Communication of Pain and Anxiety Between Mothers and Infants During Routine Immunization Procedures

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Abstract

Infants are a very vulnerable population who undergo numerous common, yet painful, medical procedures, such as immunizations. Infants use social referencing, a complex level of communication and learning, during novel situations (i.e. medical procedures) to establish how they should react in novel situations. If the infant's mother is fearful of needles she may inadvertenlty send these "danger" messages to her infant making the immunization process a more painful experience for the infant. It was found that neither maternal self-reported needle fear nor maternal fear behaviour influenced infants' pain expression during immunizations. Results, however, did indicate that immediately following the immunization males, 12-months of age, exhibited more guarded body movement than males 18-months of age. It was also found that females, 12-months of age, exhibited more guarded body movement than females 18-months of age prior to the immunization.

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Communication of pain and anxiety between mothers and infants during routine immunization procedures

Infants are a vulnerable population, dependent on their caregivers for all of their survival needs, such as protection and removal from dangerous situations. Infants are also dependent upon their caregiver to teach them how to respond in novel situations. If an infant sees their caregiver smile at a friendly person, the infant will learn through observation that a particular person is safe and not to be feared. However, if the infant's caregiver sees a stranger and reacts in fear, the infant may learn that the stranger is dangerous. If the infant sees the stranger again, there is a chance that the infant will communicate to the caregiver, through bodily action and cries, that they are in danger and need to be removed from the situation. This type of social learning and communication would be especially useful in situations where the infant could be harmed or fatally injured. The infant could attend to the caregiver's emotional state during novel situations, and the infant could model their emotional state accordingly. Displaying their emotional state would allow the infant to communicate to their caregiver that they are either safe or in danger. The main objective of this study was to identify negative emotional affective states mothers may experience while observing their infants undergoing a common medical practice, and to determine how this emotional state influences her infant during a common medical practice. Specifically, mothers' level of needle anxiety was evaluated to determine if it influenced their infants' pain response during routine immunizations.

Immunizations are among the most invasive medical procedures for healthy infants. They are also the most common source of acute pain that infants experience. There is evidence that early painful experiences can have longstanding negative effects on pain reactivity and other health behaviours (Taddio, Katz, Hersich & Koren, 1997; Rocha, Prkachin, Beaumont et al, 2003; Rocha & Prkachin, 2007). An infant's pain experience may be influenced by the reactions of those around them. For example, if a mother is inadvertently sending her child "danger" messages during these early medical procedures, the infant may be conditioned to expect that needles are dangerous and they are to be feared; thereby, increasing the likelihood of future needle fears and phobias. In addition, there is reason to believe such fears enhance pain sensitivity in the infant, due to the hightened level of anxiety. From this reasoning, it is hypothesized that infants whose mothers are fearful of needles will display a more intensive pain expression as compared to those infants whose mothers are not fearful of needles.

Literature Review

Pediatric Pain

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 world through experiences related to injury in early life." (IASP, 2008, np). This widely endorsed definition of pain is comprehensive in that it includes criteria related to physical stimulation, subjective experience and it allows for pain in situations where there is not any apparent tissue damage (Owens, 1984).

The criterion of tissue damage is easy to satisfy by direct observation or considering contextual factors (i.e. medical procedures such as circumcision, immunization, or tissue damage resulting from an accident). It should be noted, however, that the IASP definition provides for pain experience even when tissue stress or damage are not evident. The central feature of this definition is subjective distress. Subjective distress is more complex in that it requires inference from the behaviour of the individual or organism in pain (Owens, 1984).

Assessing subjective distress in verbal populations is a relatively simple task as self-report can be utilized. This type of assessment has been called the "gold standard" in pain assessment (Abu-Saad, Bours, Stevens et al, 1998; Anand & Craig, 1996). Even though self-report allows for an evaluation of a person's subjective pain experience, and self-reports of pain are easy to gather in the methodological sense, they do have limitations. Hadjistravropoulus, Craig & Fuchs-Lacelle (2004), point out that self-reports of pain can be affected by response bias, situational demands and conscious distortion. They further point out that a failure to recognize these limitations could mean that self-reports of pain are actually forms of "fool's gold" (Hadjistravropoulus, Craig & Fuchs-Lacelle, 2004). Researchers are over dependant on self-reported pain and they may fail to recognize that there are other forms of pain assessment. The "gold standard" of pain assessment has resulted in the under use of nonverbal expression in measuring pain experiences in infants (Barr, 1992).

The over-emphasis on self-report and the under-emphasis of nonverbal pain expressions has led to questions about the generalizability of the IASP's definition of pain to non-verbal populations. In terms of pain assessment, this definition of pain becomes problematic when dealing with infants and other populations with limited ability to communicate verbally (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).

Paediatric pain was an issue ignored for decades. This was due to a failure to look beyond self-report measures of pain, and as well, there was a lack of detailed studies looking at how infants respond when in pain. Current researchers have pointed out that, in the past, infants were viewed as being insensitive to pain, incapable of experiencing pain neurologically, and unable to remember pain. Consequently, pain in infants was repeatedly construed as inconsequential (Owens, 1984; Stevens, Johnston & Grunau, 1995). The result of these misguided views, was the mismanagement and under treatment of pain in this very vulnerable population.

There has been an increased interest in the area of infant pain research over the past few decades. Researchers and clinicians have come to realize that infants use non-verbal pain cues during noxious events and these cues can be utilized to measure pain. From current research, the IASP changed their definition of pain to include the following statement, "Note: The inability to communicate verbally does not negate the possibility that an individual is experiencing pain and is in need of appropriate pain-relieving treatment" (IASP, 2008, np). Currently, infants are viewed as having a multifaceted repertoire of pain behaviours, which can be used to determine their level of pain experience. These pain behaviours include facial activity, body movement, and the infant's cry; however, attention must be given to the assessment of infant pain. Specifically, assessing infant pain requires an understanding of the internal biological responses of pain, and an understanding of the expression and caregiver interpretation of pain behaviours. Pain assessment in infants should take into account the pain displays of the infant, as well as the different factors that may influence a caregiver's understanding of the pain behaviour because the caregiver may have cognitive biases. It is important to remember that assessing pain in infants is not as easy as it is in older, verbal population.

Difficulties in Assessing Infant Pain

Assessing pain in infants is a difficult process. One of the most challenging factors in assessing pain is its subjective nature. Each person's experience of pain is influenced by previous pain experiences and mental and emotional states. Persons with verbal skills are at an advantage because they can verbally express their subjective pain experience. In comparison to adults, infants are at a disadvatage as they cannot verbally express their pain. This lack of verbalization is often cited as a problem by researchers (Abu-Saad et al, 1998; Franck & Miaskowski, 1997). The most direct way to measure or assess pain is to use self-report, but this type of measurement would exclude all those who do not have verbal capabilities, such as pre-verbal infants. According to Anand and Craig (1996), pain assessment in infants must conform to their limited level of communication abilities. The implication is that we must use non-verbal forms of communication to assess infants' pain, such as facial expressions and body movements.

Using non-verbal cues to ascertain pain behaviour in infants presents its own set of challenges. According to Franck and Miaskowski (1997), infants may respond to both painful and non-painful stimuli with similar behaviours due to relatively immature motor capabilites. Similar responses to pain and non-painful stimuli would make decoding the distressing signal more complex. Therefore, the caregiver must learn to decipher between pain, hunger, fatigue and other negative states even though the infant is giving similar behavioural cues. As it has been stated earlier, caregivers bring with them their own set of cognitive biases which could influence their assessment of the infant's distress behaviour. This could lead the caregiver to either overestimate, or underestimate the infant's pain response. As a result, a more objective form of infant pain assessment would be beneficial. A number of researchers have proposed that most useful indicators of infant pain are behavioural; such as, facial expressions, guarded body movement, crying, and physiological responses (Craig et al, 2000; Lilley, Craig & Grunau, 1997; Stevens & Johnston, 1994).

Physiological indices also present challenges in the assessment of infant pain, for such indicies are not always in agreement with each other. For example, Field and Goldson (1984) found that heart rate and facial expressions appear to be independent of each other when measured in infants. Craig, Whitfield, Grunau et al (1993), also found that when investigating physiological indicators of pain in preterm and full term infants, heart rate, oxygen saturation, and respiration rate were not always in accord. These studies point to the multidimensional and complex characteristics of infant pain. The restricted relationship between the different indices of pain may correspond to the different dimensions of the pain experience (Franck & Miaskowski, 1997).

We should conclude that no one measure of pain is adequate to indicate pain response in infants. It seems valid that pain in infants should be viewed as a multifaceted experience requiring various forms of assessment. Using a multidimensional approach to infant pain assessment has been endorsed by numerous researchers (Craig & Grunau, 1993; Owens, 1984; Stevens, 1998). It follows, then, that a multidimensional approach to infant pain assessment should include measuring different observational indices of pain, such as, infant facial pain expression and guarded body movments.

Infant Facial Expressions of Pain

Facial expressions have become one of the most reliable indicators of pain in infants. Craig, in collaboration with a number of researchers, has found that facial expressions demonstrate high specificity in response to painful stimuli and they appear to be the most unique of all the behavioural signs in terms of signalling pain to caregivers (Craig & Grunau, 1993; Craig et al, 1993, Craig et al, 2000). Stevens (1998) has also described facial expressions as the one of the most consistent signals of pain across infants.

To understand why facial expressions are such a good indicator of pain, the evolutionary benefits of facial expression to communicate pain ought to be considered. An evolutionary argument might contend that, both the expression and experience of pain provide an adaptive response to tissue damage for not only adults, but for infants as well. The emotions necessary for survival are the first to appear in development, and therefore, the ability to signal tissue damage is a requirement for infant survival (Anand & Craig, 1996). The behavioural reactions of infants to noxious events have tremendous survival value in terms of being able to communicate survival needs and physical states to caregivers (Craig et al, 1988; Craig, Gilbert-MacLeod, & Lilley, 2000; Grunau & Craig, 1987). It would be maladaptive for newborn infants to be insensitive to pain, for they would be unaware of tissue damage and consequently would not be able to cue adults that they are in distress and desire to be removed from the situation (Craig et al, 1988). Ultimately, it is crucial to be consious of the fact that infants do not have the verbal capacity to convay the feeling of distress; regardless, infants can portray distress through other means of communication, such as facial expressions.

In newborns the facial musculature is well developed to accommodate feeding, and it has been suggested that the well developed facial musculature is a primary mechanism to communicate emotional states (Craig et al, 1994). Facial expressions can portray a large amount of information in a relatively short period of time (Ekman, 1992), making it possible to communicate distress very quickly. Due to the fact that infants have an under developed cortex, these facial expressions can be viewed as reflexive and not voluntary (Rinn, 1984), further strengthening the evolutionary agrument. Therefore, facial expressions in young infants reflect the sensory and affective qualities of the pain experience (Grunau et al, 1990). It can be further surmised that facial activity in infants can be used as a reasonably accurate measure of their true pain experience.

