EFFECTS OF AUDIENCE ON SELF-REPORT, BEHAVIOURAL AND PHYSIOLOGICAL RESPONSES TO THE COLD PRESSOR TEST

by

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ABSTRACT

The present study concerned the influence of the presence of others on pain response. To the extent that pain responses are predicated upon impact on observers, it would be expected that different audiences would have a differential impact on the nature of the response depending upon the measure or response system studied and characteristics of both the person in pain and the audience. The cold pressor test was used to induce pain in 120 healthy undergraduate students. An equal number of males and females were randomly assigned to each of 3 audience conditions (male versus female versus implicit). Dependent variables included behavioural pain tolerance, self-report ratings, heart rate, and facial display. A 3 (audience condition) X 2 (participant gender) between-subjects multivariate analysis of variance indicated that there was an impact of audience on pain responses. Univariate analyses of variance and Student Newman Keuls post hoc comparisons conducted on significant effects indicated higher mean unpleasantness ratings, and maximum heart rate during pain in the implicit group compared to the female and male audience groups. A similar pattern of results was found for judges’ ratings of participants’ pain based on facial display. Other measures of facial action, self-reported pain intensity and behavioural pain tolerance were not significantly different. These findings stress the importance of considering social context when interpreting pain response. Furthermore, they indicate that the presence of an audience affects domains of pain response differentially, or that certain dependent measures may not be sensitive or participant to the impact of an audience.
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INTRODUCTION

Pain is a virtually universal experience responsible in both its acute and chronic forms for considerable human suffering. Although there have been striking advances in our understanding of the biomedical parameters of pain and patients have been the beneficiaries of innovative surgical and pharmacological treatment strategies, many people continue to suffer despite the best care available. In part, this reflects inadequate understanding and interventions, but in many cases, our technological capacity to control pain far exceeds the realities of commonplace health practice (Melzack, 1988). Although caregivers may have the skills to deliver care and alleviate pain, unless pain is accurately communicated and identified people may continue to suffer.

There is reason to believe care is sometimes not provided for people in acute pain despite their personal distress. This is partly a reflection of the inadequacies of common practices in pain assessment. These practices need to be examined from the perspective of a communications model (Craig, Lilley, & Gilbert, 1996; Prkachin & Craig, 1995) in the interests of providing information on how to ameliorate the provision of specific and effective care. The process of pain communication can be seen as a matter of information transmission from internal experience through pain behaviour to social interpretation. Delivery of care to a person in pain must be preceded by a complex sequence of events. First, pain is initiated by tissue stress, either injury or disease provoked (and sometimes falsified), and processed subjectively as pain (or the intent to display pain behaviourally), with complex and interactive, affective and cognitive components, as well as sensory parameters. Second, the person in pain must encode their distress by evincing manifest evidence of painful distress, either verbal or nonverbal. Next, observers must be able to
identify pain, respond empathetically, and accurately evaluate the nature of the person's distress. Finally, observers must possess the skills necessary to deliver care, perhaps in the form of medication or nonpharmacological pain interventions, and be predisposed to do so.

In sum, the communications model of pain includes different levels of processing related to the complex tissue stress, psychological concomitants, encoding, decoding, and action sequence involved in a pain episode. This model extends the dominant biomedical view of pain to incorporate psychological and social parameters including the complex social contexts in which pain is experienced.

Although the communications model of pain represents an advancement over the traditional medical model, it is oversimplified because it omits details of various levels of processing and eliminates the transactional and feedback components. Pain assessment is often completed in the presence of others and invariably in demanding social contexts. In a hospital setting, patients are frequently observed by hospital staff, visitors and other patients. However, relatively little is known about the effects of being observed on the expression of pain. Existing data suggest that pain expression is changed by the presence of an audience. In a study investigating children's display rules for pain, children reported that they would be significantly less likely to express pain in front of a peer than when alone (Zeman & Garber, 1996). Furthermore, Kleck and colleagues (1976) found that males' expressive responses to painful shock were attenuated when they were observed as compared to when they were alone. However, they only studied males, so interactions between sex of adult participants and audience effects on pain have yet to be investigated.

The present experiment will further elucidate how the presence of an explicit audience can impact the encoding level of communication by examining multiple channels of
information available to observers, namely, self-reports, nonverbal behaviour and physiological activity. The laboratory setting provides an opportunity to pursue the encoding level of processing given the control available over the situation and pain induction. The present study will evaluate the impact of being observed by same- or opposite-sex peers on pain responses of females and males exposed to the cold pressor test. In the future, this information may be used to extend the current focus on biological parameters of pain to incorporate psychological and social parameters, to provide further details of the encoding level of processing in the communications model of pain, and to improve pain assessment practices through increased knowledge regarding the communication of pain.

LITERATURE REVIEW

Views of Pain

Currently, sophisticated models of pain view it as a complex biopsychosocial phenomenon, in which an individual’s perception of and response to pain is influenced by a variety of subjective qualities of experience (Turk, 1996). Indeed, the definition of pain as “an unpleasant sensory and emotional experience primarily associated with actual or potential tissue damage or described in terms of such damage” endorsed by the International Association for the Study of Pain (1979) reflects the recognition of the importance of psychological factors. Current models of pain experience trace their ancestry to the Gate Control Model of Pain proposed by Melzack and Wall (1965). Melzack and Wall (1965) advanced the notion of pain as a multidimensional experience and the influential Gate Control Theory supplanted the classical, unidimensional view of pain which described the phenomenon as a specific sensory response arising from stimulation of pain receptors and proportional to the number of receptors stimulated. According to Gate Control Theory, pain
sensation is not a direct representation of noxious information; pain is the product of a complex and interconnected web of influences including central control processes, as well as motivational and affective influences. In addition to addressing both sensory and physiological components of pain, the theory described a 'central control' component of pain perception, indicating pain was mediated by emotions, memory, and attention, as well as by peripheral stimulation. This has proven to be a powerful heuristic and explanatory construct. It is currently recognized that both psychological factors and environmental cues affect the experience of pain and play major roles in pain response and pain behaviours (e.g. Craig, 1986; Fordyce, 1976; Levine & DeSimone, 1991; Prkachin & Craig, 1986).

