderly individuals (Hadjistavropoulos, Craig, Martin, Hadjistavropoulos & McMurty, 1997; Kunz, Scharmann, Hemmeter, Schepelmann & Lautenbacher, 2007). Such findings conflict with research indicating that those with cognitive impairments report less pain, therefore implying that these individual must feel less pain (Parmelee, Smith & Katz, 1993; Haasum, Fatborn, Fratigliomi, Kareholt & Johnell, 2011). The belief that those with cognitive impairments feel less pain may be manifested in the reduced analgesic treatment in this population (Won et al. 1999; Morrison & Siu, 2000). Building on research that has demonstrated that elderly individuals with cognitive impairments are more likely to express higher levels of pain through facial movement, two logical questions emerge: why does this population expresses higher levels of pain through facial expressions even though they report feeling reduced pain, and will this pattern of increased pain expression be present in individuals who are in the stages of pre-dementia?

To answer these questions it is important to look at how aging and the development of dementia can affect brain structures, in particular the frontal lobe. The frontal lobe is generally thought to be responsible for higher order executive functioning (Chan, Shum, Toulopoulou &

Chen, 2008) and it is also involved in the regulation of social behavior (Stuss & Benson, 1984). Contemporary research has shown that damage to the frontal lobe impairs the ability to regulate behavior. Patients with frontal lobe damage have been observed engaging in uncontrolled and "tasteless" social behavior such as inappropriate joking (Stuss & Benson, 1984). In addition, individuals with frontal lobe damage have been observed greeting strangers by giving them a kiss or a hug (Rolls, Hornak, Wade & McGrath, 1994), social displays most often reserved for more intimate acquaintances and inhibited by cognitively intact individuals. As dementia is a mechanism that can damage the frontal lobe, it can be expected that elements of social inhibition would decrease in some people during the early stages of cognitive impairment. One could further theorize that the release of social inhibition would affect numerous areas of social behaviour, such as pain expression. In fact, research has shown that the expression of pain is subject to social inhibition under normal circumstances (Williams, 2002). If general social inhibitions were released, an individual would have a more arduous time hiding pain expressions from those around them.

The purpose of the present study was to obtain evidence of the possibility that reduced frontal lobe functioning causes an increase in facial expressions of pain. It was hypothesized that the elderly who suffer from mild cognitive impairments and show evidence of a reduced level of frontal lobe functioning would display higher levels of pain expression, when compared to elderly individuals who do not suffer from such cognitive impairments.

Literature Review

Mild Cognitive Impairment

Cognition is defined "the mental action or process of acquiring knowledge and understanding through thought, experience, and the senses" (Oxford Dictionary, 2013). It is

anticipated that some cognitive decline will occur at older ages, but this decline is not uniform across all cognitive tasks. It is important to be aware of the specific stages of cognitive decline when an individual is moving from normal to impaired cognitive functioning.

Mild cognitive impairment (MCI) is a clinical syndrome thought to represent the transition phase between normal cognitive functioning and dementia (Albert & Blacker, 2006). One of the earliest references to mild cognitive impairment described a predementia stage (Reisberg, Ferris, de Leon, et al., 1988). Considerable research and clinical evidence supports the argument that there is a transitional phase between normal functioning and dementia. Research has indicated that the reduction in memory is important in the early detection of Alzheimer's disease (Backman, 2008). Dysfunctions in cognitive domains other than memory may be an early sign of vascular or other non-Alzheimer dementias (Padovani, Di Piero, Bargoni, et al, 1995). Studies of imaging and other biomarkers of AD pathology demonstrate the presence of alterations in non-demented individuals with cognitive impairments that are intermediate between normal individuals and those with mild AD (Albert & Blacker, 2006). Therefore, MCI can be thought of as the clinical intermediary between cognitive impairment and not cognitively impaired.

MCI is currently thought to identify a spectrum of diseases that include impairments in both memory and non-memory cognitive domains (Petersen, 2004; Winblad, Palmer, Kivipelto, et al., 2004). This is in contrast to the earlier diagnostic criteria for MCI in which memory impairment was one of the requirements for diagnosis. The current criteria for a MCI diagnosis are as follows: cognitive complaint, decline, or impairment; objective evidence of impairment in cognitive domains; essentially normal functional activities; and not demented (Petersen, 2004; Petersen, Roberts, Knopman, et al., 2009). MCI can, therefore, be classified into two subtypes:

amnestic and non-amnestic (Petersen, 2011). Amnestic mild cognitive impairment is clinically significant memory impairment that does not meet the criteria for full dementia. Alternatively, non-amnestic mild cognitive impairment is characterized by a subtle decline in cognitive functions not related to memory, but affecting attention, use of language or visuospatial skills (Petersen, 2011). According to Peterson et al. (2009), this classification by subtype relates directly to the underlying etiology and pathology, the clinical presentation, and outcomes. Furthermore, MCI may consist of impairment in a single cognitive domain or impairment in multiple cognitive domains. The number of affected domains has vital implications for understanding the extent of the underlying brain pathology or disease, disease severity, and likelihood of progression to dementia. Information from both the MCI phenotype (amnestic MCI vs. non-amnestic MCI) and the number of cognitive domains affected (single vs. multiple) is hypothesized to determine future outcomes (Petersen et al., 2009). Single-domain or multiple-domain amnestic MCI is hypothesized to progress to AD if there is an underlying degenerative etiology (Petersen et al.). The non-amnestic mild cognitive impairment subtype is less common than the amnestic subtype and may be the forerunner to dementias not related to AD, such as frontotemporal lobe degeneration or dementia with Lewy bodies (Molano, Boeve, Ferman, et al., 2010).

Prevalence of Mild Cognitive Impairment

Research on the prevalence of mild cognitive impairment has produced inconsistent results, mainly because of differing definitional criteria and assessment procedures (Bischkof, Busse & Angermeyer, 2002). However, population-based studies indicate that rates of mild cognitive impairment are almost double those of dementia (Morris, Storandt & Miller, 2001). Similar to dementia, incidence rates of MCI seem to increase with age, and are higher for people

with lower levels of education (Bischkof, Busse & Angermeyer, 2002). In contrast to the epidemiology of dementia, incidence rates for mild cognitive impairment may be higher in men than women. (Ganguli, Dodge, Chen, Belle & Dekosky, 2000). To determine the prevalence and incidence rate of MCI, Roberts, Geda, Knopman, Cha, Pankratz, Boeve, et al. (2008), conducted a prospective population based study. It was found that 12.25% of the sample (n = 2685) met criteria for an MCI diagnosis.

According to Statistics Canada, 1 in 11 Canadians over the age of 65 has Alzheimer's disease or a related dementia (Statistics Canada, 2008). It is expected that in the next five years these numbers will grow to 1 in 6 and they will double within 25 years. Specific to British Columbia, more than 70,000 individuals are thought to be currently living with some form of dementia. Research has shown that cognitive decline may reduce an individual's ability to effectively communicate pain to health care providers (Tsai & Means, 2005). Therefore, it is essential to not only understand pain, but to understand how individuals who have mild cognitive impairment may display pain.

Defining Pain

Before proceeding to the discussion of mild cognitive impairment involvement in pain expression, it is beneficial to understand the concept of pain in further detail. 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. Pain is always subjective. Each individual learns the application of the word through experiences related to injury in early life. (2008, np).

This definition is widely endorsed, as it includes criteria related to physical stimulation and subjective experience and allows for pain in situations where tissue damage may not be apparent (Owens, 1984).

Pain, at the most basic level, serves as a protective mechanism for the human body. Pain perceptions signal the body to move away from tissue damage or from noxious stimuli. It is a largely subjective and individualized perception because it requires the central nervous system to interpret the damaging stimuli. The same level of tissue damage may cause different levels of pain and pain expression in different individuals. Pain can be perceived differently from one individual to another individual and even from one time to another time in the same individual (Montes-Sandoval, 1999). This variability in pain perception makes consistent pain identification difficult for the outside observer.

In some cases fulfilling the criteria for pain identification is simple, yet in other cases it is quite complex. Identification of potential pain through tissue damage can take place by direct observation or by considering contextual factors such as the occurrence of surgery, vaccinations, or tissue damage resulting from an accident. Despite the fact that potential pain from tissue damage is readily identifiable to the observer, the central feature of IASP's pain definition is subjective distress. Identifying subjective distress is more complex in that it requires the observer to assess pain based on physical or verbal cues (Owen, 1984).

There are distinct pain categories attended to by clinicians and researchers: (a) acute, i.e. following an injury or a surgery, (b) chronic malignant, i.e., resulting from a progressive, often fatal, disorder such as cancer, and (c) chronic non-malignant, i.e., a progressive disorder that does not directly lead to death, such as arthritis (Forrest, 1995). Chronic pain is arbitrarily defined as any pain that persists for more than one month, beyond the course of an acute illness,

or endures after a reasonable time to expect that healing should have been achieved (Bonica, 1990). A major distinction between acute and nonmalignant chronic pain is that acute pain can be viewed as a warning sign or clinical indicator of tissue damage whereas after time, chronic nonmalignant pain serves no clinical usefulness (Forrest, 1995). Although pain affects all ages, its perception becomes more complex as a person ages.

The Effects of Aging on Pain

Researchers have attempted to evaluate age-related changes in pain perception, but the results have been inconsistent. Studies have been used to assess age-related changes in pain reactivity using controlled stimuli. Laboratory studies often use acute pain stimuli to determine pain thresholds and tolerances in differing age groups. Experimental pain stimuli often include exposure to heat or cold, electrical muscle stimulation, or mechanical stimulation and are delivered only to the point of passing the individual's pain threshold or their tolerance for pain. Laboratory results have been inconsistent with some researchers finding that pain thresholds do not differ in older adults (Zheng, Gibson, Khalil, Helme & McMeeken, 2000) while other researchers find that pain thresholds and pain tolerance increase with age and cognitive status (Tucker, Andrew, Ogle & Davidson, 1989; Benedetti et al., 1999; Carlino et al., 2010). The difference in findings may be explained by the variance in experimental pain stimuli used to test pain thresholds and pain tolerance. Lautenbacher, Kunz, Strate, Nielsen & Arendt-Neilson (2005) found that somatosensory thresholds (warmth, cold, and vibration) for non-noxious stimuli increased with age. They also found that pressure pain thresholds decrease with age, but no age differences were found when heat was used to induce pain.