Numerous studies have used facial expressions across a variety of infant populations, to demonstrate pain responses. Grunau and Craig (1987) showed that infants receiving heel lances, for the purpose of blood collection, showed a distinct grimace when the skin was broken. It has also been demonstrated that low birth weight, premature infants show different facial expressions between a non-inasive medical procedure and inasive medical procedures (Johnston et al, 1995). Concerning intramuscular injection, it has been found that infants repond to immunizations with increased facial activity (Grunau et al, 1990). Klassen and Craig (in preparation), also found that infants' facial pain expression increased with each immunization given during a single medical check-up.

In order to use facial expressions as a pain indicator in infants, consistency in the facial patterns must be present. Research has shown that infants display a number of similar facial characteristics when experiencing a painful stimuli. An infant's pain face is characterized by the bulging and lowering of the brows, eyes squeezing shut, deepening of the nasolabial furrow, opening of the lips, vertically and horizontally stretching the mouth, and a dished, taught tongue (Craig & Grunau, 1993; Craig et al, 2000, Grunau & Craig, 1987). Other pain characteristics can include a pursing of the lips and a quivering of the chin (Grunau & Craig, 1987).

To gain a more in-depth understanding of the multifaceted pain expression an infant exhibits during a noxious event, other forms of pain assessment need to be utilized. Guarded body movements have also been used to assess infant pain.

Infant Guarded Body Movement

In comparison to facial activity, guarded infant body movement has not received an equal amount of research attention; however, research conducted on infant guarded body movement has indicated that such bodily movement can be used as a form of pain assessment in a non-verbal population. Guarded body movements refer to bodily movements that guard or protect an area that has been injured. Hadjistavropoulos, von Baeyer & Craig (2001), conceptualized guarded body movements as an attempt on the infant's part, to escape or to avoid physical harm. Due to developmental immaturity, body and limb movements can appear to be random, and are not as discriminating as facial indices of pain. However, Franck (1986) described young infants as displaying vigorous gross body movements and withdrawal from a painful stimulus. Johnston and Strada (1986) found that during an intramuscular injection, infants displayed a rigidity in the torso and the limbs, which dissipated shortly after the noxious event.

It has also been established that infants use non-affected limbs to protect the affected limb. Franck (1993) found that in response to a heel lance, infants used the unaffected leg to swipe at the site of the heel lance. Craig and Grunau (1993) have suggested that this type of swiping motion or guarded movement, serves as an active, defense behaviour.

As previously mentioned, a consistent pattern of guarded body movements must be evident in response to a noxious event to consider guarded body movement as a reliable measure of infant pain. Research has indicated that, when responding to a painful stimulus, an infant will display an increase in hand and foot movement, arm movement, leg movement, head movement and torso movement (Grunau & Craig, 1987).

In summary, facial expressions and guarded body movements are two types of behavioural indicies that can be used to identify and measure infant pain after a noxious event. However, infant pain is not as easily identified or described as a noxious event that causes tissue damage. Social factors and learned behaviours have also been shown to affect an infant's pain experience.

Sociocommunications Model

As previously discussed, it is beneficial, from an evolutionary perspective, for newborns and infants to communicate distress to their caregivers to ensure survival. If an infant was in danger or hurt, it would be maladaptive if the infant did not signal to the caregiver that they wanted to be removed from the situation. The survival of the infant not only depends on his/her ability to communicate pain to their caregiver, but the infant's survival also depends on the caregiver's ability to correctly interpret communication and take the appropriate action. The challenge for the adult caregiver is to be able to decipher the infant's behaviour, and then determine the presence of pain (Craig et al, 1988). To interpret the infant's communication of pain correctly, caregivers not only need to be aware of consistent displays of pain, but they also need to be aware of the context in which the infant is communicating pain.

It was from this perspective that Craig and colleagues developed the Sociocommunications Model of pain (Craig, Lilley & Gilbert, 1996), which attempts to account for the complex social interactions, between children in pain and their caregivers (see Figure 1). This model was developed in reaction to the biomedical model of pain, which neglects the social factors involved in the pain experience and as well as the role a caregiver plays in providing distraction and relief from the suffering an infant/child is experiencing. According to the Sociocommunications Model, in order to understand pain one must move beyond the experience of pain, the noxious event, and examine the expression of pain. This model also takes into account the skills of the caregiver and the cues used by the caregiver to assess the infant's pain. It also takes into consideration the caregiver's disposition to act on what they believe the child is experiencing (Craig et al. 1996). The Sociocommunications Model observes that the sequence of events associated with pain begins with tissue damage, stress or other physiological events that are noxious to the infant. What the child experiences as a result of the event is determined by a number of factors including perception, maturation, affective mechanisms, setting and psychological capabilities of the infant (Craig et al, 1996).

Some of the strengths of this model are that it gives insight into both how the infant encodes the pain experience and how the caregiver can improve their strategies to decode pain expressions in the infants. As well, it gives insight into the role of social and psychological mechanisms for the control of pain (Craig, 1998). The Sociocommunications Model takes the understanding and the research of infant pain beyond the internal experience of the infant and views pain as a defensive system. The design of this defensive system gives priority to avoidance of tissue damage, or escape from the situation when tissue damage has occurred. More importantly, this defence system motivates caregivers to remove infants from the dangerous situation. Craig (1998) explains this in the following way, "Infants have, in effect, a protolanguage that says, 'Help! I am in great need!' that ordinarily allows caretakers to attend to and begin to understand the nature of needs for care" (p. 104). Infants express this protolanguage in response to tissue damage through their facial expressions, guarded body movements, and through vocalizations (Craig et al, 1996). However, this nonverbal language can be difficult for caregivers to decipher, and events causing the reaction may be unclear.

An unclear triggering event would make pain assessment even more difficult for caregiver, because the caregiver must first decode the infant's signal of distress to determine if the infant is actually experiencing pain. However, there is often a lack of agreement between the infant's experience of pain and the caregiver's actual perception of pain (Craig, 1998). Decoding pain expression requires that the caregiver possess skills of observation and interpretation. This complex decoding process requires the caregiver to be attuned to the infant's normal behaviour, and detect any behavioural abnormalities that could signal a pain response. Therefore, the caregiver must not only be aware of pain behaviours in the infant, but they also must correctly decipher these pain cues. The Sociocommunications Model recognizes that a caregiver's sensitivity, cognitive bias, knowledge and relationship to the infant can greatly influence their interpretation of an infant's pain response.

In previous research, using the sociocommunications model, I found that infants' pain expression increased with each subsequent venipuncture given during a single doctor's visit (Klassen & Craig, in preparation). This study did not examine the complex communication relationship between mothers and infants, it only examined the infants' pain response to the noxious event. One hypothesis, derived from this study, is that mothers signal to their infant when a situation is either safe or dangerous and this signalling affects the infant's pain behaviour. The infant interprets the mother's behavioural cues and expresses either anxiety or calmness in the situation. The infant conveys their emotional status through crying, facial expressions and body movements, signaling to the mother that they want to be removed from the situation.

The complex relationship between mothers and infants has also been the focus of intense investigation in developmental psychology. Increasingly, the importance of this relationship is being emphasized in health psychology. Interactions within the caretaker-child dyad have become of interest due to the idea that forces operating within it may have longstanding implications for the child's emotional and physical health. Central to much current thinking is an emphasis on the communication of affective states between mother/caretaker and child. Specifically, social referencing can be used to explain this complex communicative state between mothers and their infants. Social referencing is a form of communication in which an infant learns different emotional states through observation.

Social Referencing

Infants depend upon their caregiver not only for food, shelter, and security, but also to teach them how to respond and how to approach novel situations. Research has illustrated that infants look to their caregiver at an early age when they encounter a novel situations such as a visual cliff (Klinnert, Emde, Butterfield & Campos, 1986), ambigious toys (Walden & Baxter, 1989), or live animals (Hornik & Gunnar, 1988). It is believed that infants base their behavioural reactions toward novel situations on emotional messages provided by their caregiver. This act of early information gathering behaviour is known as social referencing.

Social referencing is a process of emotional communication in which one's perception of another person's interpretation of events is used to form one's own understanding of the situation (Feinman, 1982). An individual will draw from a second individual's responses to an event to formulate their own ideas and feelings about that particular situation. The phenomenon of social referencing was orginally studied in adults, but researchers have begun exploring social referencing between mothers and their infants.

Social referencing has been reliably demonstrated to begin at the ages of 10 to 12 months of age (Feinman, Roberts, Hseih, Sawyer & Swanson, 1992). At this stage in development, infants seek information from others in unique situations, and they use this information to model their own response to that novel situation or stimulus. Walden and Ogan (1988), state that social referencing may play a significant role in infants' learning about the world and about themselves. They further indicate that infants simply imitate behaviours seen in the mother. For example, if the mother feels threatened by a situation she will express fear and retreat to safety. An infant, seeing and sensing this emotional response, will show fear when that same stimulus is presented to them.

A study conducted by Murray, Cooper, Creswell, Schofield and Sack (2007) showed that infants of mothers with social phobia often show early signs of reduced social responsivness. Mothers, with and without social phobia, were asked to interact with a stranger in front of their infant, and mothers were also asked to encourage their infant to interact with the stranger. It was found that mothers with social phobia, when compared to non-socially phobic mothers, displayed significantly more anxiety when asked to interact with the stranger, and the phobic group was less likely to encourage their infants to engage with the stranger (Murray et al, 2007). It can be concluded, if a mother shows outward signs of fear in a social situation, with her infant present, her infant would also display signs of fear or nervousness in the same sort of social situation. Other research has shown that the impact of an infant viewing a socially anxious interaction between his/her mother and a stranger carried forward to the infant's interaction with that same stranger (de Rosnay, Cooper, Tsigaras & Murray, 2006). This type of anxiety transference between infants and their mothers has also been shown in situations where the mother is play acting (Gerull & Rapee, 2002). The inducement of fear seems to be due to the many parameters of adult communication directed at the infant during the first few months, inlcuding voice, direction of gaze, and facial expression of emotion (Trevarthen & Aitken, 2001). As a result, the effect of social referencing between infants and mothers appears to be quite influential, and could help explain certain aspects of mother/infant communications during other novel, and potentially fearful situations, such as common paediatric medical procedures.

In summary, the sociocommunications model highlights the difficulties and complexities of identifying pain in infants, and the social referencing phenomenon highlights the complexity of communication interaction that occurs between a mother and an infant during a novel and potentially fearful and painful situation. Integrating the literature on pediatric pain, information from the sociocommunications model, the literature on social referencing and my own previous research led to the following hypotheses.

Specific Hypotheses

1) Directly after a first immunization infants'facial expressions and guarded body movements will show higher levels of pain than before the immunization.
2) Mothers *self-reported* level of needle fear will predict infants' pain response (facial expression and guarded body movement) after the immunization.
3) Mothers who *display* needle fear prior to the immunization will predict infants' pain response (facial expression and guarded body movement) after the immunization.
4) Influence of maternal self-reported needle fear on infant facial expression and guarded body movement will be mediated by maternal fear behaviour.