**Communications Model of Pain**

Recently, a communications model of pain has been proposed that incorporates the influence of social and psychological factors on the individual's subjective experience of pain, its outward display, and how interested observers interpret these actions and decide to respond behaviourally (Craig et al., 1996; Prkachin & Craig, 1995). The communication process generally begins with a noxious stimulus which leads individuals to experience an internal state of pain. Next, the subjective state of pain is encoded in diverse patterns of verbal and nonverbal activity. This model recognizes that the pain experience of the encoder can be understood by another only through interpretation of its observable manifestations (Hadjistavropoulos, Craig, Hadjistavropoulos, & Poole, 1996). Using this behavioural information, along with other variables (i.e., medical status, life history, and current circumstances) (Hadjistavropoulos et al., 1996), the observer decodes information available from the encoding individual, a task which requires skill in both observation and interpretation of the pertinent sources of information (Prkachin & Craig, 1995). Caregivers
must not only attend to specific cues but must interpret these signs as reflecting pain, differentiating them from other states. Finally, once the caregiver has inferred that the individual is in pain, he or she must choose whether or not to intervene, and how to do so. Thus, the process of pain communication can be seen as a matter of information transmission from internal experience through pain behaviour to social interpretation. Individuals who have a stake in understanding, assessing and managing pain must achieve greater understanding of the interactive biological, psychological and social forces that affect each of these stages.

Social Factors

There is now considerable evidence that social factors influence the communication of pain, playing a role in pain experience and influencing both the perception of sensory intensity and the resulting pain behaviour (Koutanji, Pearce, & Oakley, 1998). It is currently recognized that interactions among psychological and social factors have a potent impact on pain experience and behaviours (e.g. Craig, 1986; Craig & Weiss, 1971; Fordyce, 1976; Levine & DeSimone, 1991; Prkachin & Craig, 1986). Studies of social modeling influences on pain behaviour demonstrate the sensitivity and plasticity of pain expression to the social context (Patrick, Craig, & Prkachin, 1986). Although variability in the facial and bodily expression of pain to comparable noxious events has frequently been observed across persons and situations (Beecher, 1959), the factors responsible for this variability have been difficult to pinpoint. Both verbal and nonverbal displays of pain are powerful elicitors of others' caretaking responses (e.g., Sternbach, 1968; Szasz, 1957). Important as such expressive behaviours may be to insuring the person's well being, relatively little is known about the variables which affect the encoding of pain. Ordinarily, it is to the encoder's advantage that
the experience be translated into an observable referent or message which could then be interpreted by someone in the social environment, a receiver (decoder), who could be in a position to make a difference for the sufferer. However, little is known about how social context impacts these observable messages. Demand characteristics of different social contexts may vary, with suppression of pain being expected in some situations and exaggeration of pain being the norm in other circumstances. For example, certain cultural and religious groups assert that pain is a character building experience (Craig et al., 1996). Pain expression may be viewed negatively in such situations, and therefore, manifesting pain behaviour could be viewed as maladaptive. On the other hand, if an insurance settlement required that an individual manifest evidence of injury, pain behaviours may be exaggerated. Although there is a superficial presumption in health care settings that claims of pain are faithful to the experience (Craig, Hill, & McMurtry, 1999), astute researchers and clinicians are aware that psychosocial factors can promote suppression or exaggeration of pain on the part of the encoder.

Encoding of Pain

Encoding of pain is likely based upon both innate factors and social learning experiences. From birth humans possess a well-developed repertoire of behaviours for expressing pain (Grunau & Craig, 1993). There are profound innate roots, as the newborn facial response to tissue damage is similar to that of older children and adults (Craig & Grunau, 1991; Grunau, Johnston, & Craig, 1990). Nevertheless, children become acculturated to display different patterns of pain and illness behaviour in conformity with family and cultural expectations (Craig & Wyckoff, 1987). The relatively global reflexive reactions of very young infants to tissue damage become shaped and transform during the
course of development into differentiated and socially responsive patterns of behaviour (Craig, McMahon, Morison, & Zaskow, 1984). It is not possible to postulate a simple dichotomous debate when it comes to innate and learned factors. There appear to be phylogenetic, ontogenetic, physiological, and functional levels of pain communication. Evolutionary preparedness for sending and receiving messages, ontogenetic development of interpersonal communication skills, physiological concomitants of various types of nonverbal interactions and the social function of nonverbal messages all contribute to communication (Segerstrale & Molnar, 1997). Current research in nonverbal communication shows an increasingly complex picture of human communicative ability as both biologically and socioculturally influenced.

Measurement of Pain

In order to better understand the influences of biological and psychosocial factors on the multidimensional experience of pain, it is beneficial to examine a number of domains of pain response (e.g., self-report, behavioural and physiological responses). Verbal self-report measures are widely used to assess pain in clinical settings (Jensen, 1997). Although self-report measures have been touted as the “gold standard” in pain assessment by some (Merskey & Bogduk, 1994), limitations have been noted by others (Jensen, 1997). In addition to verbal report, information about an individual’s present affect can be found in autonomic activity (e.g., heart rate), as well as motor activity (e.g. facial expressions, and withdrawal). Craig (1992) asserts that decisions about pain in both clinical settings and the everyday environment are heavily influenced by nonverbal communications. Nurses have reported that physiological signs and nonverbal behaviours are better indices of pain than patients’ verbal reports (Johnson, 1977) and judges tend to discount self-report when it is
inconsistent with nonverbal expression (Poole & Craig, 1992). Research indicates that nonverbal behaviours may be a more accurate source of information than verbal reports because they are less participant to motivated dissimulation (Kraut, 1978), and nonverbal displays appear less amenable to response bias (Craig & Prkachin, 1983). Hadjistavropoulos, Craig, Grunau, and Whitfield (1997) found that behavioural information was clearly an important variable in arriving at judgments on the severity of discomfort; procedural or contextual information concerning whether or not there had been tissue damage did not contribute uniquely to judgments of pain. Thus, both verbal and nonverbal communications have important clinical implications, conveying information about the affective experience of pain and influencing others’ responses to persons with pain (von Baeyer, Johnson, & McMillan, 1984).