Research has been done concerning the effects of aging on autonomic pain responses and spinal motor responses. Mylius, Kunz, Hennighausen, Lautenbacher & Schepelmann (2008)

investigated nocifensive responses to noxious electrical stimulation, and compared physiological responses in young adults to elderly adults. They found that galvanic skin responses declined with age, whereas no differences were found between young and elderly adults when the nociceptive flexion reflex was stimulated. The study suggests that a decline in the sympathetic skin response indicates that the central or peripheral efferent sympathetic functions are altered by age.

Acute pain experiences induced in a laboratory setting are very different from acute pain experiences in a clinical setting. The major difference between laboratory pain stimuli versus pain stimuli in a clinical setting is that laboratory stimuli are acute, controlled, and can be terminated as soon as the individual indicates they have reached their maximum threshold or tolerance. Conversely, clinical pain neither stops at an individual's threshold of pain, often going beyond it, nor can the stimulus be immediately terminated.

In summary, the effect of aging on pain is still unclear, as laboratory results have shown inconsistent findings. Caution should be used when generalizing acute laboratory pain experiences to real life clinical pain. Pain tolerance and threshold methods used in a controlled setting do not truly imitate or represent clinical levels of pain or chronic pain.

Prevalence of Pain in the Elderly

The prevalence of pain in the elderly is higher than other age populations, due to higher rates of painful diseases such as arthritis and cancer in the elderly (Reyes-Gibby, Aday & Cleeland, 2002). It is estimated that the prevalence of elderly Canadians suffering from chronic pain is 15% - 18% (Reitsma, Tranmer, Buchanan & Vandenkerkhof, 2011). Feldt (2000) reported that 45 to 80% of nursing home residents experience pain on a daily basis. Ferrell and Ferrell (1990) reported that 70% of nursing home patients described having significant pain, and

one-third of that same population suffered from consistent or chronic pain. Furthermore, Ferrell et al. (1990) indicated that 71% of nursing home residents reported having some pain part of the time. Among residents with pain, 66% reported intermittent pain and 34% indicated consistent pain.

Pain is also prevalent in community-dwelling elderly individuals. In 1994, Mobily, Herr, Clark and Wallace conducted a large community-based survey. They surveyed over 3,000 individuals for any type of pain they may have experienced over the previous year. Eighty-six percent of the participants reported having pain. Interestingly, the study further indicated that individuals over the age of 85 reported fewer pain complaints than those aged 65 - 74 (Mobily *et al.*, 1994).

The prevalence of pain among the elderly is thus generally high, not only in nursing homes but in the community as well. It is important to be able to accurately assess pain in the cognitively intact elderly, and it is even more imperative to be able to assess pain in those with cognitive impairments. Those with cognitive impairments have a more difficult time communicating their level of pain, in customary ways, to those around them.

Assessing Pain in the Elderly

Assessing pain in verbal populations can be a relatively simple task, as self-report measures can be utilized. Self-report has been termed the "gold standard" in pain assessment (Abu-Saad, Bours, Stevens & Hamers, 1998). Even though self-reports allow for an evaluation of a person's subjective pain experience and are easy to gather in a methodological sense, they have major limitations. Hadjistavropoulos, Craig & Fuchs-Lacelle (2004) point out that self-reports of pain may be affected by response bias, situational demands and conscious distortion. They summarized their critique with the implication that self-reports of pain are actually "fools' gold".

They argue further that researchers are over-dependent on self-reported pain; in failing to recognize other forms of pain assessment, they consequently ignore populations that do not have strong verbal communication skills (i.e. infants, autistic individuals, and the elderly with cognitive deficits). In these populations, the reliance on self-report measures for pain assessment has resulted in the underuse of nonverbal expression in measuring (Barr, 1992).

The overemphasis on self-report measures and the underuse of nonverbal pain expressions brings the generalizability of the IASP's definition of pain into question, as applied to non-verbal populations or those with limited verbal skills. In regards to pain assessment, the IASP's definition becomes problematic when dealing with populations with limited abilities to communicate effectively in a verbal manner (Anand & Craig, 1996). Hadjistavropoulos, von Baeyer & Craig (2001) summarize the problem, stating:

> It is often assumed that because the experience of pain is a subjective state, the only means whereby it can be tapped is through the suffering person's verbalizations... The current definition of pain, which emphasizes the use of self-description, can only be taken to imply that states of pain and suffering cannot be understood in nonverbal persons. This position limits attention to the availability and usefulness of nonverbal expression. (p. 137)

The limitations of this position result in difficulties when assessing pain in the elderly with verbal difficulties due to cognitive impairments. As Feldt (2000) indicates, verbal reports from elderly individuals with cognitive impairments may be difficult to obtain or they may be unreliable because of short-term memory loss or impairment in language skills.

Pain in Elderly Individuals with Cognitive Impairments

In 2002, an estimated 15% of the Canadian population was over the age of 65, with this figure expected to rise to over 18% by the year 2025 (Martin-Matthews, 2002). With the rapid increase in people over the age of 65 in Canada, the number of elderly individuals suffering from cognitive impairments has also increased substantially. In 1994, it was estimated that over 250,000 elderly Canadians were suffering from dementia, with this number expected to increase to 592,000 by the year 2021 (Canadian Study of Health and Aging Working Group, 1994). The large number of elderly individuals with cognitive impairments suffering from pain further highlights the importance of understanding nonverbal signs of pain in this population. Cognitive impairments often progress to a point where the individual becomes non-verbal or verbal skills are compromised. Consequently, they are unable to report pain levels through traditional means such as self-report. For these reasons, it often falls to an outside observer (i.e., physician, caregiver) to identify the patient's pain and provide appropriate treatment.

Research has been conducted to determine if elderly individuals with cognitive impairments identify and display pain in a similar manner to non-cognitively impaired individuals. Studies have shown that individuals suffering from dementia will rate pain stimuli similarly to healthy individuals (Kunz, Mylius, Scharmann, Schepelman & Lautenbacher, 2009). It has also been found that facial expressions of pain are preserved in individuals with dementia (Kunz, Scharmann, Hemmeter, Schepelmann & Lautenbacher, 2007). An interesting outcome of the research is the level of facial pain displays, as individuals with cognitive impairments display pain differently when compared to cognitively intact individuals.

Clinically, it has been found that individuals with cognitive impairments have more intense facial displays of pain when compared to cognitively intact elderly. Facial expressions in those with dementia have been assessed, using facial coding, during flu injections

(Hadjistavropoulos, Craig, Martin, Hadjistavropoulos & McMurty, 1997), venipuncture (Hadjistavropoulos, LaChapelle, MacLeod, Hale, O'Rouke & Craig, 1998; Porter, Malhotra, Wolf, Morris, Miller & Smith, 1996), and exacerbated musculoskeletal pain during physical exercise (Hadjistavropoulos, LaChapelle, MacLeod, Snider & Craig, 2000). Even though the type of clinical pain varied in these studies, the results are homogenous. It was consistently found that facial expressions to noxious stimuli increased in patients with dementia (Hadjistavropoulos, LaChapelle, MacLeod, et al., 2000; Porter et al., 1996), suggesting that these facial expressions could be reliably used to assess levels of pain in dementia patients who are verbally compromised. Results from these studies also uniformly found that facial expressions in patients with dementia significantly intensify when compared to baseline periods.

To further explore the increase in facial expression, Kunz, Scharmann, et al. (2007) conducted an experimental study to determine if facial expressions of pain would be more intense in dementia patients when compared to cognitively intact individuals in a controlled environment. Their findings confirmed previous clinical research, showing that facial responses to noxious electrical stimulation were significantly increased in patients with dementia when compared to healthy controls. The researchers further found that facial responses were closely related to the intensity of the pain stimulation. To extend these findings, Kunz, Mylius et al. (2009), assessed multiple components of pain in a sample of patients with MCI. They found that when they assessed subjective, facial, motor reflex and autonomic responses to a noxious electrical stimulus, dementia patients were more reactive in their behavioural responses to pain relative to intact controls. Once again, facial responses to noxious electrical stimulation were significantly increased in patients with dementia. Thus, the available literature is consistent across clinical and experimental studies in showing that pain reactivity is enhanced among

patients with dementia. The question remains, why are facial pain responses more intense in those elderly suffering from dementia, when compared to facial pain responses of cognitively intact elderly individuals? The Kunz et al. study investigated the differences between facial pain responses of elderly people with and without cognitive impairment. Within these groups, psychometric indicators of frontal lobe functioning were examined as they relate to facial responses to pain.

Frontal lobe and Social Inhibition

There is a rich history regarding the current understanding of how the human brain controls behaviour. A well-known contributor to this level of understanding is John Hughlings Jackson, who is often regarded as the father of British neurology (Gillett & Franz, 2013). As most physicians in the later part of the 19th century Hughlings Jackson was faced with the need to diagnose neurological diseases with no systematic scientific methodology. Hughlings Jackson's approach to clinical neurological symptoms was greatly influenced by Herbert Spencer's emerging evolutionary approach to the mind and brain (Franz & Gillett, 2011). Spencer championed the dismissal of metaphysical and supernatural explanations in science and human knowledge and he explained the emergence of higher mental processes – the cognitive functions to do with thought, memory, imagination and mortality. He achieved this through the expansion of primitive sensorimotor 'forbearers', using only the resources of biological theory (Spencer, 1885). From Spencer's theories of sensorimotor forbearers, Hughlings Jackson emphasized the importance of "the corresponding organism with the environment" (Hughlings Jackson, 1884, pg. 705); therefore, the higher brain centers are suited to the re-representation of the body and the conditions to which it is responsive. This led to his hypothesis that the brain evolved with increasingly higher levels of re-representation of the basic (primitive) sensorimotor

representations. He further proposed a three-level system that effectively encompasses a sensorimotor machine (the whole brain), with its lower level defined as anterior spinal horns and motor nerve nuclei, its middle level of motor control and basal ganglia and highest level, that which "re-re-represents the body", consisting of the premotor (frontal) cortex (York & Steinberg, 2006, pg. 19). Hughlings Jackson further postulated the dissolution of evolved higher functions was the key to clinical conditions in which nervous system damage affects an individual's ability to function (Hughlings Jackson, 1884). Therefore, damage to the highest level of the sensorimotor machine (e.g. the frontal lobe) would affect an individual's ability to function.