Methods

Participants

A community sample of 95 mother/infant dyads was recruited from two local healthy baby clinics. Recruitment was conducted between May 2008 and September 2008. The inclusion criteria for participation included: 1) the infant was at the healthy baby clinic to receive 12 or 18-month-old immunizations, 2) the mother accompanied the infant for the immunization, 3) the mother could speak and read English, and 4) the mother consented to have the infant participate in the study.

According to the British Columbia Ministry of Health Services (2003), at 12 months and 18 months, infants receive measles, mumps, rubella (MMR), meningococcal conjugate vaccine, and the combination of Diptheria, Tetanus, Acellular Pertussis (DTaP), Inactivated Polio (IPV) and Hemophilius influenza Type B (Hib) vaccine into a single injection. There is an option of receiving a Varicella (chicken pox) vaccine at these ages resulting in either three or four injections for twelve-month-old infants and eighteen month old infants. These immunization occasions have been selected specifically because they involve booster shots; therefore, they have the advantage that both the mother and the child have experienced these particular immunizations in the past. Thus, these episodes should optimize the ability to capture important mother-infant interactions relevant to painful situations.

Of the 95 mother/infant dyads who originally agreed to participate, one mother dropped out of the study prior to the immunization, one mother failed to return the questionnaire packet, four mothers did not complete the questionnaire packets, and six mothers were excluded from the study due to the obstruction of the mother's face during the pre-immunization video. No significant differences were found between the dyads retained in the data set and those that were excluded from the data set on the following demographics: infant's age, infant's weight at birth, hours since infant was fed, hours since infant slept, and mother's age. The final number of mother/infant dyads included for analysis was 84.

Procedure

Upon arrival at the health clinic, a research assistant approached and explained the study objectives and procedures to the mothers. Mothers who agreed to participate, read and signed a consent form (Appendix A). After the infant received their routine medical exam a research assistant entered the cubicle to record the immunization procedure. Video recordings were made with a Sony Digital Camera capturing both the mother's behavioural responses and the infant's behaviour in response to the vaccinations. For the purposes of later behavioural coding, the exact moment of needle insertion was identified by the research assistants who said "poke" quietly into the camera microphone.

Upon completion of the immunization procedure, mothers were asked to fill out a general demographic questionnaire. Mothers were also asked to fill out a questionnaire indicating their level of needle anxiety, and a questionnaire indicating their infant's temperament. Mothers were asked to fill out these questionnaires after the immunization procedure for two reasons. The first was to prevent the mother's potential needle fear level from heightening. If the mother is fearful or anxious of needles, she may become cued to her own fear, causing her to act abnormally during the immunization procedure. The second reason was time. After an infant receives vaccines, they are required to wait for 15 minutes before they leave the clinic to ensure they do not have an adverse reaction to the vaccines. Asking the mothers to fill out the questionnaire packet during this time, ensured we would not take up any more of their time.

Apparatus and Materials

One Sony Digital Video camera was used to record the immunization procedure at the clinic. All digital video was then downloaded from the video camera into a standard Dell desktop PC. The downloaded video was further edited into separate participant files using Adobe Priemier, a standard editing, movie making computer program.

For coding purposes, each infant video was downloaded into ICODE, a computer program which allows frame by frame behavioural coding. To extract the exact number of identified behavioural codes out of ICODE, a computer program called PEMetric was utilized. This computer program extracts all of the identified behavioural codes from ICODE into an Excel spreadsheet, allowing a total behavioural pain score to be calculated.

A 20-minute video was compiled of all the mothers' responses prior to their infants' first vaccination using Adobe Premier. This video consisted of 10-second pre-needle segments focusing on each of the mother's facial expression prior to her infant's immunization. Between each mother's 10-second clip, a 5-second black screen was presented to facilitate rating. This video was viewed by six independent judges to evaluate the mothers' fear behaviour prior to the immunization.

Measures

Self-Report Measures: Demographic Information. Mothers filled out a questionnaire inquiring about their child's overall health status, the child's age, date of birth , the last time the child slept and ate, if the infant was born prematurely, if the child was given any pain medication, and finally the mother's age (Dahlquist, Gil, Armstrong et al, 1986; Appendix B).

This demographic questionnaire was used to control for pain expressions in infants. If an infant had not slept or eaten they may be more irritable, as compared to an infant that had just rested and eaten. As well, it has been shown that premature infants show different pain expressions as compared to full-term infants (Abdulkader, Freer, Garry, Fleetwood-Walker & McIntosh, 2008; Morison et al, 2003). This sort of demographic or pain cues questionnaire has been used in previous infant pain judgement studies to measure potential confounds involved in pain judgments (Pillai, Hoe Yan Ho, & Craig, 2002; Smith et al, 2002).

Self-Report Measures: Needle Anxiety. Maternal needle anxiety was measured using the Phobic Stimuli Response Scale (PSRS; Cutshall & Watson, 2004). The PSRS is a 44-item self report scale, with five factor analytically derived dimensions of phobic reaction (Appendix C). Specifically, the Blood-Injection Phobia subscale was used, which consists of ten items rated on 4-category Likert scales. The Blood-Injection Phobia subscale asks questions pertaining to situations involving needles or being exposed to blood. The higher the ratings the more fear the person has toward the stimuli. The overall scale displays good psychometric properties, including high internal consistency and evidence of construct and convergent validity (Cutshall & Watson, 2004).

Self-Report: Infant Tempermant. Infant temperment was measured to control for any influence it may have on the social referencing process. The initial apprasal of the environment may affect the liklihood that an infant will seek information from their parent; however, this initial appraisal may be influenced by the infant's temperment. For example, Bradshaw, Goldsmith & Campos (1987) found that infants who had positive tempermants were more likely to look to their parent for information during a novel situation as compared to infants who had a negative temperment.

Infant tempermant was assessed using the Infant Behavior Questionnaire (IBQ; Rothbart, 1981). The IBQ measures infant temperarmental dimensions of: activity level, smiling/laughter, fear (distress to novelty items or situations), distress to limitations, soothability, and duration of orienting (Appendix D). The IBQ has shown strong test-retest reliability, convergent validity and temporal stability in numberous studies (Lamb, Frodi & Hwang, 1983; Rothbart, 1986).

Observational Measures. Recordings of infant and maternal behavior were examined for evidence indicative of pain and fear, respectively. For infants, measures of pain were observed from video recording; coders were looking for indices of facial expressions of pain and guarded body movements post needle insertion.

Maternal fear was examined using the same video as the infant recordings. Maternal fear was examined by independent judgers, who made independent fear ratings based on the mothers' behavior prior to the needle insertion into the infant's skin.

Observational Measures: Facial Expressions of Infant Pain. Facial activity displayed by the infants during the immunization procedures were coded using the Neonatal Facial Coding System (NFCS; Grunau & Craig, 1987). NFCS is a facial coding system specifically designed to assess the pain experience in young infants through facial actions. The system codes ten facial actions: brow bulge, eye squeeze, nasolabial fold, open lips, vertical mouth stretch, horizontal mouth stretch, taut tongue, lip purse, chin quiver, and tongue protrusion (Craig & Grunau, 1993). NFCS has shown high levels of convergent validity (Craig, 1998), sensitivity to changes in pain severity (Stevens, Johnston & Grunau, 1995), and high inter and intra relater reliability (Abu-Saad, Bours, Stevens & Hamers, 1998).

The major behavioural reaction to a physical insult in infants occurs within approximately ten seconds after the event (Craig, Hajistavropoulos, Grunau & Whitfield, 1994; Craig, Whitfield, Grunau, Linton & Hajistavropoulos, 1993; Johnston, Stevens, Craig & Grunau, 1993). Therefore, the time segments analyzed for behavioural coding were the ten-second pre-needle phase and the ten-second, post needle insertion, pain phase for the first vaccine given to the infant. To determine the infants overall change in facial pain expression from the pre needle phase to the post needle phase. The total observed scores from the pre needle phase was subtracted from the post needle phase, producing a single pain reaction score.

Two coders, trained in the NFCS coding system, completed the coding. Ten percent of the video segments were coded a second time to determine inter-rater reliability. Inter-rater reliability was calculated using Pearson's r. Inter-rater reliability for this sample was found to be r = .98, which is considered very good.

Observational Measures: Infant Guarded Body Movements. The body movements made by the infant during the immunization procedure were coded using the Infant Body Coding System (IBCS; Craig et al, 1993). The IBCS scores body movements as either present or absent in a number of regions of the body including the hands and feet, the arms, the legs, the head, and the trunk or torso of the infant's body. The IBCS has been shown to differentiate between painful and nonpainful events in infants and this coding system has demonstrated very good inter-rater reliability (Craig et al, 1993).

The same time segments used for the facial expression coding were also used for the guarded body movement coding. That is, the initial ten-second pre-needle phase, and ten-second pain response phase were coded. Once again, to determine the infants overall change in guarded body movement from the pre needle phase to the post needle phase, the total observed scores from the pre needle phase were subtracted from the post needle phase, producing a single guarded body movement score for the first vaccine given to the infant.

The same two coders who coded the pain expression also coded the guarded body movements. Ten percent of the videos were coded a second time to ensure reliability. Inter-rater reliability was calculated using Pearson's r. Reliability between the two coders was found to be r = .98 which is considered to be very good.

Observational Measures: Maternal Fear Behaviour. Six independent judges (4 female, 2 male) with an average age of 35.16 years (*SD* = 13.06) rated mothers' behaviours in the pre-immunization video. Each judge rated each of the 84 mothers on a single behavioural fear dimension. The fear dimension was assessed via a 7-point Likert scale ranging from 1 (*no fear*) to 7 (*high fear*). This type of rating scale has been used in previous judgement studies (Ambady & Rosenthal, 1993; Shepherd, 2008).

The effective reliability (Rosenthal, 1987) of the judges' ratings on the fear dimension was calculated. They were found to have an Intraclass Correlation of $r = .84$, which exceded the previously set minimum cutoff of $r = .70$ (see Rosenthal, 1987) . This indicated that the judges' ratings were sufficiently homogeneous to calculate a single fear rating score to simplify statistical analysis. A single fear rating score was derived for each mother by taking the average score from the six judges.

Results

Demographics

Table 1 summarizes descriptive data about the infants and the mothers who participated in the study. Of the 84 infants who participated in the study, 38 (45%) were male and 46 (55%) were female, and 45 (54%) of the infants were 12 months old and 39 (46%) were 18 months old. Forty (48%) of the infants were first born. Of the 84 infants, 13 (15.5 %) were born premature, with the number of weeks premature ranging between 1 to 5 weeks ($M = 0.47$, $SD = 1.32$). All of the parents answered "yes" to the question, "Is your baby generally healthy?". Twenty-six (31%) mothers gave their infants pain medication, with 18 (69%) giving Tylenol and 8 (31%) giving another type of pain medication to help prevent a fever that could result from the immunizations.