Facial Display

Among the several nonverbal channels of information available to the observer, facial display appears to be the most useful in terms of availability, specificity and richness of information. The face is well prepared for nonverbal communication at birth, with all the important muscles needed for emotional expressions well developed (Ekman, 1982). Evidence supporting this assertion is available from primatological studies indicating homologies between primate and human facial expressions (Chevalier-Skolnikoff, 1973), human ethological research on facial expressions of blind and deaf children (Eibl-Eibesfeldt, 1989), identification of cultural universals (Eibl-Eibesfeldt, 1989), cross-cultural research on facial expressions (Ekman, 1973), and psychophysiology of the human face (Dimberg, 1982). Facial display is a particularly rich source of information because of its plasticity and dynamic range (Craig, Prkachin, & Grunau, 1992; Ekman & Friesen, 1975). The set of
facial changes described in adults and children as a response to painful stimuli appears to be specific to pain (Prkachin & Craig, 1995), but this has not been firmly established. Accumulating information on facial activity indicates it is the most sensitive and discriminating of the sources of information presently available (Hadjistavropoulos et al., 1997). Despite this empirical support, relatively little is known about the psychosocial factors that can impact the facial display of pain.

**Audience Effects**

It appears that measures of expressiveness in the presence of others may provide a sensitive indicator of important social processes. For example, “audience effects demonstrate the sensitivity of displays to the social context of their emission and have been widely noted in both nonhumans and humans” (Fridlund, 1994, p. 146). Audience effects require the presence of a triad of experimental factors: (1) a displayer, signaler or referrer (e.g., the participant), (2) the object of the display or the reference (e.g., the pain stimulus), and (3) an audience or referee (e.g., a confederate, peer, parent etc.). In effect the audience creates a social context in which a display may be emitted, and audience effects, when observed, indicate that the responses are context sensitive.

Researchers have shown that encoders may express pain differently while being observed or assessed as compared to when they are alone. Kleck and colleagues (1976) found that male participants were less expressive in response to painful electric shock (lower self-reports of pain, skin conductance, and observer reports of pain) when they believed themselves to be under observation than when they presumed themselves to be alone. More recently, Zeman and Garber (1996) found that type of audience (mother, father, peer, alone) influenced children's decisions to control or express their pain. Children listened to stories
and reported use of display rules, reasons for their decisions, and method of expression if the story had happened to them. Participants reported controlling their expression significantly more in the presence of peers than with either their mother or father or alone. Because pain assessments often occur in the presence of others (e.g., hospital patients may have family members and/or friends with them, or strangers may be present in a nearby bed), it is imperative to determine the impact of conditions varying in sociality on pain response. While such studies clearly demonstrate the effects of an audience on pain response, further research on this topic is needed to confirm these findings and provide information regarding how observable responses during pain activity should be interpreted.

Type of Audience

In the present study an unknown peer audience was chosen so a reliable approximately age, sex, and status matched sample could be established. The present investigation was similar to previous studies (e.g., Kleck et al., 1976; Zeman & Garber, 1996) in that the peer observing was not the elicitor of the pain displays. Thus, this study examined pain responses in the presence of a neutral observer or audience rather than the object of the display. Unlike previous studies where the audience viewed through a one-way mirror (Kleck et al., 1976) or was postulated about in a vignette study (Zeman & Garber, 1996), the peer audience was actually physically present in the same room as the participants in the explicit audience conditions of this study.

Pain responses of participants who are in the explicit presence of a peer were compared to responses from participants who underwent the cold pressor test while alone in the testing room (implicit audience condition). However, just because a participant was alone in a room did not mean that social factors were excluded. Fridlund (1994) asserts that
sociality can be implicit as well as explicit. For example, even when steps are taken to lead participants to believe that they are unobserved (e.g., using a hidden camera), the experimenters still may constitute an implicit audience. Furthermore, we often (1) treat ourselves as interactants (e.g., talking to ourselves), (2) act as if others are present when they are not (Chovil, 1991; Fridlund, 1991a); and (3) imagine that others are present when they are not (Fridlund, Kenworthy, & Jaffey, 1992; Fridlund et al., 1990; Fridlund, Schwartz, & Fowler, 1984; Wagner & Smith, 1991). These are just a sample of the reasons Fridlund (1994) used to buttress the implicit sociality view, which indicates that implicit or imaginal interactants can never be excluded. When subjects are alone rather than in the presence of others what differs is the directness, or the degree to which one’s social engagement is related to specifiable others, not necessarily the amount of sociality (which would be difficult to quantify because it is in fact subjective, and reliant on the participant).

**Audience Effects and Gender**

Evidence from research in primary care suggests that gender plays an important role in patient-caregiver communication (McCaffery & Ferrell, 1992). Awareness of how gender interacts with social context to influence pain responses could impact clinical pain assessment. Therefore, a secondary purpose of the present study was to explore whether pain response varied as a function of the gender of the participant and the audience. There is a precedent for gender differences in expression of pain in the presence of an audience for children. For example, Zeman and Garber (1996) found that girls reported that they would be significantly more likely than boys to express pain in the presence of an audience. This gender difference could indicate underlying biological differences or may reflect different socialization histories. For example, boys may have received more negative consequences
for expressing pain whereas girls could have received more support for emotional expressiveness and help-seeking. If this were the case, we would expect to see this pattern of results in adults. However, Kleck et al. (1976) only looked at a sample of male participants so no empirical data is yet available to confirm this hypothesis. The present study examined whether Zeman and Garber’s (1996) findings would be replicated in an adult population and Kleck et al. (1976)’s finding of no differential impact of audience gender on male participants’ pain responses could be extended to female participants’ responses.

Self-monitoring

A final goal of the study was to explore individual differences in the extent to which individuals can and do control expressive presentation. The Self-monitoring Scale (Snyder, 1974), a measure which differentiates individuals with respect to their tendency to observe and control their own expressive behaviour, was administered. According to Snyder (1974), the high self-monitor is concerned with the social appropriateness of her or his behaviour and actively manages it in response to social cues whereas the low self-monitor is less responsive to such cues and more responsive to internal states. Individuals high in self-monitoring are presumed to be better able to manage their expressions relative to the social situation (Snyder, 1974). The data were examined post-hoc to ensure that there are no significant differences in self-monitoring between the experimental groups.