In humans, the frontal lobes encompass all the tissue anterior to the central sulcus and constitute roughly 20% of the neocortex (Kolb & Whishaw, 2009). The frontal lobe is responsible for higher-level executive functions, including organizing and following social norms, and can be divided into the motor, premotor and prefrontal areas. Damage to this lobe can cause changes in personality and result in difficulties following social norms. The most publicized example of personality change subsequent to frontal lobe damage is that of Phineas Gage. John Harlow first reported this extraordinary case in 1868. Gage was a railway construction supervisor who survived an explosion that blasted a meter long, 3cm wide at its widest point iron-tamping bar through his frontal cortex. According to Harlow, Gage's behaviour changed completely after the accident. Gage had been of average intelligence and was energetic and persistent in executing all of his plans. However, following the injury Gage's personality was described by Hallows as:

> The equilibrium or balance, so to speak, between his intellectual faculties and animal propensities seem to have been destroyed. He is fitful, irreverent, indulging at times in the grossest profanity, manifesting but little deference to his fellows, impatient of

> restraint or advice when it conflicts with his desires, at times pertinaciously obstinate, yet capricious and vacillating, devising many plans of operation, which are no sooner arranged than they are abandoned in turn for others appearing more feasible. (Blumer & Benson, 1975, p.153).

If a person with damage to the frontal lobe cannot follow social norms, he or she may not inhibit social responses, such as occurs when hiding pain. Thus, if progressive neurological impairments have damaged the frontal lobe it would be expected that the individual would be unable to inhibit the social pain response and would show pain levels through their facial expressions.

Facial expressions are an elemental mechanism for communication in many species and an important element in the management of interpersonal relationships and social interactions (Darwin, 1872; Ekman, 1999). The degree to which this mechanism can display emotional states can vary greatly from individual to individual, with one extreme of individuals being stoic and not expressing emotions to other individuals being very expressive. Ekman and Friesen (1969) suggest that a lack of expressiveness reflects a form of inhibitory control, which is regulated by societal rules and norms. This concept suggests that the expression of emotions would be a default response that individuals learn to suppress following social demands. As facial expressions play an important role in social interactions, research has investigated the neural basis of communication via facial expressions. Behavioural studies in patients with frontal lobe lesions suggest an involvement of the frontal cortex in regulating facial expressions (Blair, 2003; Weddell, 1994). Goldin, McRae, Ramel and Gross (2008) added to this research by conducting a functional magnetic resonance imaging study in healthy controls. Results from this study indicated that while watching negative emotion-eliciting films, activity of the prefrontal lobe

increased when individuals were instructed to suppress their facial expressions. Not only do individuals suppress facial expressions related to negative emotions, but individuals are also known to hide their pain through the inhibition of their facial expressions of pain. Kunz, Chen, Lautenbacher, Vachon-Presseau and Rainville (2011) conducted a study to determine which brain areas were activated when individuals inhibited their pain processes. They hypothesized that low facial expressiveness would be accompanied by stronger prefrontal activation consistent with an inhibitory process. Results indicated that pain expression was indeed inversely related to frontostriatal activity, consistent with the down-regulation of facial displays (Kunz et al., 2011). Kunz et al. used healthy adults to demonstrate the activation of the frontal lobe through the suppression of pain expressions. One could speculate that an inverse effect would occur if elderly individuals with mild cognitive impairment were tested for the association between mild cognitive impairment and frontal dysfunction. That is, impairment to the frontal lobe should yield an increase in facial expressions when individuals are exposed to acute noxious stimuli, as their ability to inhibit their facial expressions of pain would be impaired.

The notion that individuals with frontal lobe damage would lose the ability to control their facial expressions of pain can further be explained in relation to social inhibition. People are often compelled to act on impulse and inclination, but they simultaneously regulate their social behavior according to social norms. The act of regulation is termed social inhibition (Beer et al., 2003). It is theorized that self-conscious emotions (e.g., shame, embarrassment) have developed for the purpose of regulating the impulsive approach and lack of inhibition tendencies that could threaten or violate social relations (Tangney, Miller, Flicker & Barlow, 1996). Therefore, individuals who violate norms governing social behaviour due to frontal lobe damage should show deficits in these self-conscious emotions. Research has shown that damage to the

orbitofrontal cortex, an area richly connected to areas associated with emotional and social processing (Brothers, 1996), can cause disruptions in social regulation. Research has further shown that patients with frontal lobe damage who engage in self-disclosure during interviews disclosed unnecessarily intimate information when describing their past emotional experiences; whereas, health controls did not disclose unnecessary intimate information (Beer, Heerey, Keltner, Scabini & Knight, 2003). Building on this idea, the present study addressed possible relationships between frontal lobe functions, their involvement in social inhibition, and pain responses in aged individuals in relation to their mild cognitive impairment.

The link between level of pain expression and disinhibitory processes was assessed indirectly by neuropsychological tests known to be sensitive to frontal dysfunction and through a self-disclosure interview. Numerous areas of functioning can be so tested to determine frontal lobe involvement. These areas of functioning include response inhibition, verbal fluency, nonverbal fluency, motor control, language comprehension, working memory, and planning (Kolb & Wishaw, 2009). Furthermore, it has been established that executive functioning tests are also useful in characterizing frontal lobe brain lesions (Kennedy, 2004; Raazani, Boone, Miller, Lee & Sherman, 2001). Poor performance on executive function tests is thought to represent a variety of cognitive deficits including deficient abilities in planning, organization and initiation (Lezak, Howieson & Loring, 2004). A number of tests exist that are drawn on to assess executive functioning of the frontal lobe. To assess response inhibition, the Wisconsin Card Sorting test (Milner, 1964) and the Stroop Test (Perrett, 1974) are commonly administered. To examine a patient's level of verbal fluency, the Thurstone Word Fluency Test (Milner, 1964) may be used while the Tower of London (Owen, Sahakian, Hodges, Summers, Polkey & Robbins, 1995) is used to assess planning abilities. The Wisconsin Card Sorting Test, the Stroop test, and

the Phonemic Verbal Fluency Task were used in the present study to assess frontal lobe functioning as they are the most frequently used executive functioning tests (Stuss & Levine, 2002). In conjunction with the executive functioning tests, a self-disclosure interview was conducted to evaluate social disinibition in participants with mild cognitive impairment.

In addition to testing the relationship between executive functioning, social inhibition and pain expression in individuals with mild cognitive impairment, memory for pain was also explored. Research has indicated that individuals without cognitive deficits have good memory for acute pain intensity and can accurately report their pain intensity at a later date (Erskine, Morley & Pearce, 1990). Research has also shown that elderly individuals suffering from chronic pain often complain of memory impairments and concentration issues (Munoz & Rosa, 2005). Despite these findings, research has not adequately investigated whether elderly individuals with cognitive impairments are able to accurately report previous acute pain instances. Therefore, this study also examined pain memory in the elderly to determine if individuals with and without cognitive impairments are able to accurately recall past pain experience.

The following specific hypotheses were addressed.

1). Participants with probable Mild Cognitive Impairment (MCI) will have increased facial expressions of pain when compared to controls.

2). Participants with probable MCI and control participants will report similar levels of pain directly post needle insertion.

3). Participants with probably MCI will have a poorer memory for their pain experience when compared to controls.

4). Participants with probable MCI will have impairment in selected neuropsychological measures of frontal lobe functioning when compared to controls.

5). There will be a negative relationship between frontal lobe functioning and facial expressions of pain in participants with probable MCI.

6). Control participants will have higher rates of social inhibition when compared to participants with probable MCI.

7). There will be a negative relationship between social inhibition and facial expressions of pain in participants with probably MCI.

Methods

Participants

Similar to previous studies, which have examined pain in individuals with cognitive impairments (see Felt, Ryden & Miles, 1998; Bendetti et al., 1999; Hadjistavropoulos et al. 2000), a community sample of elderly individuals was recruited from 4 local health clinics. Recruitment was conducted between October 2012 and November 2013. Inclusion criteria for participation included: (1) a score of 25 or lower on the Montreal Cognitive Assessment (MoCA) (target group only), (2) no medical conditions which could cause pain sensitivity such as diabetes, arthritis, osteoarthritis, cancer and peripheral vascular disease (Forrest, 1995), (3) the participant was at the health clinic to receive a routine seasonal flu vaccination, (4) the participant could read and write English, (5) the participant was able to give informed consent, and (6) the participant agreed to either a home visit or a university visit. A comparison group of elderly individuals was also recruited from the same health clinics. Inclusion criteria for the comparison group only differed from the target group in that they had to have a MoCA score of 26 or more.

Apparatus and Materials

A Sony HD AVCHD Handycam, model number HDR-XR100 was used to record the participants' behavioural responses to the vaccination. All digital video recordings were downloaded into a standard iMac computer for behavioural coding and analysis. The downloaded video was further edited into separate participant files using iMovie, a movie-making computer program.

Using iMovie, a 26-minute video was compiled of all the participants' behavioural responses to the vaccination procedure. This video consisted of randomly sequenced 10-second video clips, which focused on the participants' facial expressions prior to the injections and post-injection. Between each participant's 10-second clips, a 5-second blank screen was presented to facilitate ratings. To evaluate the participant's pre-injection and post-injection pain expressions, five independent judges viewed the behavioural video.

Demographic questionnaire (Appendix B). Participants filled out a questionnaire inquiring about their age, level of education, overall health status, the presence of any chronic pain conditions or any diseases that could cause chronic pain, and if they took any analgesic medication prior to their vaccination.

The questions inquiring about their age, level of education, overall health and chronic pain status were used to ascertain study eligibility. The question regarding analgesic medication was used as a control for pain expressions, as analgesic medication could potentially reduce the physical pain sensation when the needle is inserted in arm.

Neuropsychological/Executive measures.