Pre-Analysis

Prior to conducting the statistical analysis, pre and post immunization for infant facial expression of pain, pre and post immunization for infant guarded body movement, maternal fear behaviour, and maternal self-reported needle fear were examined through various SPSS analysis for accuracy of data entry, missing values and extreme outliers.

Three cases with a single missing value on maternal self-reported needle fear scale were pro-rated. That is, the average was taken from the other answered items within the subscale and this number was substituted in for the missing value to obtain the participants score for the subscale.

Conducting stem and leaf plots, no extreme outliers were found for infant facial expressions of pain, pre and post immunization, nor were outliers found for infant guarded movement, pre and post immunization. No extreme outliers were found for maternal fear behaviour or maternal self-reported needle fear.

Infant Pain Expression

Facial Expressions of Infant Pain. To determine if pain medication had an effect on infants' facial expression of pain directly after the immunization, an independent samples t-test was conducted. Results showed no differences between infants who were given pain medication prior to the immunization (M = 937.88; SD = 562.06) compared to those who were not given pain medication prior to the immunization (M = 949.34; SD = 615.61), $t(82) = .08$, $p = .94$, SEM = 110.23.

A three-way mixed model of analysis of variance (ANOVA) was conducted to evaluate the effect of infants' gender and infants' age on pre immunization and post immunization facial expressions of pain. The between-subjects factors were infants' gender (male and female) and infants' age (12-month and 18-month). The within-subject factor was facial expression of pain (pre injection and post injection). The pre-immunization and post immunization facial expression main effect, the pre and post immunization facial pain expression X infants' gender interaction effect, the pre and post immunization facial pain expression X infants' age, and the pre and post immunization facial pain expression X infants' gender X infants' age interaction effect were tested. The pre immunization and post immunization facial expression of pain main effect was significant, F (1, 79) = 204.47, $p <$ .01, MSE = 3.52, partial $\eta^2 = .72$, with an observed power of 100%. Infants showed more facial expressions of pain after the injection (M = 1,381.85, SD = 547.56), than before the injection (M = 436.05, SD = 544.69). The interaction effect between pre and post immunization facial expressions of pain X infants' gender was not significant, F (1, 79) = .95, p = .33, MSE = 162,350.74, partial $\eta^2 = .04$, with an observed power of 40%. The interaction effect between pre and post immunization facial expression of pain X infants' age also did not show significance, F (1, 79) = 2.63, p = .11, MSE = 451,269.83, partial $\eta^2 = .01$, with an observed power of 19%. The final interaction effect between pre and post immunization facial expression of pain X infants' gender X infants' age did not show significance F (1, 79) = .18, p = .68, MSE = 30,217.17, partial $\eta^2 = .00$, with an observed power of 6%. Due to the fact the interactions were not significant no follow-up tests were conducted.

Infant Guarded Body Movements. To determine if pain medication had an effect on infants' guarded body movements directly after the immunization; an independent samples t-test was conducted. Results showed no differences between infants who were given pain medication prior to the immunization (M = 187.85; SD = 384.69) compared to those who were not given pain medication prior to the immunization (M = 230.3; SD = 301.74), t(82) = .55, p = .59, SEM = 75.44.

A three-way mixed model analysis of variance (ANOVA) was conducted to evaluate the effect of infants' gender and infants' age on pre immunization and post immunization guarded body movement. The between-subjects factors were infants' gender (male and female) and infants' age (12-month and 18-month). The within-subject factor was guarded body movement (pre injection and post injection). The pre-immunization and post immunization guarded body movement main effect, the pre and post immunization guarded body movement X infants' gender interaction effect, the pre and post immunization guarded body movement X infants' age interaction effect, and the pre and post immunization guarded body movement X infants' gender X infants' age interaction effect were tested. The pre immunization and post immunization guarded body movement main effect was significant, F (1, 79) = 30.77, $p < .01$, MSE = 1,602,272.99, partial $\eta^2 = .28$, with an observed power of 100%. Infants showed more guarded body movement after the injection (M = 511.99, SD = 349.91), than before the injection (M = 294.77, SD = 271.14). The interaction effect between pre and post immunization guarded body movements X infants' gender was not significant, F (1, 79) = 1.17, $p = .28$, MSE = 60,893.02, partial $\eta^2 = .02$, with an observed power of 19%. The interaction effect between pre and post immunization guarded body movements X infants' age also did not show significance, F (1, 79) = .71, $p = .40$, MSE = 36, 946.76, partial $\eta^2 = .01$, with an observed power of 14%. The interaction effect between pre and post immunization guarded body movements x infants' gender X infant's age did show a difference F (1, 79) = 4.01, $p < .05$, MSE = 208,879.90, partial $\eta^2 = .05$, with an observed power of 50%.

A two-tailed, independent sample t-test was conducted on pre and post immunization guarded body movement examining male infants, to determine where the differences occurred in the interaction (see Figure 2). It was found that the mean for guarded body movement, post needle insertion, in males, 12 months of age (M = 634.92, SD = 398.00) was significantly greater than the mean for guarded body movement, post needle insertion, in males 18 months of age (M = 384.69, SD = 253.59), $t(36) = 2.05$, $p < .05$, SEM = 121.87. That is, at 12 months of age, males exhibited greater incidents of guarded body movements, post needle insertion, than males 18 months of age. No significant mean differences were found for guarded body movements prior to the needle insertion in males 12 months of age (M = 287.24, SD = 275.25) and 18 months of age (M = 245.85, SD = 167.83), $t(36) = .50$, p = .62, SEM = 83.69.

To further examine the interaction, a two-tailed, independent samples t-test was conducted on pre and post immunization guarded body movement examining female infants (see Figure 3). It was found that the mean for guarded body movements in 12-month-old females prior to the immunization (M = 419.20, SD = 341.48) was significantly greater than the mean for guarded body movements in 18-month-old females prior to the immunization (M = 198.12, SD = 156.61), $t(25.36) = 2.68$, $p < .01$, SEM = 82.53. That is, at 12 months of age females show more guarded body movements, pre needle insertions, as compared to females at 18 months of age. No significant mean differences were found for guarded body movements, post needle insertion, in female infants, 12-months of age (M = 540.50, SD = 334.59), and female infants, 18-months of age (M = 404.60, SD = 294.68), $t(43) = 1.45$, p = .15, SEM = 93.88.

Infant Pain Expression and Infant Temperament

Pearson correlations were used to examine the relationship between mothers' self-report of their infants' temperament and the infants' observed pain expressions. This was used over a unidirectional regression analysis for two reasons. Firstly, it was used determine if a relationship existed between the infants' pain response and the infants' temperament. Secondly, since the questionnaire used had multiple dimensions using a more stringent test reduced the changes of Type I errors.

Correlation coefficients were computed between the infants' facial expressions of pain, infants' guarded body movements, and the six IBQ subscales: activity level, smiling/laughter, fear (distress to novelty items or situations), distress to limitations, soothability, and duration of orienting. The results of the correlational analysis are presented in Table 2. No significant relationships between the infants' facial pain response and the six IBQ subscales were found, nor were significant relationships found between the infants' guarded body movement and the six IBQ subscales. Due to the lack of relationship between the infants' pain expressions and the IBQ subscales, the IBQ was not analyzed further.

Maternal Fear Behaviour

Maternal Self-Reported Needle Fear and Fear Behaviour

To determine if there was a relationship between mothers' self-reported needle fear, total score on the PRS blood-needle subscale, and their behavioural fear, independent judges' rating of the mother's fear prior to the needle insertion, a Pearson correlation was conducted. Results indicated a signficant relationship between mothers' self-reported needle fear and their observed behavioural fear, $r = .41$, $p < .01$. Mothers who self-reported higher levels of needle fear, also tended to display behavioural fear prior to their infant's immunization.

Maternal Fear Behaviour and Infant Pain Expression

To demonstrate that mothers' self-reported needle fear, mediates infant pain expression the Baron and Kenny (1986) method of analysis was utilized. This type of analysis can be used to evaluate mediational or moderational hypotheses about how the mother's behavioural fear response affects infants' pain expression, both facial expressions of pain and guarded body movements. The Baron/Kenny method of analysis is a form of regression analysis in which a given variable is said to function as a mediator between the predictor variables and the criterion variables under specified statistical conditions. For a variable to function as a mediator it must meet the following criteria: variations in levels of the independent variable significantly account for variations in the mediator (Path *A*), variations in the mediator significantly account for variations in the dependent variable (Path

B), and when both Paths *A* and *B* are controlled for, a previously significant relation between the independent and dependent variable is no longer significant, with the strongest demonstration of mediation occuring when Path *C* is zero (Baron & Kenny, 1986).

The Baron/Kenny method of analysis was chosen over alternative approaches, such as Structural Equation Modeling (SEM), for a number of reasons. Firstly, the Baron/Kenny is often used in this type of research where one is looking at the effects of a predicted variable on a criterion behavioural variable, mediated by a behaviour. The central idea in this model is that the effects of stimuli on behaviour are mediated by various transformation processes internal to the organism (Baron & Kenny, 1986). As hypothesized, maternal fear behaviour would influence infant pain behaviour after the immunization. The second reason the Baron/Kenny was chosen over SEM is that SEM is typically used when one knows the potential relationship between variables. As indicated previously, looking at the social referencing Phenomenon in terms of maternal fear and how this would affect her infant's pain response has not been looked and therefore a previously known relationship between the varaibles was not available.

The Baron/Kenny method (Figure 4) was first used to analyse infants' facial expression of pain. A linear regression analysis was conducted to evaluate Path *A*; that is, to evaluate the prediction of the independent variable, mothers' self-reported needle fear, on the mediator, mothers' behavioural fear. The linear regression of mothers' self-reported fear significantly predicted mothers' behavioural fear, $R^2 = .17$, adjusted $R^2 = .16$, $F(1, 83) = 16.18$, $p <.05$, with an observed power of 59%. This indicates that Path *A* is significant. A second linear regression was conducted to test Path *B*. That is, to evaluate if the mediator, mothers' behavioural fear, significantly predicted the criterion variable, infants' facial expression of pain. The linear regression of mothers' behavioural fear did not significantly predict infant's facial expression of pain, $R^2 = .00$, adjusted $R^2 = -.01$, $F(1, 83) = .03$, $p = .86$, with an observed power of 95%. This indicates that Path *B* was not significant. Due to the fact that Path *B* did not significantly predict the criterion variable, the final regression on Path *C* was not conducted; that is, to determine if both mothers' self-reported fear and behavoural fear would both significanlty predict infants' facial expression of pain. The results indicate that mothers' behavioural fear prior to the immunization cannot function as a mediator of infants' facial expression of pain after the needle insertion.