Rationale

In sum, to the extent that pain responses are predicated upon impact on observers, it would be expected that different audiences would have a differential impact on the nature of the response. Although researchers have shown that encoders may express pain differently while being observed or assessed as compared to when they are alone (Kleck et al., 1976;
Zeman & Garber, 1996), details regarding the impact of an audience on specific parameters of pain response need to be explored in more detail. Kleck and colleagues (1976) only tested males, and observers were not visible to the participants. Furthermore, shock was used as the painful stimulus, which may elicit more of a startle component than other painful stimuli more equivalent to clinical pain which tends to be persistent, and enduring. Moreover, no detailed examination of nonverbal behaviour was conducted by Kleck et al. (1976). In addition, Zeman and Garber (1996) assessed only speculations of how children would behave in the presence of others, which is not necessarily reflective of what they would actually do. The present experiment attempts to overcome some of the limitations of previous studies by exploring the effects of being explicitly observed by same or opposite sex peers, on both male and female participants' self-report, behavioural, and physiological responses to the cold pressor test. Furthermore, this experiment provided a fine-grained analysis of facial display at the encoding level of processing with the comprehensive Facial Action Coding System (FACS; Ekman & Friesen, 1978) in an attempt to identify responses that were sensitive and specific to pain and the impact of social context on the display of pain.

METHOD

Participants

120 healthy undergraduate students (60 female, 60 male) between the ages of 18 and 29 years (M = 20.70 years, SD = 2.21 years) who participated in the study met inclusion criteria. Sample size was set at 120 based on estimates of the minimum sample size necessary to detect medium effect sizes with power set at .80 and alpha set at .05 (Cohen, 1988). Twenty-five participants identified their ethnicity as Caucasian, 82 as Asian, 10 as Indo-Canadian, and 3 as “other”. Participants who reported any suspicion regarding the
experimental manipulation, refused consent for release of their videotape or chose not to be observed by a confederate were excluded.

Apparatus and Materials

Cold Pressor

Pain stimulation was produced with the cold pressor apparatus. It used a commercially manufactured plastic cooler, measuring 23.5 cm wide, 43.5 cm long, and 28.0 cm deep, that was divided into two compartments by a plastic porous screen, with ice, water and a pump on one side and water on the other. There was an 11 cm by 11 cm square opening in the top on the ice-free side. The water was maintained at a constant temperature of 2 degrees Celsius (+/- 1 degree). A pump immersed in the tank continuously circulated the water to prevent local warming near the participant’s hand during the test. A ground fault circuit interrupter protected the pump’s power line. A plastic armband was positioned around the participant’s right arm just below the elbow joint so that when the participant inserted her or his hand into the tank, their hand was submerged up to the wristfold and the armband made contact with 2 microswitches that activated an electronic timer.

The cold pressor apparatus is a safe and widely used painful stimulus that meets the criteria important for experimental noxious stimulation (e.g., stimulus controllability, reliability, discriminability, convenience, and validity) (Hirsch & Liebert, 1998). Since it also presents no risk to participants, it has become a standard technique and is considered one of the most valid methods for inducing pain (Wolff, 1984; Wolff, Kantor & Cohen, 1976). Furthermore, cold pressor tonic pain can closely simulate the subjective properties of a wide variety of types of clinical pain (Chen, Dworkin, Haug, & Gehrig 1989).
**Timer**

A desktop electronic timing device attached to 2 microswitches placed near the opening of the cold pressor apparatus was used to measure the amount of time in seconds participants kept their hand submerged in the cold water.

**Heart Rate Monitor**

A Polar Accurex Plus™ Heart Rate Monitor was used to provide wireless, continuous and accurate heart rate measurement. It was used to noninvasively and automatically obtain a standard heart rate recording (beats per minute) from the participant every 5 seconds for the periods one minute prior to cold pressor, during cold pressor, and one minute after the cold pressor test. Polar Interface Plus™ with Training Advisor Software for Windows® was used to organize the data.

**Setting**

The experiment was conducted in a testing room adjacent to a control room in the Social Learning Laboratory at the University of British Columbia. Participants sat in the testing room. Their faces were recorded using a Sony Digital Hyper HAD colour videocamera placed in the control room on the opposite side of a one-way mirror which was partially obscured using curtains to allay the participant’s potential suspicions about being observed. The camera was attached to a Panasonic Time Date Generator [TDG] which imposed a time on the videotape recording. The TDG was connected to a Sharp colour television and a Panasonic Super VHS videocassette recorder with slow, freeze frame, as well as jog shuttle capabilities. Only visual information was recorded.
Dependent Measures

Pain Experience

Self-report

Participants were asked to rate the intensity and unpleasantness of their pain immediately following administration of the cold pressor test. It is standard to obtain single self-reports after a pain episode in studies of the relationship between facial expression and/or physiological measures with subjective measures of pain (Brown & Schwartz, 1980; Ekman & Rosenberg, 1997). Furthermore, the methods that do exist for measuring subjective experience on a relatively continuous basis may introduce artifacts (e.g., the constant demand to report on experience may interfere with the degree to which the participant becomes responsive to the stimulus; self-report during pain stimulation may increase self-consciousness and the sense of being observed which may alter expressivity as well as affect (Kleck et al., 1976); reports may interfere with facial display).

Intensity.

A visual analog scale [VAS] was used to measure pain sensation intensity. Participants marked the severity of their worst pain during the cold pressor test on a VAS 10-cm line anchored with endpoint labels “no pain” and “worst pain possible”. Scott and Huskisson (1976) reported that visual scales with clearly delineated end points that are 10 to 15 cm in length are least open to biases. The VAS is among the most widely used measures of pain (McGrath, 1990) and evidence suggests it is a reliable and valid ratio measure of pain intensity (Jensen & Karoly, 1992).

Unpleasantness.
A ratio scale of affective verbal pain descriptors (Gracely, McGrath & Dubner, 1978a, 1978b) was administered to assess the unpleasantness of cold pressor pain. Participants reported their worst pain over an interval defined by concrete events (e.g. between the start and finish of the cold pressor test). Ratings were made by selecting one of 13 ratio scaled adjectives depicting subjective experience of pain in the category of unpleasantness. The scale assessing perceived unpleasantness was anchored with the words “very intolerable” and “no discomfort.” The results of several experiments have demonstrated that ratio scales of sensory and affective verbal pain descriptors are valid, reliable and objective (Gracely et al., 1978a, 1978b).

Heart Rate

Physiological measures of heart rate were obtained for one minute prior to the onset of the pain stimulus, during the pain stimulus, and for one minute following cessation of the pain stimulus. Heart rate was chosen as a physiological measure because of practicality and reliability of continuous measurement and its demonstrated relation to pain. A 5 second recording interval was used and heart rate calculated as the number of beats per minute. The cardiovascular response was quantified as the arithmetic difference between measurements of heart rate obtained during participants’ exposure to the cold pressor test and the preceding baseline period recording. The maximum heart rate during baseline and the maximum heart rate during pain were selected as the units of analysis because not all participants kept their hand in the water for the same amount of time, and average heart rate scores might obviate differences. Using averaged measures could obscure differences between groups or create artifactual differences. For example, a participant whose tolerance time was 43 seconds might have higher heart rate scores than a subject who tolerated the cold for 180 seconds.
simply because there was generally more physiological reactivity at this time in the cold pressor test rather than at the 180 second end point.