Montreal Cognitive Assessment (MoCA; Nasreddine et al., 2005). The MoCA is a brief one-page, 30-point test used to assess cognitive abilities. Specifically, the MoCA assesses the

following cognitive domains: short-term memory recall, visuospatial abilities, executive functioning, attention, language, and orientation. This measure was used to assess participant's level of cognitive functioning. It is important to note that the MoCA cannot provide a clinical diagnosis of MCI, but rather can be used as part of the diagnostic assessment. To make a clinical diagnosis of MCI the individual should be assessed using the following criteria: individual is neither normal nor demented; shows essentially normal function in activities; and can either present memory or no memory impairment (Petersen, 2004). For the purpose of this study, however, a score of 25 or lower on the MoCA indicated probable MCI (Nasreddine et al., 2005). The MoCA has shown acceptable psychometric properties, and results suggest that it is more sensitive than the Mini Mental Status Exam in sensitivity and equivalence in specificity (Sweet, Van Adel, Metcalf, Wright, Harley, Leiva, et al., 2011). The MoCA has also been shown to be a sensitive and accurate instrument for screening individuals with behavioural-variant frontotemporal dementia (Freitas, Simoes, Alves, Duro & Santana, 2012).

Wisconsin Card Sorting Task (WCST; Heaton, 1981). The WCST consists of 128 cards divided equally into three categories: forms (circles, crosses, stars and triangles), numbers (one to four), and colours (blue, green, red, and yellow). The task required participants to match each card from the pile, to one of the 4 stimuli cards by sorting into one of the three categories (forms, numbers, or colours). Correct category sorting was achieved by finding the correct classification principle by trial and error, and by examiner feedback. For example, initially the correct solution was colour; when the participant determined this solution, after 10 correct, consecutive matches the principle changed without warning, demanding a flexible shift in set. The WCST was not timed and sorting continued until all cards were sorted, or a maximum of six correct sorting

criteria was reached (Heaton, 1981). Outcome measures included number of categories completed, and number of sorting errors.

The WCST was employed as a measure of response inhibition thought to reflect frontal lobe function. This test has been found to be an effective tool in measuring frontal lobe function (Nagahama et al., 1996). Research has shown that patients with brain lesions to the frontal lobe due to stroke (Struss et al., 2000; Mukhopadhyay et al., 2008), tumors (Goldstein, Obrzut, John, Ledakis & Armstrong, 2004) and epilepsy (Giovagnoli, 2001) perform worse on the WCST when compared to healthy controls.

Stroop Test (Trenerry et al., 1989). To further assess response inhibition thought to reflect frontal lobe damage a variant of the Stroop test was administered in two conditions. In the congruent task, participants were required to identify and say aloud the colours of 112 colour bars (blue, green, red, tan). In the incongruent task they were shown 112 colour printed in a different colour of ink (e.g., the word "green" written in blue ink). Participants were required to name the colour of the ink in which the word was printed (e.g. if the word 'green' is written in blue ink, the participant should say "blue"). Two outcome measures were calculated. The first was the difference in time between the congruent and the incongruent task. The second was the difference between the number of errors made in the congruent task and the number of errors in the incongruent task.

The Stroop test measured the interference that the automatic process of reading has on more effortful processes. Research has shown that individuals with frontal lobe damage showed deficits in inhibiting reading the words in the interference condition (Perrett, 1974).

Verbal fluency test. To determine participants' level of verbal fluency a phonemic fluency task, the F-A-S task, was administered. The participants were instructed to generate as

many words as possible beginning with the letters "F", "A" and "S" within a 1-minute time period for each given letter, excluding proper nouns and the same word with a different suffix. The following instructions were given to all participants: "I will say a letter of the alphabet. Then, I want you to give me as many words you can that begin with this letter, as quickly as possible. For example, if I say B, you can say bed, big, but you cannot say proper nouns like Bob or Brazil. Also, you can't say the same word with a different ending like bug and bugs". Subsequently, participants were asked if they understood the instructions.

The F-A-S is a sensitive task that has been used to assess frontal lobe functioning (for review see Alvarez & Emory, 2006). Vilkki and Holst (1994) used F-A-S to determine differences in the types of frontal lobe lesions. The F-A-S phonemic fluency task has also been used to assess word fluency performance in post-stroke aphasia. Sarno, Postman, Cho and Norman (2005) found that the task was sensitive in identifying increases in verbal fluency following comprehensive treatment.

Self-report: Pain assessment.

Coloured Analogue Scale (CAS; McGrath et al., 1996). To assess participants' subjective pain directly following their vaccination, the CAS was administered. The CAS is a visual analogue scale that was initially developed to provide a practical pain measure for children and others with marginal self-report skills (McGrath *et al.*, 1996). Pain on the CAS is rated by moving a plastic glide along a 14.5 cm. long triangular shape that varies in width and colour, from 1 cm width and a light pink colour at the bottom to a 3 cm width and deep red colour at the top. The extremes of the scale are anchored with "No Pain" at the bottom and "Most Pain" at the top. This scale allows participants to have visual cues for scaling their pain severity, not only in the variation in width and changes in colour, but also in the length of the scale and the anchoring

words. The scale has numbers marked on the back so that the person administrating the scale can record a number (ranging from 0-10), representing the highest level of pain felt by the participant during the vaccination procedure.

This visual analogue scale has been shown to be valid and reliable when used with the elderly without cognitive deficits and with elderly individuals who have mild to moderate cognitive deficits (Hadjistavropoulos et al., 1998).

McGill Pain Questionnaire (MPQ; Melzack, 1975; Appendix C). To further assess participants' subjective pain perception at the time of the vaccination and to assess their pain memory, they were asked to complete a subset of the McGill Pain Questionnaire. The McGill Pain Questionnaire is a self-report pain-rating tool that can be used by most elderly persons with normal to moderately impaired cognitive functioning (Manz, Mosier, Nusser-Gerlach, Bergstrom & Agrawal, 2000). The McGill Pain Questionnaire consists of three sections: verbal descriptors of pain, temporal aspects of pain, and pain severity. For the purpose of this study, only the verbal descriptor section was used. This section consists of 20 word groupings such as temporal, spatial and punctate pressure. Within each grouping, a number of pain descriptor words are provided. These groupings are further collapsed into four categories: sensory, affective, evaluative and miscellaneous (Melzack, 1983). The participant was instructed to circle one descriptor word within each category that best described the pain they felt during the vaccination. If a category did not include a descriptor word describing their pain experience, the participant had the option to select "no words applicable" for that particular group. Each descriptor word had a previously assigned numeric rating, and a final pain score for each of the four categories was calculated by adding all the ratings within each specific category. An overall error score was also calculated for each of the four categories. Comparing pain words selected directly post

immunization (Time 1) to pain words selected during the follow-up visit (Time 2) derived this score. An error was scored if the participant chose a word at Time 1 but failed to indicate that same pain descriptor word at Time 2, an error was also scored if a participant chose a pain descriptor at Time 2, but they had not selected that word at Time 1.

Geriatric Depression Scale Short Form (GDS; Sheikh & Yesavage, 1986; Appendix D). Depression has been shown to be prevalent in elderly populations living in private households or in institutions, with rates ranging from 1% to 16% (Djernes, 2006). Depression has also been shown to amplify pain sensations (von Korff & Simon, 1996). To control for depression and its potential effects on pain behaviours within the target population, it was assessed using the GDS.

The GDS short form is a self-report measure consisting of 15 yes-no items specifically designed to assess depression in an elderly population. This instrument has been shown to be both reliable and valid. These strong psychometric properties have been demonstrated when the GDS is administered to samples of functionally impaired, cognitively intact, community dwelling or primary care participants (Friedman, Heisel & Delavan, 2005).

Semi-Structured Interview.

Social inhibition: Self-disclosure task (Beer et al., 2003; Appendix E). To test social inhibition, participants were asked to complete a face-to-face interview, which focused on levels of self-disclosure. Participants were presented with a set of emotional terms. The emotional terms included five self-conscious emotions: embarrassment, guilt, pride, self-conscious, and shame. After each emotional term was given, the participant was asked to define the term and to provide a narrative of when they felt that particular emotion. The self-conscious emotional terms were counterbalanced.

Each participant's self-disclosure interview was recorded using a hand-held Sony digital voice recorder. These recordings were later transcribed, word for word, for further coding analysis.

Procedure

Influenza vaccination clinic. Upon arrival at the influenza vaccination clinic, a research assistant approached potential participants and explained the study objectives and study procedures. Participants who agreed to take part in the study were asked to read and sign the consent form (Appendix A). To ensure patient privacy, the research assistant entered the cubical after the vaccination procedure was explained to the participant. The vaccination procedure was recorded with the digital camera, which captured the participants' behavioural responses to the vaccination. For the purposes of later behavioural coding, the research assistant recording the procedure clicked a pen to indicate the exact moment of needle insertion.

To determine subjective pain experience, participants were asked to make a pain rating by drawing a line on the Coloured Analogue Pain Scale immediately following the influenza vaccination procedure. To further assess their subjective pain experience, participants were given a list of pain descriptors from the McGill Pain Questionnaire and asked to identify which pain words best described their pain experience during the injection.

Due to time and space considerations following the influenza vaccination procedure, not all questionnaires could be completed immediately. Therefore, a research assistant made a follow-up appointment with the participant to complete the remaining questionnaires (see follow-up appointment procedure below).

Follow-up appointment. After an average of 30 days (SD = 35 days) following the influenza vaccination, follow-up appointments for participants were completed. During the

follow-up appointment a trained research assistant gathered demographic information, measured cognitive functioning, assessed memory for pain with the MPQ, and conducted a semi-structured Social Inhibition Interview (Beer et al., 2003). Specifically, the Montreal Cognitive Assessment (MoCA) was used to assess the overall level of cognitive function and frontal lobe functioning was measured using the Wisconsin Card Sorting Task, the Stroop test and the Phonemic Verbal Fluency Task.

To test the level of social inhibition of participants, each participant was asked to engage in a self-disclosure interview. The self-disclosure interview used in this study was modeled after Beer et al. (2003). Each participant was presented with a set of self-conscious emotional terms and asked to define each term and provide an example of when they felt that emotion.

To assess the memory for pain of participants, the same list of MPQ pain descriptors used during the vaccination procedure was presented and participants were asked to recall their pain experience during the influenza vaccination.

Observational measures. Video recordings of participant behaviour were examined for evidence indicative of pain. Measures of pain were observed looking for specific indices of facial expressions of pain post needle insertion.