The Baron/Kenny approach was also used to analyse infants' guarded body movements (Figure 5). A linear regression was conducted to evaluate Path *A*; that is, to evaluate the prediction of the independent variable, mothers' self-reported needle fear, on the mediator, mothers' behavioural fear. The linear regression of mothers' self-reported fear significantly predicted mothers' behavioural fear, $R^2 = .17$, adjusted $R^2 = .16$, $F(1, 83) = 16.18$, $p <.05$, with an observed power of 59%. A second linear regression was conducted to evaluate Path *B*; that is, to test if the mediator, mothers' behavioural fear, significantly predicted the criterion variable, infants' guarded body movements. The linear regression showed that mothers' behavioural fear did not significantly predict infants' guarded body movements, $R^2 = .02$, adjusted $R^2 = .01$, $F(1, 83) = 1.98$, $p = .16$, with an observed power of 85%. This indicated that Path *B* was not significant. Due to the fact that Path *B* did not significantly predict the criterion variable, the final regression on Path *C* was not analysed; that is, to determine if both mothers' self-reported fear and behavoural fear would both significanlty predict infants' facial expression of pain. These results indicate that mothers' behavioural fear prior to the immunization cannot be used as a mediator or predictor of infants' guarded body movements after the needle insertion.

Discussion

Infant Pain Expression

Facial Expressions of Infant Pain. Infants, in the present study, displayed increased overall facial activity in response to the immunization injection, when compared to facial activity during the harmless events preceding puncturing of the skin with the needle. The increase in overall facial activity was associated with an increase in a number of discrete facial actions including: furrowed eyebrows, eyes squeezed shut, deepened nasolabial furrow, open mouth with associated vertical and horizontal mouth stretch and a tense, cupped tongue. This profile of facial actions is consistent with the literature on pain in infants (Craig et al, 2000; Craig & Grunau, 1993; Grunau & Craig, 1987; Grunau et al, 1990; Izard et al, 1983; Johnston et al, 1993; Lilley et al, 1997;). The finding is consistent with other studies looking at the amount of increased facial activity post immunization (Klassen-Ross & Craig, in preparation).

As expected, infants' age did not influence their facial expression of pain. No significant differences were found between 12-month old infants' expression of pain, and 18-month old infants' expression of pain. This finding is consistent with previous research looking at developmental changes of pain expression in older infants. Izard, Hembree, Dougherty & Spizzirri (1983) found that the facial response to immunizations in infants became less prominent with age, and Nader (2006) found no developmental differences in facial expression of pain in infants after they received routine immunizations.

No gender differences were found in the present study in regards to infant's facial expression of pain. Male and female infants had similar facial expressions of pain, post immunization. This finding is not surprising, as previous studies have not shown gender differences in facial expressions of pain (Fuller, 2002; Owens & Todt, 1984; Stevens, Johnston & Horton, 1994); however, it should be noted that some research has shown female infants display greater facial expressions of pain during medical procedures than male infants (Grunau & Craig, 1987; Guinsburg et al, 2000).

Guinsburg et al. (2000), suggest that these gender differences, found in previous research, may be due to biological mechanisms that affect pain experience. The gender differences in biological mechanisms can include hormones, opiod receptors in the body, and mechanisms of nerve growth (Berkley, 1997). These biological mechanisms may be influential *in utero*, and they may continue to exert their influence with the maturation of the peripheral and central nervous system (see Unruh and Cambell, 1999). It has also been suggested that females are more sensitive to pain, and their pain expression is enhanced (Tesler, Holzemar, & Savedra, 1998). Further research needs to be conducted in the area of gender and facial expressions of pain. This research should be undertaken to determine if there are gender differences in pain expression, as researchers looking at biological mechanisms have suggested, or to determine if there are no gender differences in facial pain expression as was found in the current study.

Infant Guarded Body Movements. As with facial activity, the infants in the present study displayed an overall increase in guarded body movements in response to the immunization injection. The overall increase in guarded body movement was associated with an increase in hand and foot splay, arm and leg movement, head movement, and trunk movement. This was a predictable finding as overall increases in infant body movement in response to a painful stimulus have been previously reported (Craig et al, 1993; Franck & Miaskowski, 1997; Craig et al, 2000).

Surprisingly, an interaction was found in this study, between infant's age and gender in regards to the pre and post immunization guarded body movements. Male infants, 12-

months of age, were found to display more guarded body movements after then immunization when compared to males, 18-months of age. Interestingly, the level of guarded body movement seen in 12-month old females increased significantly over females 18-months of age prior to the immunization. Once again, this is a surprising finding, as research in this area has not shown developmental differences in guarded body movements (Fuller, 2002; Nader, 2004). Of the studies that have examined infant guarded body movement, gender has not been a significant predictor of infant guarded body movement (Fuller, 2002; Ipp, Taddio, Goldbach, David, Stevens & Koren, 2002). Experimental studies indicate that complex anatomical and functional interactions between different neurotransmitters are important in determining sex differences in response to adverse stimuli (Aloisi, 1997), which may account for the differences found between the 12-month old males and the 12-month old females in their guarded body movements before and after the immunization. More research needs to be conducted in the area of guarded body movements to determine what factors are involved, not only in the gender differences, but also in the developmental differences.

Maternal Fear Behaviour and Infant Pain Expression

Contrary to hypothesis two and three, mothers' self-reported needle fear and mothers' fear behavior did not predict infants' pain expression. Also, mother's fear behaviour did not mediate infants pain expression. Numerous explanations could be given for these three null results. One could argue that the mother was not actually showing needle fear and therefore the infant could not gather sufficient evidence to determine if this was a safe or dangerous situation. However, results from this study indicated that if a mother self-reported needle fear she also behaviourally displayed needle fear prior to her infant's injection. Thus, we can conclude, on the basis of observers' judgements, that a behavioural fear response was present for the infant to gain information about the situation.

Since behavioural response from the mother was present, we ought to ask why it did not predict infant's pain expressions. For this answer, we need to turn back to the social referencing phenomenon. For social referencing to be effective, the infant must actively engage with the referee, in this case the mother, to determine the status of the situation. Specifically, does the caregiver feel the situation is safe or is it dangerous. This situational communication is usally done through visual cues (Feinman, Roberts, Hseih, Sawyer & Swanson, 1992). The infant will look at the caregiver to judge how they should respond to the situation. In this study, infants could not look at their mother directly prior to the immunization as the mothers were instructed by the nurses to hold the infant with their back to their mother's front. The positioning of the infant prior to the immunization could offer an explanation as to why mothers' fear behavior did not influence infants' pain expression after the immunization.

A second explanation for the lack of results could be that the pain assessment tools used in this study were not fine grained enough to determine differences in pain expression between the infants whose mothers reported and displayed needle fear and those infants whose mothers did not report nor display needle fear. As the results showed, a majority of the infants, regardless of maternal fear status, showed a hightened pain response post immunization, through facial expressions and guarded body movements. This could imply that the measures used were in fact too sensitive, showing an overwhelming pain response masking all other pain influences, such as social referencing.

Finally, the lack of results in this study may simply be due to an inaccurate research hypothesis. It was hypothesised that infants of mothers who self-reported and displayed needle fear would have a higher pain response as compared to infants of mothers who did not report or display needle fear. This hypothesis was based on previous findings looking at the social referencing phenomenon, and how mother's reactions, in social situations, influenced their infant's response in the same situation. It was recognized that the social referencing phenomenon had not been studied in infants undergoing common, yet painful, medical procedures. It could be the case, that the research condition, observing immunizations, in which the social referencing phenomenon was studied was inappropriate. Firstly, as previously discussed, social referencing has been shown to appear in infants around 10-months of age; however, this does not mean that all infants will start to display this type of communication behaviour at 10-months of age. This sample included infants either 12 or 18-months of age, and the sample may have been too young, overall, to actually see the social referencing phenomenon take place prior to the immunization. Secondly, the pain response may have been too great to show the effects of this phenomenon. In previous research, the effects of social referencing were measured in terms of an infant's level of avoidance or fear response to a novel situation. In this study, the effects of social referencing were measured in terms of the infant's pain response to the immunization. As the results indicated, all of the infants showed a pain response to the immunization, which one would expect. The fact that the majority of the infants showed pain response could have, in effect, washed out any influences social referencing had on the infant.

Limitations of Study

The findings of this study should be considered with some important limitations. The first limitation that needs to be addressed was the large variation (standard deviations) found in the ANOVA and independent t-test analyses. The type of observational coding conducted on the infant pain expressions allowed for large pain scores. Each infant was coded on 600 different frames, with up to 15 different pain scores for each frame. Simple mathematics would indicate that each infant's pain score could be quite large and any variation between the infants' on their pain score would cause the large variations seen in the statistical analysis.

Secondly, while conducting the study in clinical settings enhanced its real-world validity, it led to an inability to control potential interactions of the infant reactions. While all of the infants were receiving immunizations, some infants received the immunization in the upper arm, while others received the immunization in their upper thigh. Consequently, the pain stimuli may have differed between injection sites. Nonetheless, I was unable to find any empirical studies demonstrating a differential pain response in infants receiving injections in the arm versus the leg.

Another potential source of variance in the immunization procedure was that a number of different nurses administered the injections. It is possible that individual nurses have different techniques for giving the injection and this could lead to greater or lesser pain experienced by the infant, but given that the research was conducted in active and busy clinical settings, there was no way to control who gave the injections. It may also be the case, that the infants, being in a relatively unfamiliar setting, may have been focusing more on the nurse, other people in the room, and their surroundings instead of their mother.

A final source of potential variance in the immunization procedure was the clinic itself. Participants were recruited from two separate healthy baby clinics. At one clinic, infants were given immunizations in separate closed-door rooms. In contrast, at the second clinic multiple infants were given immunizations, in a large room, at the same time. The room was divided into four separate cubicles, by freestanding cubicle dividers. Such dividers do not offer any soundproofing and you can easily hear the cries from the other infants receiving immunizations. This lack of soundproofing could potentially cause a heightened level of anxiety in the infants causing them to display higher levels of pain expressions.

Suggestions for Future Research

This study found some interesting relationships that should be researched further. An area of research could be examined is the socialization of males and females and how this could influence their pain response at 12 and 18-months of age. It was suggested earlier, that the socialization of males' responses to pain may begin during the second year of life. One could test this hypothesis by looking at parental reactions to their infants when they are undergoing common, but painful, medical practices.

A final area of future research could be looking further into the social referencing phenomena. In this study, mothers' fear reaction prior to the needle did not significantly predict infants' pain responses after the needle. As stated earlier, for the infant to gain information from their caregiver about a novel situation they must be able to pick up behavioral cues from the caregiver. A future research project could control for infant positioning. The infant could be positioned in way which would allow them to focus on the mother prior to the immunization. A second research project, could look at the social referencing phenomenon after the immunization is given. Most often infants are given multiple injections during a single healthy baby visit. This would allow one to look at the mother's fear behaviour throughout the immunization process, measure the number of times an infant looks at their mother for situational cues, and see if these two behaviors predict infant pain expression throughout the immunization process.