Because arithmetic difference scores are occasionally correlated with baseline measurements (Manuck, 1994), baseline-adjusted or “residualized” change scores were calculated. Residualized change scores emphasize that portion of the interindividual variability seen in heart rate during the cold pressor test that cannot be predicted from a knowledge of the variability that exists in heart rate and among the same individuals in the absence of such pain stimulation (e.g., at rest).

**Behavioural Pain Tolerance**

Behavioural pain tolerance [BPT], the point at which a participant will terminate or withdraw from noxious stimulation (Wolff, 1984), was recorded. The total time in seconds from immersion to removal of the hand during the cold pressor test was considered that participant’s BPT score. A ceiling of 3 minutes was imposed to guard against negative consequences of exposure to cold, as has been done in previous studies using the cold pressor test (e.g. Chen, et al., 1989 – Study VI) and participants had knowledge of this when they began the experiment. If the participant did not terminate the pain stimulation by the time the cut-off point had been reached, the maximal level attained was taken as BPT.

**Facial Display**
Facial behaviour was videotaped continuously for one minute prior to the onset of the pain stimulus (cold pressor test), during the cold pressor test, and for one minute following cessation of the cold pressor test via a camera surreptitiously concealed behind a one-way mirror.

**Judges’ ratings of facial display.**

Four untrained observers (2 males, 2 females) viewed the videotapes of each participant’s facial behaviour during the baseline period and cold pressor test. The videotapes, which consisted of a frontal view of the participant’s face, were presented. Observers were instructed to make judgments of “individuals undergoing cold pressor pain in a laboratory situation”. Judges viewed the tapes in real time once and were not permitted to review any portions. Immediately after viewing each participant, observers rated the apparent intensity and unpleasantness of the participant’s pain using the same scales that participants had used to make their own ratings. They also judged the degree to which the participants expressed pain using global ratings of inexpressive, somewhat expressive and very expressive. The levels of expression were assigned values of 0, 1 or 2 respectively for quantitative analyses. Judges were not informed as to the experimental hypotheses or the observer manipulation.

**Facial Action Coding System.**

Facial display was coded using the Facial Action Coding System [FACS] (Ekman & Friesen, 1978), a widely used, comprehensive, atheoretical, anatomically based, observational system. FACS measures all visually discernible facial movements on the basis of 44 unique action units [AUs], as well as several categories of head and eye positions and movements. Based on precedent in the FACS literature (Hadjistavropoulos & Craig, 1994;
three sets of action units were combined to form new variables. AU 6 (cheek raiser) and AU 7 (lid tightener) were combined to form a variable, orbit tightening, because they have similar muscular bases. AU 9 (nose wrinkle) and AU 10 (upper lip raiser) were combined into levator contraction because these actions involve contractions of different strands of the levator labii muscles, resemble each other, have been hypothesized to represent different stages of the same expression (Prkachin & Mercer, 1989), and have been considered elements of a unitary expression in other research (Ekman & Friesen, 1978). Finally, AU 25 (mouth open), AU 26 (jaw drop) and AU 27 (mouth stretch), which represent different degrees of mouth opening, were combined into the variable of mouth open with three levels of intensity (1=lips part, 2=jaw drop, and 3=mouth stretch) (LaChapelle et al., 1999; Prkachin & Mercer, 1989).

Only a portion of the videotape collected was scored for the presence of facial action units specified by FACS. Up to seven periods each of 10 seconds in duration were coded for each subject. A 10-second period that occurred immediately prior to cold pressor test onset (Pre-cold pressor test period) was coded. During the cold pressor test the following 10-second periods were coded (if they were available): 0-10 (Pain Period 1), 30-40 (Pain Period 2), 60-70 (Pain Period 3), 90-100 (Pain Period 4), 120-130 (Pain Period 5), 150-160 (Pain Period 6). Facial actions were scored for these seven 10-second periods with each period further broken down into 5 2-second segments. Each AU was scored as present or absent during each segment. As well, the majority of actions were rated on a 6-point intensity scale (Friesen & Ekman, 1992), which varied from ‘no action’ (0) through ‘minimal action’ (a ‘trace’ coded as 1) to ‘maximal action’(5), following a priori criteria specified by FACS.
Those actions (e.g., blink) that did not lend themselves to an intensity rating were coded in a binary format as present (2) or absent (0).

Two coders, each of whom had undergone extensive FACS training, examined each videoclip. They had successfully met criteria for accurate and reliable scoring, and passed the test of proficiency devised by the developers of the system. The periods chosen from the tape for each participant were coded in random order with FACS coders blinded to the nature of each period being coded (e.g., they were unaware of experimental hypotheses, manipulations and participant demographics, with the obvious exceptions of sex, approximate age and a general idea of ethnicity). Coders were able to use slow motion and stop frame feedback while viewing the tapes. A randomly chosen 20% of all data was scored by a third coder, also certified in the use of FACS.

**The Self-Monitoring Scale**

The Self-Monitoring Scale [SMS] (Snyder, 1974) was used to assess individual differences in the social psychological construct of self-monitoring (self-observation and self-control guided by situational cues to social appropriateness) of expressive behaviour and self-presentation. The SMS has been reported to be an internally consistent, temporally stable self-report measure of individual differences in self-monitoring. John, Cheek and Klohnenn (1996) suggest that to adequately assess the conceptual domain of self-monitoring phenomena, researchers should administer the original 25-item SMS rather than the abbreviated 18-item SMS-R because the 25-item SMS version has greater discriminant validity.

**Suspiciousness Assessment Interview**
A semi-structured interview was created for the purpose of assessing whether or not subjects were suspicious of the experimental manipulations. Participants were asked how they heard about the study, and what they understood the purpose of the study to be. The experimenter probed for suspicions regarding being watched or videotaped, the peer who observed them, and the true purpose of the experiment.

Procedure

Written ethical approval to conduct the study was obtained from the University of British Columbia's Behavioural Research Ethics Board. Participants volunteered for the experiment using a sign up sheet posted in the Department of Psychology at the University of British Columbia. Once in the laboratory, participants were told that the investigator was interested in learning about subjective and physiological responses to cold. They were informed that the study would examine how individuals respond to a standardized experimental procedure, namely the cold pressor test, designed to simulate the sensations brought on by a painful medical procedure.