To provide further rigor to the assessment of observed pain in this elderly sample, volunteer independent judges examined participant pain, post needle insertion. The independent raters based their pain ratings upon participants' general behaviour post needle insertion.

Index of Facial Pain Expression (IFPE; Prkachin & Rash, unpublished manuscript). Facial activities indicative of pain displayed by participants during the vaccination procedure were coded using the IFPE. The IFPE is a facial coding system that has been derived from the more complex Facial Action Coding System (FACS; Ekman & Friesen, 1978). FACS identifies

44 actions that the face is capable of performing. These facial actions are defined in terms of the underlying musculature and the changes the muscle movement makes in the facial appearance. Research in pain has shown that there are a limited and distinct number of facial actions that appear when a person is experiencing pain. The IFPE is a coding system that has been developed to observe these limited and distinct facial actions and has been used in a number of studies (Prkachin, 1992; Prkachin & Solomon, 2008; Rocha, Prkachin, Beaumont, Hardy & Zumbo, 2003). Using the system, observers code four facial actions: brow lowering, orbit tightening, levator tightening, and closing of the eyes. If the facial action is present, it is further coded for intensity. Intensity ratings can range from 1 (trace) to 5 (extreme). For eye closure, a code of Y (yes) is given a score of 1; N (no) is given a score of 0. The numeric scores for each action are simply summed, yielding the IFPE score, which can range from 0 to 16 for any individual.

Behavioural coding. The time segments analyzed for IFPE coding were the 10-second pre-immunization phase and the 10-second post-immunization phase. These two phases were further broken down into 2-second segments. To determine the participants' overall change in their facial expression of pain from the pre-immunization segment to the post-immunization segment, the total observed scores from the pre-immunization segment were subtracted from the post-immunization segment, producing a single pain reaction score.

Independent ratings of pain. To further quantify the pain expressions in this study, a judgment study was conducted. Judgment studies have two components, an encoder and a decoder. The encoder is the individual who emits behaviour and the decoder is the individual who interprets, scores, rates, or judges the behaviour. As indicated by Rosenthal (1987), the basic judgment study ABC model is made up of three parts: encoders' internal state or emotion

(A), encoder behaviour (B), and decoder judgment (C). For the purpose of this study, the encoders were the participants receiving vaccinations and the decoders were independent judges.

Five independent decoders (3 female, 2 male) with an average age of 34.20 years *(SD* = 6.30) rated participants' pain behaviour using the same pre- and post-immunization video segments used to obtain the IFPE pain score. Each judge rated each of the 58 participants' pre-immunization segment and post-immunization segment on a single behavioural pain dimension. The pain dimension was assessed via a 4-point Likert confidence interval rating scale ranging from -2 (absolutely no pain) to 2 (absolutely pain). To obtain a single observed pain score for each participant, the pre-immunization segment pain score was subtracted from the post-immunization pain score. This type of rating scale has been used in previous judgment studies (Ambady & Rosenthal, 1993).

The effective reliability (Rosenthal, 1987) of the decoders' ratings on the pain dimension was calculated. They were found to have an intraclass correlation of $r = .64$, which exceeds the recommended cutoff of $r = .60$ (see Rosenthal, 1987). This indicates that the decoders' ratings were sufficiently homogeneous to calculate an average behavioural score for both the pre-immunization segment and the post-immunization segment. To simplify statistical analysis, two behavioural ratings (pre-immunization segment and post-immunization segment) were derived for each participant by taking the average score across all 5 decoders.

Social inhibition: Self-disclosure task (see Beer et al., 2003; Appendix E). To test social inhibition, participants were asked to complete a face-to-face interview, which focused on levels of self-disclosure. Participants were presented with a set of emotional terms. The emotional terms included five self-conscious emotions: embarrassment, guilt, pride, self-conscious, shame. After each emotional term was given, the participant was asked to define the term and to provide

a narrative of when they felt that particular emotion. The self-conscious emotional terms were counterbalanced.

Coding self-disclosure task responses. To code the participants' responses three judges, blind to the participant's cognitive status, reviewed the transcribed interviews. They coded the participants' responses for the intimacy of their self-disclosure when defining the emotional terms and when providing examples of when they had felt a particular emotion. A self-disclosure rating for each emotion was made using a 7-point Likert Scale, from 1 (not at all) to 7 (very much). Ratings for each participant were averaged across all emotions to produce an overall index of self-disclosure intimacy. Furthermore, ten percent of the interviews were coded a second time to determine inter-rater reliability. Inter rater-reliability was calculated using Person's r (Rosenthal, 1987). Inter-rater reliability was found to be quite high at $r = .98$.

Results

Demographics

Of the 74 elderly individuals who originally agreed to participate in the study, one participant was excluded due to having a previously diagnosed chronic pain condition, one participant's influenza vaccination was not captured on videotape, and 14 elderly individuals did not complete their follow-up visit. The number of participants included in the final analysis was 58. Table 1 summarizes descriptive data about the elderly individuals who participated in the study. Of the 58 participants in the study, 24 (41%) were male and 34 (59%) were female. The average age of the participants ranged between 56 and 92 years ($M = 69.7$ years of age, SD = 8.3 years of age). Of the 58 participants in the study, 54 (91.3%) had been given an influenza vaccination previously and 15 (25.9%) of the participants had taken some form of pain medication prior to their vaccination. No significant differences on facial expressions of pain

were found between individuals that had taken pain medication and those that had not taken pain medication prior to their vaccination $F(1,55) = 0.02$, ns.

To determine the number of participants who met the criteria for MCI, scores from the MoCA were utilized. Results indicated that of the 58 participants, 34 (17 males and 17 females) had a MoCA score of 25 or lower, therefore meeting the study criteria for MCI. The remaining 24 (7 males and 17 females) who had a MoCA score of 26 or higher were used as the comparison group.

Pre-Analysis

Prior to conducting the statistical analysis, pre- and post- immunization expressions of pain (observational and judgment rated), neurological and executive functioning tests, and self-reported pain measures were examined through various SPSS analyses for accuracy of data entry, missing values, extreme outliers, and tests for normality.

Conducting stem and leaf plots, extreme values were found for the dependent variables: IFPE pain rating, the average decoder behaviour ratings for the pre and post video segments, CAS, and the McGill pain questionnaire administered at time 1 and 2. To determine if these extreme scores affected the normal distribution of the variables, a test for normality was conducted.

Tests for normality indicated that the following variables did not fit a normal distribution: the IFPE pain ratings, the decoder behaviour ratings, and the CAS (see Table 2). If a variable varies widely from a normal distribution, standard practice (see Tabachnick & Fidell, 2001) is to use a transformation method that produces skewness and kurtosis values as close to zero as possible. The aforementioned sample variables were transformed using loglinear transformation

to bring the distributions as close as possible to normality (see Table 2). The loglinear-transformed variables were used in all subsequent analyses.

To determine if the depression variable should be entered as a covariate in the following statistical analysis, an independent samples t-test was run. With equal variance not assumed, results indicated no significant differences in levels of depression between the MCI group (M = 2.21, SD = 2.17) and the comparison group (M = 1.54, SD = 1.38), $t(55.5) = 1.42, p = .16$. As no differences were found, depression was not entered as a covariate in the subsequent statistical analyses.

Specific Hypothesis Testing

Pain expression: Observed. To determine if the influenza vaccination produced pain expression in this sample, a single sample t-test was conducted on the IFPE scores, testing the null hypothesis that the average IFPE score did not differ from 0. Results indicated that pain expression was present in this sample $t(57) = 28.53, p < .001$, $SEM = 0.03$, $\eta^2 = 0.94$. To further determine if observed pain was evident in this sample due to the influenza vaccination, a two-tailed paired-samples t-test was conducted on the decoders' ratings of the pre-immunization segments and the post-immunization segments. Results indicated that the decoders observed significantly more pain during the post-immunization segment (M = 0.43, SD = 0.15) than during the pre-immunization segment (M = 0.25, SD = 0.16), $t(57) = 7.46, p < .001$, $SEM = 0.03$, η^2 = 0.50.

Additionally, to demonstrate that both the IFPE and the decoder interpretation of the pain segments revealed similar pain behaviours a Pearson's r correlation was conducted. Results

indicated a significant, albeit weak relationship between the IFPE and the decoders' pain scores, $r = .28$, $p < .05$ (1-tailed).

To test the first hypothesis that MCI participants would have increased facial expressions of pain when compared to controls, a two-way mixed model of analysis of variance (ANOVA) was conducted. The between-subjects factor was participants' cognitive impairment status (MCI and normal). The within-subjects factor was the decoded pain expression (pre needle segment and post needle segment). The pre-immunization and post-immunization decoded facial expression main effect, and the pre- and post-immunization decoded expressions X cognitive impairment status interaction were tested. The pre- and post-immunization decoded facial pain expressions main effect was significant, $F(1, 56) = 54.45$, $p < .001$, MSE = 0.93, partial $\eta^2 = 0.49$, with an observed power of 100%. Participants showed more pain post needle insertion ($M = 0.43$, $SD = 0.15$), than before the needle insertion ($M = 0.25$, $SD = 0.16$). The interaction effect between pre- and post-immunization X participants cognitive status was not significant, $F(1, 56) = 0.22$, $p = 0.61$, MSE = 0.01, partial $\eta^2 = 0.01$, with an observed power of 8%. Due to the fact that the interaction was not significant no follow-up tests were conducted.

To further test the first hypothesis that level of MCI could predict pain expression, two separate regressions were conducted. To evaluate the relation of the independent variable, the MoCA raw score, to pain measured using the observed IFPE score, a linear regression was conducted. Results indicated that the linear regression of the MoCA score did not significantly predict the observed IFPE score $R^2 = .01$, adjusted $R^2 = -0.01$, $F(1,56) = 0.31$, $p = 0.58$. A second linear regression was conducted to evaluate the prediction of the independent variable, the MoCA score, on observed pain measured using the decoders' pain score. The linear regression of the MoCA score did not significantly predict the decoders' observed pain, $R^2 =$

.001, adjusted R^2 = -0.02, $F(1,56) = 0.08$, $p = .78$. These two linear regressions indicate that MCI scores did not significantly predict observed facial expressions of pain during the influenza vaccination procedure.