Conclusion

In conclusion, infants are a very vulnerable population who undergo numerous common, yet painful, medical procedures. Infants use social referencing, a complex level of communication and learning, during novel situations to establish how they should react in these situations. Infants look to their mothers to learn how to react if a situation is safe or dangerous. In this study, it was hypothesized that maternal self-reported needle fear and maternal needle fear behaviour would influence infant pain expression. It was found that neither maternal self-reported needle fear nor maternal fear behaviour influenced infants' pain expression. This lack of relationship could be due to numerous reasons, such as insensitive pain measures and infants being unable to see their mother's face prior to the injection. Social referencing should not be discounted as an explanation for infant pain response during a noxious event. Rather social referencing should be studied further to determine if it plays a role in infants response to a painful event.

This study also revealed some interesting and somewhat counter intuitive findings. Results showed that males, 12-months of age, exhibited more guarded body movement than males 18-months of age directly following the immunization; whereas females at 12-months of age showed increased guarded body movement prior to the immunization as compared to females 18-months of age. Research has also shown that developmental differences in infant guarded movements are not present at 12-months of age (Nader, 2002).

This study has raised some interesting future research questions that need to be studied further to get a fuller understanding how pain is manifested in infants and how infants express this pain to their caregivers. Needless to say, as a vulnerable population, it is important to find ways to lessen infants' pain experience, especially during common medical practices such as immunizations.

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Table 1

Demographic Characteristics of Infants and Mothers

Infant's Age (in days)	$M = 458.07$; $SD = 93.33$
Infant's Age (in months)	$M = 15.29$; $SD = 3.11$
Infant's Weight at Birth (kg.)	$M = 3.41$; $SD = .58$
Hours since infant fed	$M = 1.64$; $SD = 1.12$
Hours since infant slept	$M = 2.75$; $SD = 1.50$
Mother's Age (in years)	$M = 30.83$; $SD = 4.57$

Table 2

Correlations Between Infant's Pain Expression and IBQ subscales

IBQ Subscale	Infant Pain Reaction	Infant Guarded Body Movement
Activity Level	.05	.18
Distress to Limitations	.08	-.02
Distress and Latency to Approach Sudden or Novel Stimuli	.14	-.02
Duration of Orientation	.13	-.03
Smiling and Laughter	.07	.22
Soothability	.22	-.01

APPENDIX A: Informed consent form

Informed Consent Form

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

Purpose: Babies and young infants are unable to tell their parents or health care providers how much pain they feel when they are hurt. Therefore, we need to use other ways to tell when babies are hurting, such as watching their facial expressions, body movements and listening to their cries. We are interested in discovering some of the things that affect babies' expressions when they are being immunized. We are also interested in how parents react to the immunization procedure.

Study Procedure: We will be asking your permission to videotape and audiotape you and your baby when he or she receives routine immunization injections. Your baby will not undergo any extra procedures as a result of this study, and it will not interfere with your baby's care. After the immunization, we will also ask you to complete some short questionnaires asking about demographic information, your baby's personality and how you feel about certain anxiety provoking situations. The completion of these questionnaires will take approximately 10 minutes. 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 or your baby from taking part in this study.

Benefits: Taking part will not affect your or your baby's care. It will help us understand the effects of immunization better and 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. All documents will be identified only by code number and kept in a locked filing cabinet. The videotapes will be viewed by expert project staff trained to identify the nature of your child's reaction and/or others attempting to judge his/her response to the immunization. You and your child will never be identified by name. We will retain copies of the video for our files indefinitely, but only code numbers will be used to identify either yourself or your infant.

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 at 250-960-6446. If I have any concerns about my baby's treatment or rights as a research subject, I may contact the Office of Research at the University of Northern British Columbia, 250-960-5820 or by e-mail: reb@unbc.ca.

Parental Consent: I understand that my decision to allow my baby to participate in this study is entirely voluntary and that I may refuse to participate or I may withdraw my baby from the study at any time without any consequences to my baby's medical care. I also understand that my signature on the consent form does not waive any of my legal rights.

I have received a copy of this consent form for my own records.

I consent to my baby participating in this study.

I understand that the videotapes may be used for future research, but no names will be on the tapes.

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

If yes, please write down your e-mail or mailing address ____________________

____

____
Parent Signature   Date

____
Parent Name (Please Print)

____
Witness   Date

APPENDIX B: Demographics and health status of the infant.

INFANT QUESTIONNAIRE

Subject Number: _________ Today's Date:____________

Have you participated in this study before? O Yes O No (check one)

What is your baby's first name? ________________________________

What is your baby's birthdate? (Year/Month/Day) __________________

Is your baby male or female? O Male O Female (check one)

Was your baby premature? O Yes O No (check one)

If "Yes", how many weeks before your due date was he/she born? ___

What was your baby's weight at birth (lbs)? _______________________

Is this baby your first-born child? O Yes O No (check one)

If "No", how many older children do you have? _________________

Is your baby generally healthy? O Yes O No (check one)

If "No", what illness or condition does he/she have? ____________

____

What is *your* age? ____

What is your relation to your baby? O Mother O Father Other_______

How many hours has it been since your baby was fed? ________________

How many hours has it been since your baby woke up? _______________

Did you give your baby Tylenol or another medication before the shot? _____

If "Yes", what? O Tylenol O Other ________________

APPENDIX C: The Phobic Stimuli Response Scale

ID # : ______ Sex (M/F): _____ Age: ____ Current Date (M/D/Y): __________

PSRS

Instructions: Respond to the items below using the scale provided. While it is best to answer every item, you do not need to respond to any items that make you uncomfortable.

a-strongly disagree **b-disagree** **c-agree** **d-strongly agree**

______ 1.) I do not like worms.

______ 2.) I turn away from the sight of blood.

______ 3.) I do not like to have people watch me eat.

______ 4.) Rats and mice really bother me.

______ 5.) I get nervous and uneasy during thunderstorms.

______ 6.) I often am afraid of looking foolish.

______ 7.) Watching gory movies makes me queasy.

______ 8.) I hate the feeling of being trapped in the middle of a big crowd.

______ 9.) I am very afraid of suffocating.

______ 10.) I often worry about natural disasters.

______ 11.) I do not like riding in crowded buses.

______ 12.) I would never hold a spider.

______ 13.) I hate getting shots.

______ 14.) It would not bother me to hold a snake.

______ 15.) It would be hard for me to prick my own finger.

______ 16.) I dislike the feeling of being watched by others.

<u>a- strongly disagree</u> <u>b- disagree</u> <u>c- agree</u> <u>d- strongly agree</u>

______ 17.) I feel faint at the sight of blood.

______ 18.) Public speaking makes me very nervous.

______ 19.) I do not like to look at hypodermic needles.

______ 20.) I am terrified at the thought of being buried alive.

______ 21.) I really dislike being in very crowded airplanes.

______ 22.) Witnessing childbirth would probably make me feel faint.

______ 23.) I am uncomfortable in tight, enclosed spaces.

______ 24.) I would never swim in deep water, even if someone were with me.

______ 25.) I dislike crowded places.

______ 26.) I hate sitting in the middle of a long row of people so that it is difficult to get in and out.

______ 27.) I tend to be uncomfortable around people I find attractive.

______ 28.) I get nervous when I know that people are watching me.

______ 29.) I would not like to hold a lizard.

______ 30.) I would hate to have an IV stuck in my arm.

______ 31.) I worry that someone close to me will contract a terminal illness.

______ 32.) The sight of blood used to really upset me when I was a child.

______ 33.) I hate to be places in which I do not know anyone.

______ 34.) I can't perform well if I know that others are watching me.

______ 35.) I am generally not shy around people I've just met.

a- strongly disagree b- disagree c- agree d- strongly agree

______ 36.) I am very concerned that I might contract HIV.

______ 37.) I would not like to hold a snail or a slug.

______ 38.) One of my greatest fears is that I will suffer an early, untimely death.

______ 39.) When in a new situation, I feel that everyone is watching me.

______ 40.) It would be terrifying for me to be locked in a small, dark room.

______ 41.) Watching an animal dissection would make me woozy.

______ 42.) It terrifies me to be outside when lightning is striking.

______ 43.) One of my greatest fears is that I will be diagnosed with cancer.

______ 44.) I would hate to touch a cockroach.

______ 45.) I dislike being in strange, unfamiliar places.

______ 46.) I really dislike handling slimy things.

APPENDIX D: Infant Behaviour Questionnaire

c 1978
Mary K. Rothbart
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Infant Behavior Questionnaire

1978 Version

Subject No. ________________ Date of Baby's Birth ____ ____ ____
mon. day year

Today's Date ______________ Age of Child _____ _____
mons. weeks

Sex of Child ______________

INSTRUCTIONS: Please read carefully before starting:
As you read each description of the baby's behavior below, please indicate how often the baby did this during the LAST WEEK (the past seven days) by circling one of the numbers in the left column. These numbers indicate how often you observed the behavior described during the last week.

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(X)
Never	**Very Rarely**	**Less Than Half the Time**	**About Half the Time**	**More Than Half the Time**	**Almost Always**	**Always**	**Does Not Apply**

The "Does Not Apply" (X) column is used when you did not see the baby in the situation described during the last week. For example, if the situation mentions the baby having to wait for food or liquids and there was no time during the last week when the baby had to wait, circle the (X) column. "Does Not Apply" is different from "Never" (1). "Never" is used when you saw the baby in the situation, but the baby never engaged in the behavior listed during the last week. For example, if the baby did have to wait for food or liquids at least once but never cried loudly while waiting, circle the (1) column.

Please be sure to circle a number for every item.

Feeding

When having to wait for food or liquids during the last week, how often did the baby:
1 2 3 4 5 6 7 X . . . . . . (1) seem not bothered?
1 2 3 4 5 6 7 X . . . . . . (2) show mild fussing?
1 2 3 4 5 6 7 X . . . . . . (3) cry loudly?

During feeding, how often did the baby:
1 2 3 4 5 6 7 X . . . . . . (4) lie or sit quietly?
1 2 3 4 5 6 7 X . . . . . . (5) squirm or kick?
During feeding, how often did the baby:
1 2 3 4 5 6 7 X . . . . . . (6) wave arms?
1 2 3 4 5 6 7 X . . . . . . (7) fuss or cry when s/he had enough to eat?
1 2 3 4 5 6 7 X . . . . . . (8) fuss or cry when given a disliked food?

When given a new food or liquid, how often did the baby:
1 2 3 4 5 6 7 X . . . . . . (9) accept it immediately?

1 2 3 4 5 6 7 X...... (10) reject it by spitting out, closing mouth, etc.?
1 2 3 4 5 6 7 X...... (11) not accept it no matter how many times offered?

Sleeping

Before falling asleep at night during the last week, how often did the baby:
1 2 3 4 5 6 7 X...... (12) show no fussing or crying?