Each participant completed one session that lasted approximately 45 minutes. Each participant was run individually; no two participants were ever in the same room during testing. Each participant was randomly assigned to one of three experimental audience conditions (implicit, male, female). In the implicit audience condition, the participant was alone in the experimental room during the cold pressor test. In the explicit audience conditions, one male or female confederate observed the participant and the test stimuli to which the participant responded. Participants were blocked so that an equal number of males and females were assigned to each group. The confederates were 3 male and 3 female undergraduates. The experimenters were two female research assistants.
At the beginning of the session, a demographics questionnaire to collect information concerning the participant's background characteristics was administered. After this, the participant was connected to the Polar physiological recording apparatus, which monitored heart rate.

After attachment of the apparatus, the cold pressor test was explained. In both audience conditions, the confederate knocked on the door of the laboratory during the course of this explanation. The confederate posed as a fellow student coming to participate in the cold pressor study. Within earshot of the participant, the experimenter informed the confederate that they were early for their appointment and the next experimental session would begin shortly. The experimenter told the confederate that they could either return in approximately 10 minutes or wait in the laboratory. The experimenter informed the confederate that all the rooms in the laboratory were currently being used to run other experiments but they could, conditional on the current participant's permission, wait and watch the current experiment so they could listen to the instructions to save time. The experimenter obtained permission from participants to let the confederate observe the experiment.

The experimenter gave verbal instructions for the cold pressor test before it was administered. Participants were instructed to sit upright with limbs uncrossed and feet flat on the floor. They were instructed not to talk during the procedure because it could alter their heart rate. After the procedure was explained, the experimenter exited the testing room on the ruse that they needed to give further instructions to another participant filling out questionnaires in another room. Once the experimenter had left, the participant sat quietly for 1 minute while baseline measurements were obtained. Next, an audio cue signaled
participants to immerse their right hand up to the wristfold in 2 degree Celsius water. Stimulation continued for 3 minutes or until the participant terminated the test by removing his or her hand. After 3 minutes of the cold pressor test, the participant received an audio cue to withdraw his or her hand if they had not already done so. The cold pressor test methodology described here is similar to that used in previous research on pain (e.g., Craig & Patrick, 1985). The cold pressor test was followed by a one-minute period where the participant remained seated. Facial behaviour was videotaped via a camera surreptitiously concealed behind a one-way mirror. Heart rate was recorded continuously for five minutes starting at the baseline. In the male and female audience conditions, a confederate watched quietly and attentively throughout the cold pressor test. The confederate sat four feet from the participant and was positioned so he or she could observe both the participant and the cold pressor apparatus.

After the cold pressor test, the experimenter re-entered the testing room. She informed the confederate that an experimenter was ready to test them at that point, and directed them to another room in the lab. Participants were then asked to complete the following psychological measures: 1) Visual Analog Scale, 2) Verbal Descriptor Scale, and 3) Self-Monitoring Scale. Participants were given printed copies of these measures and instructions were delivered verbally as well as being printed next to the measures. The Self-Monitoring Scale was administered last in order to control for the possibility that it might arouse participants' suspicions of the confederate. After administration of the cold pressor test and the questionnaires, participants' reactions to the procedure were assessed through a semi-structured interview, which probed for suspicion regarding the experimental manipulations.
Upon completion of the tasks, special care was taken to conduct a sensitive and thorough verbal debriefing. The experimenter carefully explained why it was necessary to use deception in the study and answered any questions or discussed any concerns that the participant had. At this point, participants were informed that they had been videotaped, and written consent was obtained for the use of the recordings for scientific purposes. Participants were informed that if they did not want their facial display analyzed, the videotape would be erased in their presence, and they would receive full compensation for their time. Participants were provided with a copy of the consent form, a written debriefing, and a copy of the consent for videotape release form. As part of the debriefing, every participant was instructed not to discuss the study with other people who might subsequently participate. Finally, the individual’s value as a participant was emphasized, and she or he was compensated a participation credit for her or his time.

RESULTS

Data Screening

Prior to analysis, dependent variables were examined through various SPSS® programs for accuracy of data entry, missing values, and fit between their distributions and the assumptions of multivariate analysis.

Background Characteristics

Relationships among background characteristics and the independent variables of gender and condition were examined for the entire data set. Random assignment was used to control for individual differences. Separate between-groups 2 (gender: male versus female) by 3 (audience condition: implicit versus male versus female) factorial Analyses of Variance (ANOVAs) indicated no significant differences between groups in age, baseline heart rate, or
baseline FACS score. A chi-square analysis indicated no significant differences between groups in ethnicity.

A main effect of participant gender on self-monitoring was found, $F(1, 114) = 6.86$, $p < .01$, indicating that males had significantly higher self-monitoring scores ($M = 13.12$, $SD = 3.38$) than females ($M = 11.37$, $SD = 3.84$). Although the mean self-monitoring scores of males and females were significantly different, neither of the mean scores were considered to be high (>15) nor low (<9) according to precedent (e.g., Snyder, 1974). Furthermore, self-monitoring was not significantly correlated with self-reports of pain intensity ($r = -.15$) or unpleasantness ($r = -.17$), judges' reports of pain intensity ($r = .01$) or unpleasantness ($r = .05$), FACS frequency ($r = .14$) or intensity ($r = .14$) scores, residualized maximum heart rate ($r = -.16$), or behavioural pain tolerance ($r = -.04$) at the $\alpha = .05$ level (two-tailed). Because participants' self-monitoring scores did not differ between conditions, and were not significantly correlated with any other dependent variables of interest, the effects of self-monitoring were not covaried out in the following analyses.

**Facial Activity**

**Reliability**

Reliabilities of FACS coding and judges' ratings were determined. For FACS coding, a randomly selected 20% of all segments from participants were scored by two different certified coders. Inter-rater scoring reliability for this sample was calculated using the formula recommended by Ekman and Friesen (1978) which assesses the proportion of agreement on actions recorded by two coders relative to the total number of actions coded as occurring by each coder. Satisfactory reliability of the FACS scoring was demonstrated, with 86% reliability between the primary coder (95 participants) and the reliability coder, and
76% reliability between the secondary coder (25 participants) and the reliability coder. Percent agreement of 76% has been deemed satisfactory reliability of FACS scoring in a previous study by Craig, Hyde and Patrick (1991), and coincides with the reliabilities reported by Ekman and Friesen (1978) and Ekman, Friesen and Ancoli (1980).