Pain: Self-report. To test the second hypothesis that both the MCI group and the comparison groups had similar levels of self-reported pain directly after the vaccine was given, a one-way ANOVA was conducted, with MCI vs. comparison group as the independent variable and CAS score as the dependent variable. Results indicated no significant differences, $F(1, 57) = 0.20$, $p = .66$, MSE = 0.03, between the amount of self-reported pain among MCI participants ($M = 0.13$, $SD = 0.17$) and normal controls ($M = 0.12$, $SD = 0.16$). Thus, both groups reported similar levels of pain after the needle was given.

To test the third hypothesis that the MCI group would have a poorer memory of their pain experience when compared to the control group, one-way ANOVAs were conducted on each of the four separate MPQ categories, with MCI vs. comparison group as the independent variable and category error score as the dependent variable. Results indicated no significant differences $F(1, 57) = 0.17$, $p = .69$, MSE = 0.69 between the number of memory errors in the sensory category among MCI participants ($M = 1.47$, $SD = 2.16$) and normal controls ($M = 1.28$, $SD = 1.82$). In regards to recall of the affect associated words, results indicated no significant differences $F(1, 57) = 1.31$, $p = .26$, MSE = 0.60 between the number of errors made among MCI participants ($M = 0.21$, $SD = 0.88$) and normal controls ($M = 0.00$, $SD = 0.00$). Further, results indicated no significant differences $F(1, 57) = 0.17$, $p = .68$, MSE = 0.02 on recall errors for evaluative associated words between MCI participants ($M = 0.12$, $SD = 0.33$) and normal controls ($M = 0.09$, $SD = 0.28$). Finally, in regards to the number of recall errors committed in the miscellaneous pain word category, results indicated no significant differences $F(1, 57) = 0.22$, p

= .65, MSE = 0.10 on the number of errors committed between Time 1 and Time 2 between MCI participants (M = 0.29, SD = 0.80) and normal controls (M = 0.21, SD = 0.51). Thus, both groups had similar rates of recall error when asked to choose words that would best describe the pain they felt during the immunization.

To further explore memory for pain, a linear regression was conducted to determine if scores of cognitive impairment could predict the number of recall errors made between Time 1 and Time 2. Results indicated that cognitive impairment scores could not significantly predict overall recall errors, R^2 = .01, adjusted R^2 = -0.02, $F(1,56) = 0.11$, p = .74.

Executive functioning. Prior to testing the fourth hypothesis that MCI participants had impairments in frontal lobe activities in comparison to the control participants, correlations were conducted between the executive functioning assessments (see Table 3). This was done to evaluate whether the Wisconsin Card Sorting task, the Stroop test, and the Verbal Fluency task were measuring a common feature within this sample. Specifically, Pearson's r correlations indicated a significant negative correlation between the Stroop test and the number of completed Wisconsin Card Sorting task categories, r = -0.26, $p < .05$. A significant negative correlation was also found between the Stroop test and the Verbal Fluency task, r = -0.41, $p <$. 01. Finally, a positive correlation was found between the number of categories completed on the Wisconsin Card Sorting Task and the Verbal Fluency task, r = 0.29, $p < .01$.

To test the fourth hypothesis that MCI participants had impairments in tests sensitive to frontal lobe functioning in comparison to the control participants, a one-way ANOVA was conducted on the executive functioning assessments. A significant difference was found on the Verbal Fluency Task, F (1, 57) = 14.41, $p < .001$, MSE = 138.10, with MCI participants performing worse on this task (M = 26.65, SD = 12.43), when compared to the normal controls

(M = 38.54, SD = 10.70). A significant difference was also found on the number of successfully completed Wisconsin Card Sorting Task categories, F (1, 56) = 9.46, p < .01, MSE = 1.92, with MCI participants completing fewer Wisconsin Card Sorting Task categories (M = 1.94, SD = 1.24), when compared to the normal controls (M = 3.08, SD = 1.56). A moderate difference was found on the time it took to complete the incongruent Stroop task, F (1, 52) = 3.59, p = .06, MSE = 33,909.33, with MCI participants taking longer to complete the task (M = 117.50, SD = 123.89), when compared to normal controls (M = 66.50, SD = 27.03).

Executive functioning and pain expression. To test the fifth hypothesis that a negative relationship would exist between measures of frontal lobe functioning and facial expressions of pain in MCI participants, Pearson r correlations were conducted. Results indicated no significant relationships between measures reflecting frontal lobe functioning and facial expressions of pain post needle insertion (see Table 4).

To determine if levels of executive functioning could predict observed pain expressions two separate linear regressions were conducted. To evaluate the prediction of the combined independent variables, number of Stroop errors, number of WCST errors and VFT on the observed pain measured using the observed IFPE score a linear regression was conducted. Results indicated that the linear regression of the executive functioning measures did not significantly predict the observed IFPE score R^2 = .05, adjusted R^2 = -0.01, F(3,50) = 0.88, p = 0.46. A second linear regression was conducted to evaluate the prediction of the independent variable, number of Stroop errors, number of WCST errors and VFT on observed pain measured using the decoders' pain score. The linear regression of the executive functioning measures did not significantly predict the decoders' observed pain scores, R^2 = .03, adjusted R^2 = -0.03, F(3,53) = 0.54, p = .66. These two linear regressions indicate that executive functioning scores

did not significantly predict observed facial expressions of pain during the influenza vaccination procedure.

Social inhibition. Prior to testing the sixth and final hypotheses, correlations were conducted to determine the relationship between the social inhibition interview and the executive functioning tests. As previously described, if a person has reduced frontal lobe functioning they may also exhibit reduced social inhibition. Pearson's r correlation indicated no significant relationship between the WCST (number of completed categories and overall errors), Stroop Task (time to complete task and overall errors), VFT and social inhibition.

To test the sixth hypothesis that comparison group participants would have higher rates of social inhibition when compared to MCI participants, a one-way ANOVA was conducted. Results indicated no significant differences between the amount of social inhibition between MCI participants and normal controls $F(1, 55) = 0.08, p = .78$, MSE = 1.58.

To further determine if rates of social inhibition could predict pain expression, two separate linear regressions were conducted. The first linear regression was run to determine if the independent variable scores of social inhibition could predict the observed IFPE score. Results indicated that scores of social inhibition could not significantly predict observed IFPE scores, $R^2 = .01$, adjusted $R^2 = -0.01$, $F(1,56) = 0.56, p = .46$. A second linear regression was conducted to determine social inhibition scores could predict decoders' observed pain scores. Results indicated that social inhibition did not significantly predict decoders' observed pain scores, $R^2 = .00$, adjusted $R^2 = -0.02$, $F(1,56) = 0.01, p = .95$.

To test the final hypothesis that a negative relationship would exist between social inhibition and facial expressions of pain in MCI participants, a Pearson's r correlation was

conducted. Results indicated no significant relationships between levels of social inhibition and facial expressions of pain, post needle insertion, in MCI participants.

Discussion

The purpose of this study was to obtain evidence that mild cognitive impairment, presumably reflecting reduced frontal lobe functioning, is associated with an increase in facial expressions of pain in the elderly. Research has shown that individuals diagnosed with dementia often display more intense facial expressions of pain when compared to cognitively intact elderly individuals (Hadjistavropoulos, LaChapelle, MacLeod, et al., 2000; Porter et al., 1996). Yet, research has not provided clear understanding of why cognitively impaired individuals display higher facial expressions of pain.

One theory is that individuals who have cognitive impairment will have a harder time inhibiting their facial expressions of pain because the brain areas responsible for emotional inhibition have diminished functioning. Kunz et al (2011) conducted a study to determine which brain areas were activated when healthy individuals inhibited their pain processes. They showed that pain expression was inversely related to frontostriatal activity, consistent with the down-regulation of facial displays (Kunz et al., 2011). Therefore, it is reasonable to speculate that, cognitive impairment, potentially reflecting impairment to the frontal lobe, should yield an increase in facial expressions of pain when individuals are exposed to acute noxious stimuli, as their ability to inhibit their facial expressions of pain would be impaired.

This study was designed to test these ideas in a community sample, making use of a commonly employed and ethical procedure as a source of noxious stimulation.

Pain Expression: Observed

Elderly individuals in the present study displayed increased facial activity in response to the influenza injection, when compared to facial activity during the harmless events preceding the needle puncturing the skin. The increase in overall facial activity was associated with an increase in a number of discrete facial actions including brow lowering, orbit tightening, levator tightening, and closing of the eyes. This facial pain profile is consistent with the literature on pain in elderly individuals (Hadjistavropoulos, LaChapelle, MacLeod, et al., 2000; Porter et al., 1996). Furthermore, the observation of pain expression after needle insertion in this sample was confirmed by the decoders' pain ratings. Thus indicating, the flu injection pain stimuli chosen for this study did meet preliminary, but low pain expectations for a noxious stimuli in this population.

Contrary to expectations, no significant differences were found between participants identified as having MCI and normal controls in their facial expressions of pain post-immunization. Furthermore, tested executive functioning scores did not significantly predict observed facial expressions of pain in this sample. These two findings are inconsistent with previous research findings (Kunz, Scharmann, Hemmeter, Schepelmann & Lautenbacher, 2007), which showed an increase in facial expressions of pain in cognitively impaired individuals when compared to normal controls. The inconsistency between the two study results can readily be explained, as Kunz et al. observed facial expression of pain in individuals who had a previous diagnosis of moderate cognitive impairment. Whereas, the sample used for this study used participants with undiagnosed mild cognitive impairment. Therefore, the differences in facial expressions of pain could be attributed to level of cognitive impairment. That is, one could speculate that the more severe the level of cognitive impairment the more intense the facial expressions of pain would become.

Pain Expression: Self-Report

As expected, elderly individuals, regardless of cognitive status, self-reported similar levels of pain post needle insertion. This finding is in contrast with previous research indicating that cognitively impaired individuals are more likely to report less pain overall, compared to normal control elderly individuals (Horgas, Elliot, & Marsiske 2009; Parmelee, Smith & Katz, 1993)

Interestingly, no cognitive differences were found in the present study in participants' memory of their pain experiences after the needle insertion. More specifically, MCI participants and normal control participants had similar levels of memory for their pain experience at follow-up. This finding was particularly surprising, as it was expected that participants with self-indicated MCI symptoms would have more difficulty remembering how they had previously described their pain experience. However, an interesting finding emerged that participants, regardless of cognitive status, were more likely to describe their post-immunization pain as being sensory in nature than describing their pain as being affective, evaluative or miscellaneous in nature. It can be concluded that within this sample, participants were more focused on the sensation of the needle insertion.