During sleep, how often did the baby:
1 2 3 4 5 6 7 X...... (13) toss about in the crib?
1 2 3 4 5 6 7 X...... (14) move from the middle to the end of the crib?
1 2 3 4 5 6 7 X...... (15) sleep in one position only?

After sleeping, how often did the baby:
1 2 3 4 5 6 7 X...... (16) fuss or cry immediately?
1 2 3 4 5 6 7 X...... (17) play quietly in the crib?
1 2 3 4 5 6 7 X...... (18) coo and vocalize for periods of 5 minutes or longer?
1 2 3 4 5 6 7 X...... (19) cry if someone doesn't come within a few minutes?

How often did the baby:
1 2 3 4 5 6 7 X...... (20) seem angry (crying and fussing) when you left her/him in the crib?

1 2 3 4 5 6 7 X...... (21) seem contented when left in the crib?
1 2 3 4 5 6 7 X...... (22) cry or fuss before going to sleep for naps?

Bathing and Dressing

When being dressed or undressed during the last week, how often did the baby:
1 2 3 4 5 6 7 X...... (23) wave her/his arms and kick?
1 2 3 4 5 6 7 X...... (24) squirm and/or try to roll away?
1 2 3 4 5 6 7 X...... (25) smile or laugh?

When put into the bath water, how often did the baby:
1 2 3 4 5 6 7 X...... (26) startle (gasps, throws out arms; stiffens body, etc.)?
1 2 3 4 5 6 7 X...... (27) smile?
1 2 3 4 5 6 7 X...... (28) laugh?
1 2 3 4 5 6 7 X...... (29) have a surprised expression?
1 2 3 4 5 6 7 X...... (30) splash or kick?
1 2 3 4 5 6 7 X...... (31) turn body and/or squirm?

When face was washed, how often did the baby:
1 2 3 4 5 6 7 X...... (32) smile or laugh?
1 2 3 4 5 6 7 X...... (33) fuss or cry?

When hair was washed, how often did the baby:
1 2 3 4 5 6 7 X...... (34) smile or laugh?
1 2 3 4 5 6 7 X...... (35) fuss or cry?

Play

How often during the last week did the baby:

1 2 3 4 5 6 7 X...... (36) look at pictures in books and/or magazines for 2-5 minutes at a time?

1 2 3 4 5 6 7 X...... (37) look at pictures in books and/or magazines for 5 minutes or longer at a time?

1 2 3 4 5 6 7 X...... (38) stare at a mobile, crib bumper or picture for 5 minutes or longer?

1 2 3 4 5 6 7 X...... (39) play with one toy or object for 5-10 minutes?

1 2 3 4 5 6 7 X...... (40) play with one toy or object for 10 minutes or longer?

1 2 3 4 5 6 7 X...... (41) spend time just looking at playthings?

1 2 3 4 5 6 7 X...... (42) repeat the same sounds over and over again?

1 2 3 4 5 6 7 X...... (43) laugh aloud in play?

1 2 3 4 5 6 7 X...... (44) smile or laugh when tickled?

1 2 3 4 5 6 7 X...... (45) cry or show distress when tickled?

1 2 3 4 5 6 7 X...... (46) repeat the same movement with an object for 2 minutes or longer (e.g., putting a block in a cup, kicking or hitting a mobile)?

When something the baby was playing with had to be removed, how often did s/he:

1 2 3 4 5 6 7 X...... (47) cry or show distress for a time?

1 2 3 4 5 6 7 X...... (48) cry or show distress for several minutes for longer?

1 2 3 4 5 6 7 X...... (49) seem not bothered?

When tossed around playfully, how often did the baby:

1 2 3 4 5 6 7 X...... (50) smile?

1 2 3 4 5 6 7 X...... (51) laugh?

During a peekaboo game, how often did the baby:

1 2 3 4 5 6 7 X...... (52) smile?

1 2 3 4 5 6 7 X...... (53) laugh?

Daily Activities

How often during the last week did the baby:

1 2 3 4 5 6 7 X...... (54) cry or show distress at a loud sound (blender, vacuum cleaner, etc.)?

1 2 3 4 5 6 7 X...... (55) cry or show distress at a change in parents' appearance (glasses off, shower cap on, etc.)?

1 2 3 4 5 6 7 X...... (56) when in a position to see the television set, look at it for 2 to 5 minutes at a time?

1 2 3 4 5 6 7 X...... (57) when in a position to see the television set, look at it for 5 minutes or longer?

1 2 3 4 5 6 7 X...... (58) protest being put in a confining place (infant seat, play pen, car seat, etc)?

1 2 3 4 5 6 7 X...... (59) startle at a sudden change in body position (for example, when moved suddenly)?

1 2 3 4 5 6 7 X...... (60) startle to a loud or sudden noise?

1 2 3 4 5 6 7 X...... (61) cry after startling?

When being held, how often did the baby:
1 2 3 4 5 6 7 X...... (62) squirm, pull away, or kick?

When placed on his/her back, how often did the baby:
1 2 3 4 5 6 7 X...... (63) fuss or protest?
1 2 3 4 5 6 7 X...... (64) smile or laugh?
1 2 3 4 5 6 7 X...... (65) lie quietly?
1 2 3 4 5 6 7 X...... (66) wave arms and kick?
1 2 3 4 5 6 7 X...... (67) squirm and/or turn body?

When the baby wanted something, how often did s/he:
1 2 3 4 5 6 7 X...... (68) become upset when s/he could not get what s/he wanted?
1 2 3 4 5 6 7 X...... (69) have tantrums (crying, screaming, face red, etc.) when s/he did not get what s/he wanted?

When placed in an infant seat or car seat, how often did the baby:
1 2 3 4 5 6 7 X...... (70) wave arms and kick?
1 2 3 4 5 6 7 X...... (71) squirm and turn body?
1 2 3 4 5 6 7 X...... (72) lie or sit quietly?
1 2 3 4 5 6 7 X...... (73) show distress at first; then quiet down?

When you returned from having been away and the baby was awake, how often did s/he:
1 2 3 4 5 6 7 X...... (74) smile or laugh?

When introduced to a strange person, how often did the baby:
1 2 3 4 5 6 7 X...... (75) cling to a parent?
1 2 3 4 5 6 7 X...... (76) refuse to go to a stranger?
1 2 3 4 5 6 7 X...... (77) hang back from the stranger?
1 2 3 4 5 6 7 X...... (78) never "warm up" to the stranger?
1 2 3 4 5 6 7 X...... (79) approach the stranger at once?
1 2 3 4 5 6 7 X...... (80) smile or laugh?

When introduced to a dog or cat, how often did the baby:
1 2 3 4 5 6 7 X...... (81) cry or show distress?
1 2 3 4 5 6 7 X...... (82) smile or laugh?
1 2 3 4 5 6 7 X...... (83) approach at once?

Soothing Techniques

Have you tried any of the following soothing techniques in the last two weeks? If so, how often did the method soothe the baby? Circle (X) if you did not try the technique during the LAST TWO WEEKS.

1 2 3 4 5 6 7 X...... (84) rocking?
1 2 3 4 5 6 7 X...... (85) holding?
1 2 3 4 5 6 7 X...... (86) singing or talking?
1 2 3 4 5 6 7 X...... (87) walking with the baby?
1 2 3 4 5 6 7 X...... (88) giving the baby a toy?
1 2 3 4 5 6 7 X...... (89) showing the baby something to look at?
1 2 3 4 5 6 7 X...... (90) patting or gently rubbing some parts of the baby's body?
1 2 3 4 5 6 7 X...... (91) offering food or liquid?
1 2 3 4 5 6 7 X...... (92) offering baby her/his security object?
1 2 3 4 5 6 7 X...... (93) changing baby's position?
1 2 3 4 5 6 7 X...... (94) other (please specify) ____________________