For the 4 untrained observers' global ratings of participants' pain intensity and unpleasantness, interjudge reliability was calculated using a 2-way random effect model (participant and observer effects random) of consistency agreement. For intensity ratings, the average measure intraclass correlation was .88 \((F (3, 357) = 8.35, p < .001)\). For unpleasantness ratings, the average measure intraclass correlation was .76 \((F (3, 357) = 4.12, p < .001)\).

**Facial Action Data Preparation**

Frequency and percent occurrence were calculated for the FACS action units examined in the study. Initial analyses of the FACS data were conducted to establish which AUs were consistently observed during the segments. Because of the potentially large number of AUs scored, analyses of facial activity were restricted to those either occurring more often than 5% of the occasions on which they could have been observed among all participants and pain segments or had been found to be related to pain in earlier studies (Craig et al., 1991; Craig et al., 1992; see Table 3 in Hadjistavropoulos & Craig, 1994). Ten AUs remained after these exclusion criteria had been applied (see Table 1 and Appendix IV for descriptions). Each of the 10 AUs remaining for further analyses had shown a significant relationship with pain in previous research with adults: AU1 (inner brow raiser) (Craig et al., 1991), AU4 (brow lowerer) (Craig et al., 1991; LeResche, 1982; LeResche & Dworkin, 1988; Patrick, Craig, & Prkachin, 1986; Prkachin, 1992; Prkachin & Mercer,
Facial actions that met criteria were combined into composite scores for the purposes of analyses. First, the raw incidence of each AU for the 5 2-second segments within each period were summed in order to derive a single value for each AU for each period. There were 6 potential pain periods X 10 AUs = 60 potential AU/period summary scores per participant. Because not all participants kept their hand in the cold pressor for the full 3 minutes, data was not available for all periods for all participants. In order to have a single pain event score for each AU, the average of the scores for all the pain periods available was calculated. This procedure was applied to two data sets: (1) FACS frequency (individual cells contained frequency coding rather than intensities, thereby providing information regarding the presence or absence of the AU) and (2) FACS intensity (individual cells contained intensity coding divided by frequency coding).

Overview of Analyses

Dependent variables were grouped into self-report, nonverbal behaviour, and physiological categories and multivariate analyses of variance [MANOVAs] were performed. The factors in all MANOVAs refer to 2 (participant gender: male versus female) X 3 (audience condition: implicit audience versus explicit male audience versus explicit female condition)
audience). Consideration of power and robustness indicated that Pillai's trace was the most appropriate multivariate criterion. Pillai's trace was chosen over the more widely used Wilks' lambda criterion because Pillai's trace is more robust (e.g., significance level based on Pillai's trace is reasonably correct even when the assumptions are violated (Norusis, 1990)). When Pillai's trace criterion was significant, the multivariate tests were followed by an examination of univariate F-tests and Student Newman Keuls post hoc tests when appropriate to establish the source of the multivariate effect.

**Group Differences in Pain Responses**

**Self-report Measures**

A 2 (participant gender: male versus female) X 3 (audience condition: implicit versus explicit male versus explicit female) MANOVA was conducted to examine whether these variables influenced the following outcome measures of pain response: (a) self-reported verbal descriptor scale of pain unpleasantness; b) self-reported VAS ratings of pain intensity. See Table 2 for descriptive statistics. A multivariate main effect was found for audience condition, $F(4, 228) = 2.38, p = .05$. Univariate ANOVAs were conducted on the dependent variables, with alpha set at $0.05 / 2 = .025$ to reduce the risk of Type I error. Univariate analyses indicated that audience condition significantly influenced self-reported pain unpleasantness, $F(2, 114) = 4.32, p < .025$, but not self-reported pain intensity, $F(2, 114) = 2.52, p > .025$. Student Newman Keuls post hoc tests showed that individuals in the implicit condition rated their pain as more unpleasant compared to individuals who participated in the cold pressor test in the presence of either a male or female audience (see Table 3).

A multivariate main effect was found for participant gender, $F(2, 113) = 5.52, p < .01$. Univariate ANOVAs were conducted on the dependent variables, with alpha set at $0.05 / 2 =$
.025 to reduce the risk of Type I error. Univariate analyses indicated that participant gender was significantly related to self-reported pain intensity, $F(1, 114) = 11.13, p < .01$, but not self-reported pain unpleasantness, $F(1, 114) = 1.70, p > .025$. Using the VAS, female participants reported that their pain was more intense ($M = 7.12, SD = 1.33$) than male participants ($M = 6.09, SD = 2.01$). Finally, no significant multivariate interaction between audience condition and participant gender was observed $F(4, 228) = 1.22, p > .05$.

Physiological Measure

A 2 (participant gender: male versus female) X 3 (audience condition: implicit versus explicit male versus explicit female) ANOVA was conducted to examine whether these variables influenced residualized change scores emphasizing that portion of the interindividual variability seen in maximum heart rate during the cold pressor test that cannot be predicted from a knowledge of the variability that exists in maximum heart rate and among the same individuals in the one minute prior to the cold pressor test. The ANOVA indicated a significant main effect of audience condition on residualized maximum heart rate, $F(2, 114) = 4.19, p < .05$. Individuals in the implicit audience group ($M = 3.06, SD = 8.14$) had significantly higher maximum heart rates than individuals in the explicit male audience group ($M = -1.62, SD = 7.77$) or the explicit female audience group ($M = -1.44, SD = 8.51$) (see Table 3). Cell means and standard deviations for both the raw maximum heart rate scores and the residualized change scores are shown in Table 2. No main effect for participant gender, nor any interaction between audience condition and participant gender were observed.

Nonverbal Behavioural Measures

Behavioural Pain Tolerance
A 2 (participant gender: male versus female) X 3 (audience condition: implicit audience versus explicit male audience versus explicit female audience) ANOVA yielded no significant main effects of audience condition \([F (2, 114) = 1.67, p > .05]\) or gender \([F (1, 114) = 2.22, p > .05]\) nor interaction between the two variables \([F (2, 114) = 2.18, p > .05]\).