Executive Functioning

Consistent with expectations arising from the fourth hypothesis, MCI participants showed significant impairment in executive functioning tasks when compared to normal controls. Specifically, MCI participants generated fewer words on the Verbal Fluency Task, completed fewer categories on the Wisconsin Sorting Task, and they took longer to complete the Stroop task. This result is contrary to current research reporting that individuals with MCI normally do not display significant deficits in executive functioning (Petersen, 2011), but rather displays

evidence of memory impairment, preservation of general cognitive and functional abilities and absence of a dementia diagnosis (Morris, Storandt, Miller, McKeel, Price, Rubin, et al., 2001). However, these results are congruent to research, which has looked at individuals who have been diagnosed with non-amnestic MCI. Non-amnestic MCI subtype has been implicated in the development of frontotemporal lobe degeneration (Petersen, 2011). The chosen executive functioning tests may have been sensitive enough to pick up minor deficits in executive functioning. These results could further indicate that a proportion of the study sample is displaying non-amnestic MCI. This would indicate, that in time, greater facial expressions of pain would be observed, as social inhibitions would be released due to frontal lobe impairment. However, the best way to determine this would be to follow the MCI participants over a long period of time to observe if they developed frontotemporal lobe degeneration, vascular degeneration or Parkinson's dementia/Lewy body dementia, and re-observe their facial expressions of pain when exposed to a common noxious stimulus.

Executive functioning and pain expression. Focusing on the hypothesized negative relationship between executive functioning and pain expression, results indicated that within this sample no relationship existed between level of executive functioning and pain expressions post needle insertion. Furthermore, executive functioning did not predict pain expression in this sample.

Social Inhibition

Contrary to the hypothesis that normal control participants would have higher levels of social inhibition in comparison to MCI participants, no differences were found between the two groups in the amount of personal information disclosed during the social inhibition interview. Furthermore, levels of social inhibition did not significantly predict levels of pain expression post

needle insertion. This result is not surprising due to the lack of significant differences in the level of disclosure between the MCI and normal control groups.

Finally, contrary to the hypothesis that a negative relationship would be found between social inhibition and pain expression in MCI participants, results showed that no significant relationship existed.

Limitations of Study

Research conducted with an elderly and potentially cognitively impaired population can be quite complex. Many ethical considerations had to be taken into account during the study design and study implementation. The first ethical consideration taken into account was the pain stimuli used to elicit a pain response in the study sample, and we wanted to avoid subjecting a vulnerable population to unnecessary pain. As per the study parameters, we did not determine level of cognitive impairment until the follow-up visit, and there was ethical concern that some individuals may inadvertently participate in the study that could not give proper informed consent due to their level of cognitive capabilities. Therefore, it was decided to use a fairly common medical procedure, influenza immunization, as the pain stimuli in this study. The second ethical consideration taken into account was level of cognitive impairment. Due to the progressive nature of cognitive impairment and its tendency to reduce an individual's ability to give informed consent or follow direction, it was decided to test the study hypothesis with individuals who had mild cognitive impairment. Research has demonstrated that elderly individuals with mild cognitive impairment are able to give informed consent (Jefferson, Lambe, Moser, Byerly, Ozonoff & Karlawish, 2008) and can therefore follow study protocol.

The findings of this study should be considered with some important limitations. The first limitation that needs to be addressed is the vaccination procedure. First, the effectiveness of needle insertion in eliciting a pain response must be considered. Prior research has successfully demonstrated that influenza immunizations (Hadjistavropoulos, Craig, Martin, Hadjistavropoulos & McMurty, 1997) and venipuncture (Hadjistavropoulos, LaChapelle, MacLeod, Hale, O'Rouke & Craig, 1998; Porter, Malhotra, Wolf, Morris, Miller & Smith, 1996) can induce facial pain responses. Furthermore, pain responses were found in this sample, although they were not strong. During initial data analysis a floor effect was observed in the IFPE scores; that is, pain was not observed in a number of the participants. Anecdotally, many participants indicated that they did not even feel the needle puncture their skin. This may have been due to the size of the needle. Influenza injections are often given using a 30-gauge needle (0.16 mm); this is quite a small needle in comparison to an intravenous 22-gauge needle (0.41 mm) or a blood draw 16-gauge needle (1.19 mm). One could conclude that the influenza vaccination may not have been sufficiently noxious to elicit a wide range of pain expressions within this sample. It should also be pointed out, the Hadjistavropoulos, et al. study, which used immunizations as the pain stimuli, found differences in facial expressions of pain between individuals who were cognitively impaired and normal controls. However, there was an important difference between the aforementioned study and the current study, and that was level of cognitive impairment. Hadjistavropoulos, et al. only retained participants who had "substantial cognitive disability" (pg. 73). These considerations may explain why differences in pain expressions were not seen between the MCI participants and the normal control participants in this sample.

Secondly, while conducting the study in a clinical setting enhanced its real-world validity, it resulted in an inability to control potential interactions of the participants' reactions. While all

the participants were receiving an influenza vaccination, the persons administering the vaccination differed from site to site. For example, nurses administered the vaccine at two of the clinics, whereas a nurse practitioner and two resident doctors administered the vaccination at the other two sites. It is possible that the majority of the individuals administering the injections used a gentler method resulting in lack of variability of subsequent pain experiences.

A final source of potential variance in the vaccination procedure was the clinic settings. Participants were recruited from four separate influenza vaccination clinics. At two clinics, individuals were given their vaccination in separate closed-door rooms. In contrast, in the other two clinics vaccinations were given in a large open room with no privacy between vaccination stations. Ferrell, Ferrell, Ahn and Tran (1994), demonstrated that distraction is an effective pain management technique in the elderly. The open room set-up could have offered distractions for the participants while the needle was being inserted into their arm. Therefore, reducing the level of observed facial expressions of pain.

Another limitation that needs to be addressed is the cognitive status of the participants. Due to the nature of cognitive impairment and the desire to ensure we had a sample that could freely give consent, fully understand the study procedure and give self-report ratings, we retained individuals with mild cognitive impairment. As previously stated, mild cognitive impairment is seen as a midway point between normal cognitive functioning and noticeably impaired cognitive functioning. Mild cognitively impaired groups may have been too similar in frontal lobe functioning to the normal control group; thus, levels of frontal lobe functioning may have been unable to predict pain expressions. If this study was to be replicated, individuals with moderate cognitive impairment should be considered. It should be noted that a few of our participants likely did have a more moderate degree of cognitive impairment (e.g., a MOCA score as low as

9/30); however low participant numbers did not allow for a statistical comparison between these participants and those with higher MOCA scores within the MCI group.

The final limitation that needs to be considered is statistical power. As reported, statistical power was quite low for many of the null results 6%-11%. This lack of power could be due to a number of factors. The first factor to be considered is sample size. Of the 74 originally recruited participants, 24 did not complete their follow-up visit; therefore, a full data set was not obtained and they were removed from the study. When possible, reasons for why the individual did not want to complete the follow-up were obtained. Many indicated they were too busy, had family emergencies, or in one instance the individual was concerned that the cognitive assessments may lead to the loss of independence. The second factor that could have contributed to a lack of power was the pain stimuli. As indicated in the results section a floor effect was seen in the facial expressions of pain. A more noxious clinical pain stimuli, such as blood draws or the insertion of an intravenous needle, may yield a larger variance in pain expression; therefore increasing power. The final factor that may influence power is cognitive status. As previously indicated, the target group was categorized as having mild cognitive impairment. A wider range of cognitive impairment levels would increase the variance therefore increasing power.

Suggestions for Future Research

This study raised issues that should be researched further. An important follow up study would be using the same research parameters put forth in this study in combination with a more painful clinical stimulus and a higher level of cognitive impairment. For example, instead of an influenza vaccination, one could observe the facial expressions of elderly individuals as they undergo rehabilitation for joint replacement. In using a more painful stimulus, a wider range of pain expressions may be obtained.

Another area of research that could be examined is that of more severe cognitive impairment and its effects on facial expression of pain through the release of social inhibitions. As pointed out earlier, mild cognitive impairment can be classified into two subtypes: amnestic and non-amnestic. One could test the hypothesis that individuals diagnosed with non-amnestic cognitive impairment show higher levels of pain expression when compared to amnestic MCI or normal controls.

Conclusion

In conclusion, elderly individuals are a vulnerable population who undergo numerous painful medical procedures, regardless of cognitive status. In addition to frequent medical treatments that may be painful, decline in cognitive abilities is common in this population. We learn from a young age to hide certain emotions, such as pain expressions. However, as we age, this form of social inhibition may be released due to frontal lobe impairment caused by dementia. Therefore, these individuals may display higher levels of pain then individuals who are cognitively intact. In this study it was found that mild cognitive impairment did not influence facial expressions of pain or levels of social inhibition. Frontal lobe involvement should be not discounted in the explanation of increased facial expressions of pain in cognitively impaired individuals. Further research should be conducted to determine the level of involvement the frontal lobe may play in the expression of pain.

This study has raised some interesting research questions that need to be studied further to get a better understanding of how pain is manifested in this vulnerable population. It is important to find ways to interpret how pain is experienced, especially during common medical practices, in order to promote optimal quality of life and well being of the elderly. As care of

elderly moves to the forefront of modern healthcare, it is of great benefit to fully understand the patient experience of the elderly, particularly the perception and expression of pain.