Figure Caption

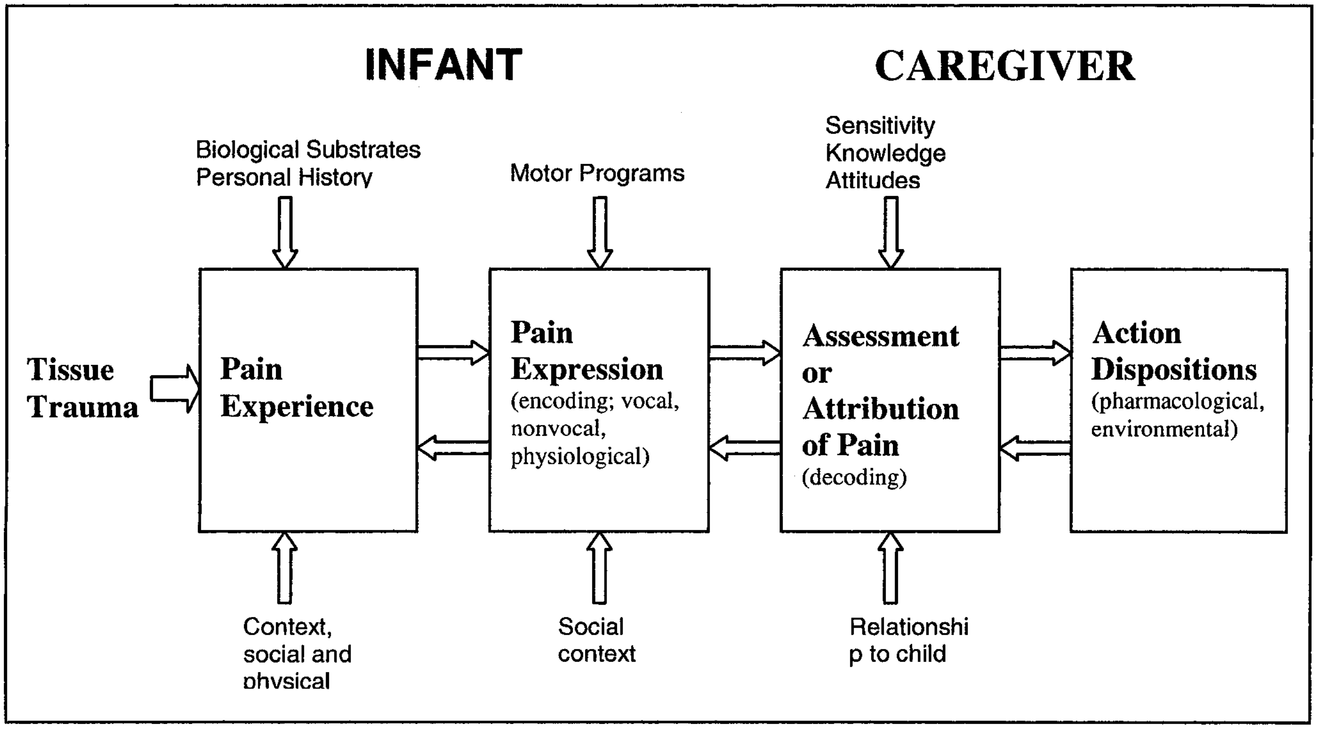
Figure 1. Sociocommunications Model

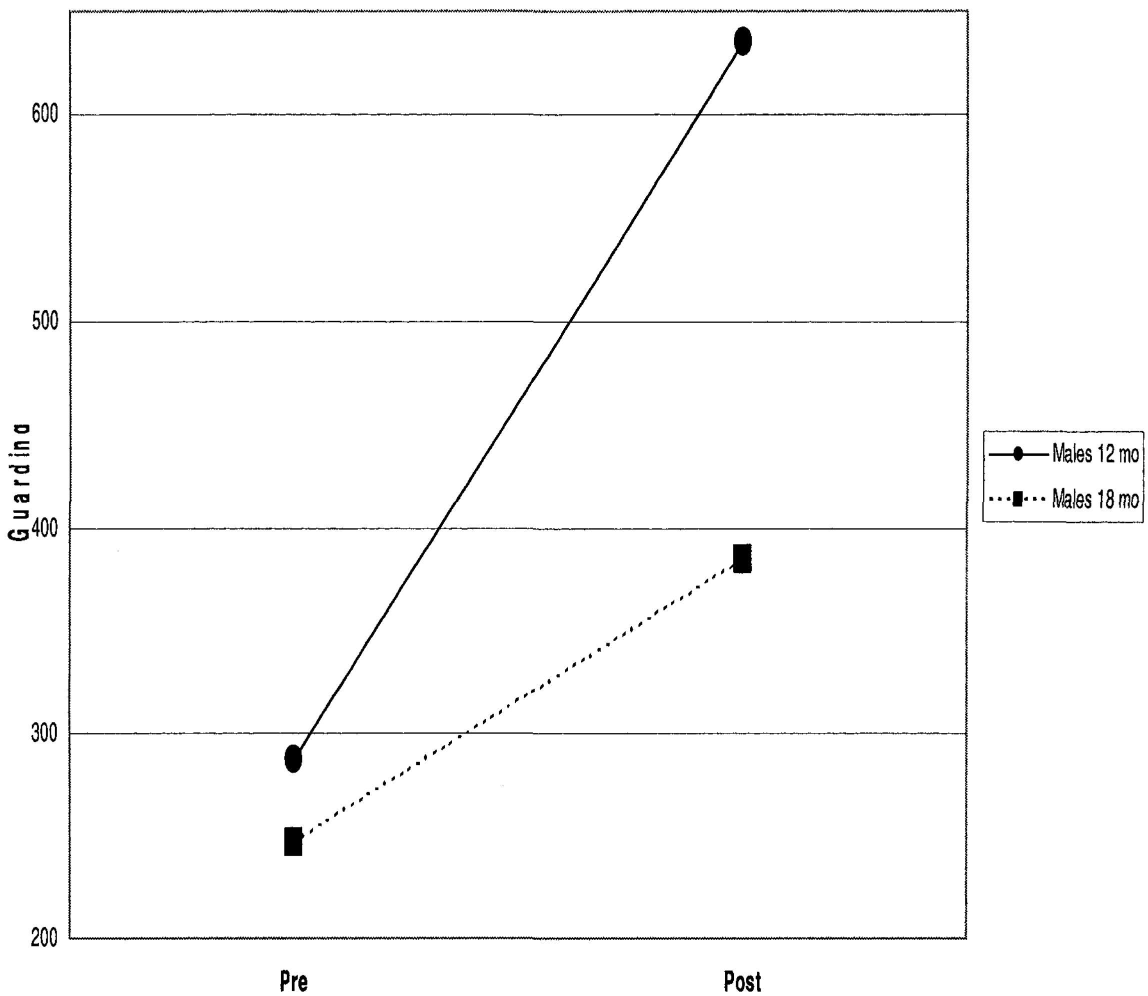
Figure 2. Interaction of pre and post guarded body movements on 12 and 18 month old male infants

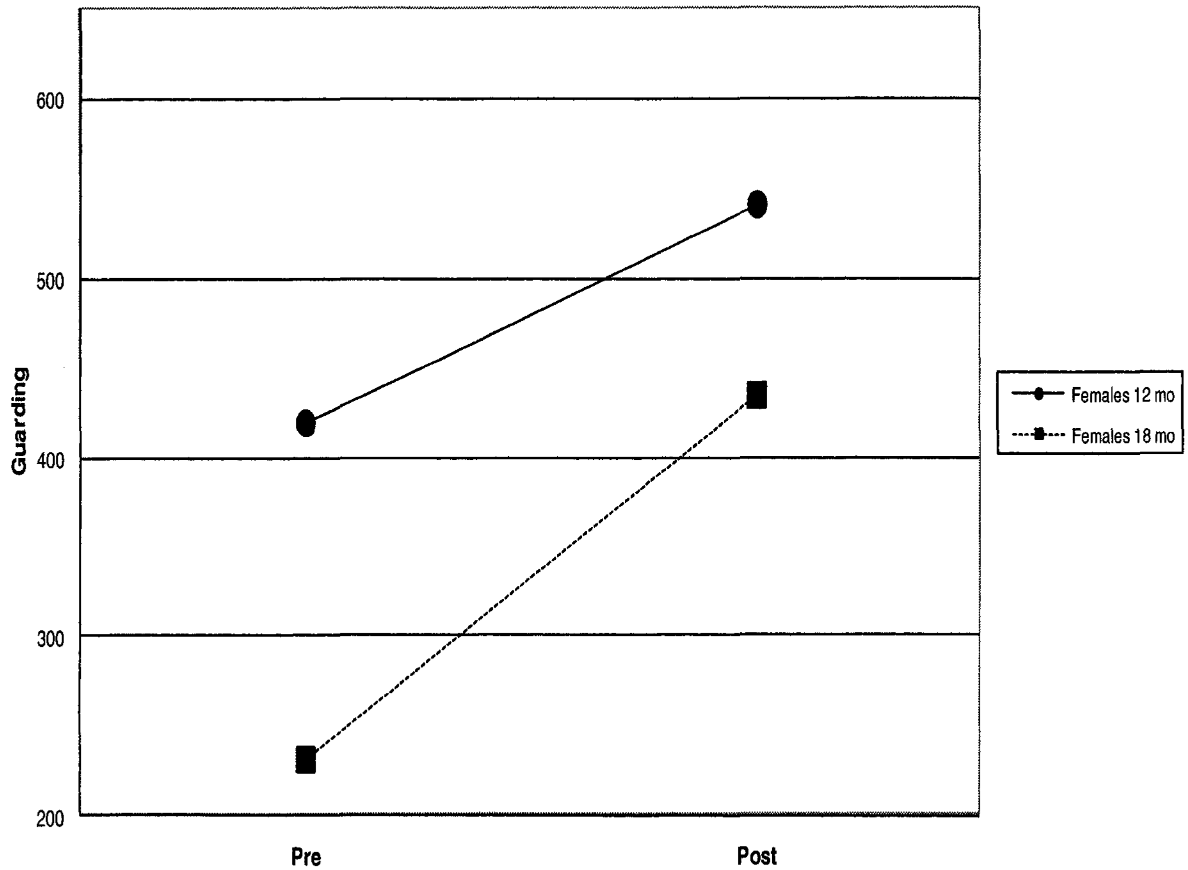
Figure 3. Interaction of pre and post guarded body movement on 12 and 18 month old female infants

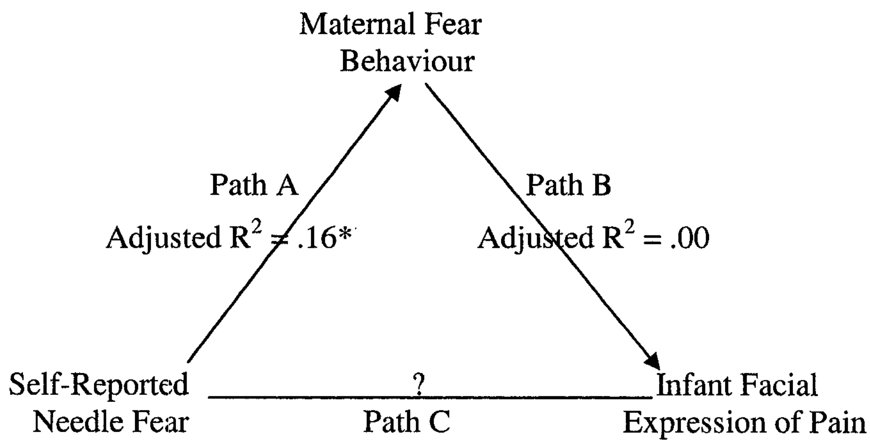
Figure 4. Baron/Kenny regression analysis: infant facial expression of pain

Figure 5. Baron/Kenny regression analysis: infant guarded body movement

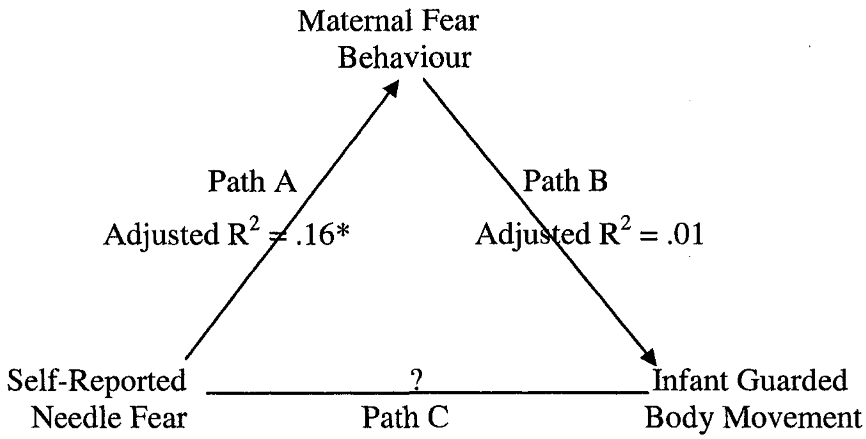

INFANT
CAREGIVER
Biological Substrates
Personal History
Motor Programs
Sensitivity
Knowledge
Attitudes
Tissue Trauma
Pain Experience
Pain Expression
(encoding; vocal, nonvocal, physiological)
Assessment or Attribution of Pain
(decoding)
Action Dispositions
(pharmacological, environmental)
Context, social and physical
Social context
Relationship to child


600
500
Guarding
400
300
200
Pre
Post
Males 12 mo
Males 18 mo


600
500
400
300
200
Guarding
Pre
Post
Females 12 mo
Females 18 mo


Maternal Fear
Behaviour
Path A
Adjusted R2 = .16*
Path B
Adjusted R2 = .00
Self-Reported
Needle Fear
?
Path C
Infant Facial
Expression of Pain

* $p < .05$



Maternal Fear
Behaviour
Path A
Adjusted R² = .16*
Path B
Adjusted R² = .01
Self-Reported
Needle Fear
?
Path C
Infant Guarded
Body Movement

* $p < .05$