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Table 1

Demographic characteristics of sample

Demographic	Normal (n = 24)	Probable MCI (n = 34)
Diagnosed Illness	19 (79%)	24 (71%)
Chronic Pain	8 (33%)	11 (32%)
Age	M = 68.1 (SD = 8.19)	M = 70.8 (SD = 8.42)
Years of Education	M = 13.9 (SD = 3.05)	M = 12.1 (SD = 2.92)
MoCA Raw Score	M = 27.5 (SD = 1.21)	M = 22.0 (SD = 3.83)
(Range)	(26 – 30)	(9 – 25)

Table 2

Descriptive characteristics of dependent variables

Variable	Controls (*n*=24) Mean (*SD*)	Probable MCI (*n*=34) Mean (*SD*)
Geriatric Depression Scale	1.54 (*1.38*)	2.21 (*2.17*)
Verbal Fluency Task	38.54 (*10.70*)	26.65 (*12.43*)
Stroop Errors	66.50 (*27.03*)	117.5 (*123.89*)
Wisconsin Card Sorting Task: Categories	3.08 (*1.56*)	1.94 (*1.25*)
Wisconsin Card Sorting Task: Error Number	18.67 (*9.54*)	22.58 (*10.42*)
Pre MPQ: Sensory	1.42 (*2.65*)	1.32 (*2.10*)
Pre MPQ: Affect	0.00 (*0.00*)	0.03 (*0.17*)
Pre MPQ: Evaluative	0.04 (*0.20*)	0.00 (*0.00*)
Pre MPQ: Misc.	0.21 (*0.59*)	0.09 (*0.51*)
Post MPQ: Sensory	1.21 (*2.32*)	1.35 (*3.03*)
Post MPQ: Affect	0.00 (*0.00*)	0.03 (*0.17*)
Post MPQ: Evaluative	0.04 (*0.20*)	0.26 (*0.96*)
Post MPQ: Misc.	0.54 (*1.79*)	0.47 (*1.33*)
Social Inhibition Interview	22.13 (*4.76*)	21.79 (*4.28*)

Table 3

Skewness and Kurtosis of Pain Related Variables

Variable	Raw Data		Loglinear Transformation	
	Skewness	Kurtosis	Skewness	Kurtosis
IFPE Pain Score	1.23 (*SE* =.32)	1.15 (*SE*=.62)	-0.27 (*SE* =.32)	2.35 (*SE*=.62)
Average decoders rating pre-needle	1.19 (*SE* =.32)	1.67 (*SE*=.62)	0.24 (*SE* =.32)	-0.47 (*SE*=.62)
Average decoders ratings post-needle	0.29 (*SE* =.32)	-.24 (*SE*=.62)	-0.61 (*SE* =.32)	0.42 (*SE*=.62)
CAS	2.50 (*SE* =.32)	8.77 (*SE*=.62)	1.19 (*SE* =.32)	0.81 (*SE*=.62)

Note. SE = Standard Error. IFPE = Index of Facial Expression of pain. CAS = Coloured Analogue Scale.

Table 4

Correlations between Executive Functioning Assessments

	WCST number of completed categories	WCST number of errors	Stroop length of time	Stroop number of errors	VFT
WCST number of completed categories	1	-0.77**	-0.14	-0.26*	0.29*
WCST number of errors	-	1	0.06	0.18	-0.09
Stroop length of time	-	-	1	0.03	-0.41**
Stroop number of errors	-	-	-	1	-0.19

Note. WCST = Wisconsin Card Sorting Task. VFT = Verbal Fluency Task.
** $p < .01$ (one-tailed)
* $p < .05$ (one-tailed)

Table 5

Correlations between Executive Functioning Assessments and Pain Expressions Post Needle Insertion

Executive Functioning Assessment	Pain Variable	
	IFPE	Decoder rating post needle insertion
WCST Completed Categories	-0.06	0.14
WCST Number of Errors	0.18	-0.21
Stroop length of time	-0.08	-0.01
Stroop number of errors	0.03	-0.23
VFT	-0.03	-0.08

Note. WCST = Wisconsin Card Sorting Task. VFT = Verbal Fluency Task

APPENDIX A: Informed Consent Form

Informed Consent Form

Principal Investigator: Dr. Kenneth Prkachin
Co-Investigator: Tammy Klassen-Ross, MSc, PhD Candidate

Purpose: As individuals age they can experience many different painful conditions. Some of these elderly individuals also develop cognitive impairments. Cognitive impairments can make it difficult for some people to express pain. We are interested in discovering how cognitive impairments can affect how elderly individuals express pain to those around them. We are asking you to participate in this research because you fit into our target age group (over 55) and you are here to receive an influenza injection. The research is being conducted as a PhD dissertation project at UNBC. Your doctor is offering this research opportunity to patients and participation is voluntary.

Study Procedure: We will be asking your permission to record your influenza injection on video. We will also ask you to complete a brief test of cognitive functioning. After the injection, we will ask you to tell us how the inoculation felt. We will also be asking you to participate in a follow-up visit within the next 2 weeks. During the follow-up visit we will ask you complete some short tests of cognitive activities and some mood questionnaires. The follow-up visit should take around 1 hour to complete. If you decide to withdraw from the study all information gathered to that point will be destroyed.

Risks: There are no known risks to you for taking part in this study.

Benefits: Taking part in this study will not affect your care. It will help us understand how elderly people with and without cognitive impairments react to painful situations. This knowledge could contribute to improved care in the future.

Confidentiality: Any information from this research study will be kept strictly confidential, only authorized personnel will have access. The results of your cognitive functioning tests will be shared with your doctor. All documents and video recordings will be identified by code number and kept in a locked filing cabinet and no names will be used. Only expert project staff will view the video recordings. We will retain copies of the video for our files indefinitely, but only code numbers will be used to identify you.

Contact: I understand that if I have any questions or desire further information with respect to this study I should contact Dr. Prkachin at 250-960-6633 or Tammy Klassen-Ross at 250-960-6446. If I have any concerns about my treatment as a research subject, I may contact the Research Ethics Board at the University of Northern British Columbia, 250-960-6735 or by e-mail: reb@unbc.ca. I may also contact

I have received a copy of this consent form for my own records (circle) **Yes/No**.

I consent for my health practitioner to receive a copy of my cognitive test results (circle) **Yes/No**.

I understand that the video recordings may be used for future research, but no names will be on the recordings (circle) **Yes/No**.

I agree to participate in a follow-up visit either at my home or at the University of Northern British Columbia (circle) **Yes/No**.

I would like a copy of the research results (circle) **Yes/No**

If yes, please write down your e-mail or mailing address and a copy of the study results will be provided to you upon the completion of the project.

_____

_____

_____ _____

Participant Signature Date

_____

Participant Name (Please print)

_____ _____

Witness Signature Date

APPENDIX B: Demographic and health status of participant

PARTICIPANT QUESTIONNAIRE

Participant Number_____ Today's Date:_____

What is your date of birth? _____

What is your highest level of education? _____

Do you have any pre-existing medical conditions? Y/N

If yes, please explain:

_____

_____

Do you suffer from Chronic Pain? Y/N

If yes, please explain:

_____

_____

Did you take any pain medication today? Y/N

If yes, what did you take:

_____

_____

APPENDIX C: McGill Pain Questionnaire

McGill Pain Questionnaire

Participant Number_____ Today's Date_____

Please Check One: _____ Post Injection _____15-min. Post Injection _____Follow-up

Please select one word in each box, or select Not Applicable if no words match your pain:

1. Flickering _____ Quivering _____ Pulsing _____ Throbbing _____ Beating _____ Pounding _____ Not Applicable _____	6. Tugging _____ Pulling _____ Wrenching _____ Not Applicable_____	11. Tiring _____ Exhausting _____ Not Applicable _____	16. Annoying _____ Troublesome _____ Miserable _____ Intense _____ Unbearable _____ Not Applicable _____
2. Jumping _____ Flashing _____ Shooting _____ Not Applicable _____	7. Hot _____ Burning _____ Scalding _____ Searing _____ Not Applicable_____	12. Sickening _____ Suffocating _____ Not Applicable _____	17. Spreading _____ Radiating _____ Penetrating _____ Piercing _____ Not Applicable _____
3. Prickling _____ Boring _____ Drilling _____ Stabbing _____ Lancinating _____ Not Applicable _____	8. Tingling _____ Itchy _____ Smarting _____ Stinging _____ Not Applicable_____	13. Fearful _____ Frightening _____ Terrifying _____ Not Applicable _____	18. Tight _____ Numb _____ Drawing _____ Squeezing _____ Tearing _____ Not Applicable _____
4. Sharp _____ Cutting _____ Lacerating _____ Not Applicable _____	9. Dull _____ Sore _____ Hurting _____ Aching _____ Heavy _____ Not Applicable _____	14. Punishing _____ Grueling _____ Cruel _____ Vicious _____ Killing _____ Not Applicable _____	19. Cool _____ Cold _____ Freezing _____ Not Applicable _____
5. Pinching _____ Pressing _____ Gnawing _____ Cramping _____ Crushing _____ Not Applicable _____	10. Tender _____ Taut _____ Rasping _____ Splitting _____ Not Applicable _____	15. Wretched _____ Blinding _____ Not Applicable _____	20. Nagging _____ Nauseating _____ Agonizing _____ Dreadful _____ Torturing _____ Not Applicable _____

APPENDIX D: Geriatric Depression Scale

Geriatric Depression Scale (short form)

Instructions: Circle the answer that best describes how you felt over the past week.

1.	Are you basically satisfied with your life?	yes	no
2.	Have you dropped many of your activities and interests?	yes	no
3.	Do you feel that your life is empty?	yes	no
4.	Do you often get bored?	yes	no
5.	Are you in good spirits most of the time?	yes	no
6.	Are you afraid that something bad is going to happen to you?	yes	no
7.	Do you feel happy most of the time?	yes	no
8.	Do you often feel helpless?	yes	no
9.	Do you prefer to stay at home, rather than going out and doing things?	yes	no
10.	Do you feel that you have more problems with memory than most?	yes	no
11.	Do you think it is wonderful to be alive now?	yes	no
12.	Do you feel worthless the way you are now?	yes	no
13.	Do you feel full of energy?	yes	no
14.	Do you feel that your situation is hopeless?	yes	no
15.	Do you think that most people are better off than you are?	yes	no

Total Score _____

APPENDIX E: Social Inhibition Interview Protocol

Social Inhibition Interview:

Explain to the participant that you will be naming 11 different emotions. For each emotion ask them to define the emotion and give a short story of when they felt that emotion.

Embarrassment
Guilt
Pride
Self-Conscious
Shame

Script:

For each emotion say the following:

Please tell me what _____ means to you.
Can you tell me a short story when you felt _____?

Thank-you, are you ready for the next emotion.

When they are ready for the next word repeat the above script.