**Facial Display**

**Judges’ ratings of pain intensity and unpleasantness.**

A 2 (gender: male versus female) X 3 (condition: implicit versus male versus female) MANOVA was conducted to examine whether these variables influenced the following outcome measures of pain response (a) judges’ ratings of unpleasantness; (b) judges’ ratings of intensity. A multivariate main effect was found for audience condition, \(F (2, 228) = 6.41, p < .001\). Univariate ANOVAs were conducted on the dependent variables, with alpha set at \(.05 / 2 = .025\) to reduce the risk of Type I error. Univariate analyses indicated that audience condition significantly influenced judges’ ratings of pain unpleasantness, \(F (2, 114) = 11.87, p < .01\), and judges’ ratings of pain intensity, \(F (2, 114) = 13.40, p < .01\) (see Table 3). Student Newman Keuls post hoc tests indicated that judges rated individuals in the implicit audience condition as experiencing a higher degree of pain intensity and unpleasantness compared to individuals who participated in the cold pressor test in the presence of either an explicit male or female audience. The differences between the latter two conditions were not significant. No significant multivariate main effect was found for participant gender, \(F (2, 113) = 2.10, p > .05\). Finally, no multivariate interaction between audience condition and participant gender was found, \(F (4, 228) = 1.75, p > .05\). See Table 2 for descriptive statistics.

**Judges’ ratings of expressiveness.**
A chi square analysis indicated that audience condition was significantly related to judges’ global ratings of expressiveness (see Table 4) \( \chi^2 (4, N = 120) = 13.04, p < .05. \). In general, participants in the implicit audience condition were rated as more expressive than participants who were observed, with 13.3% of participants in the implicit audience group being classified as very expressive as compared to 4.2% of participants in the explicit male audience group and 4.2% of participants in the explicit female audience group. Furthermore, only 7.5% of participants in the implicit audience group were classified as inexpressive as compared to 15% of participants in the male audience group and 12.5% of participants in the female audience group. The percentage of individuals classified as somewhat expressive was similar for the implicit audience (12.5%), explicit male audience (14.2%), and explicit female audience (16.7%) groups.

**Intensity analyses.**

A 2 (participant gender: male versus female) X 3 (audience condition: implicit versus male versus female) MANOVA was conducted on the intensity data set with 10 AU/event summary scores (calculated by dividing the sum of intensity ratings (0-5) across the five 2-second segments for each AU by the sums of the frequency ratings (0-1) across the five 2-second segments for each AU coded using intensity, namely AUs 1, 4, 6/7, 9/10, 12, 17, 20, 25/26/27) as the dependent variables. See Table 5 for descriptive statistics associated with individual action units. A significant multivariate main effect was found for audience condition, \( F (16, 216) = 1.79, p < .05 \) (see Table 6). Tabachnick and Fidell (1989) suggest that when the design generates many main effects, a more liberal family-wise alpha of .15 can be used. Univariate ANOVAs were conducted on the dependent variables, with alpha set at \( .15 / 8 = .019 \) to reduce the risk of Type I error. Univariate analyses indicated that
audience condition only significantly influenced AU 9/10 (levator contraction), $F(2, 114) = 4.14, p < .019$. Student Newman Keuls post hoc tests indicated that the intensity of AU 10 during pain was significantly greater for individuals in the implicit audience condition as compared to individuals in the explicit male audience and female audience conditions. The differences between the latter two conditions were nonsignificant. If a less stringent alpha of .05 were used per test, AU4 (brow lowerer), $F(2, 114) = 3.20, p < .05$ would also have been influenced significantly by audience condition. Audience condition did not influence AU1 (inner brow raiser), AU6/7 (orbital tightening), AU12 (lip corner puller), AU17 (chin raiser), AU20 (lip stretcher), or AU25/26/27 (mouth open) at $\alpha = .05$.

No significant multivariate main effect was found for participant gender, $F(8, 107) = 1.17, p > .05$, and no significant multivariate interaction between audience condition and participant gender was observed $F(16, 216) = .97, p > .05$.

**Frequency analyses.**

A 2 (participant gender: male versus female) X 3 (audience condition: implicit versus male versus female) MANOVA was conducted on the frequency data set with the sums of the frequency ratings (0-1) across the five 2-second segments for each AU (10 AU/event summary scores) as the dependent variables. See Table 7 for descriptive statistics associated with individual action units. No significant multivariate main effects were found for audience condition, $F(20, 212) = .96, p > .05$, or gender, $F(10, 105) = 1.05, p > .05$ (see Table 8). Post hoc power analyses indicated that our sample size was sufficient to detect moderate effect sizes had they been present, with .73 and .52 probabilities of correctly retaining a true null hypothesis, respectively. No significant multivariate interaction between
audience condition and gender was observed $F(20, 212) = .85, p > .05$ with a .64 probability of correctly retaining a true null hypothesis.

**Exploratory Analyses**

Exploratory correlational analyses examining relationships among the dependent measures were conducted (see Table 9). Results indicated that participants' self-reports of pain intensity were significantly correlated with self-reports of unpleasantness and with behavioural pain tolerance. Self-reports of unpleasantness were also correlated with behavioural pain tolerance as well as with residualized heart rate, and judges' reports of intensity and unpleasantness. In addition, residualized heart rate was correlated with behavioural pain tolerance. All the measures of facial display correlated significantly with each other. Judges' ratings were also correlated with self-reported unpleasantness and behavioural pain tolerance. Overall FACS frequency scores were also correlated with behavioural pain tolerance.

Because correlations between overall FACS frequency and overall FACS intensity scores did not significantly correlate with self-reports, as in other studies (e.g., Prkachin, Berzins & Mercer, 1994), correlations between specific action units and self-reports of intensity and unpleasantness were examined. Analyses of FACS frequency data for individual AUs, indicated that no individual AUs were significantly correlated with self-reports of intensity at alpha = .05. Frequency of AU 9/10 was the only action that significantly correlated with self-reported unpleasantness ($r = .19, p < .05$). Analyses of FACS intensity data for individual AUs, indicated that only AU 1 was significantly correlated with self-reports of unpleasantness ($r = -.25, p < .01$). Only the FACS intensity score of AU 20 was significantly correlated with self-reports of intensity ($r = -.19, p < .05$).
Although these findings do not support the conclusions of researchers suggesting consistency between self-report measures and facial display measures (e.g., Prkachin et al., 1994), they do not negate them either. Craig et al. (1991) demonstrated that individuals can successfully inhibit their reactions during pain. They found that masked pain could not be discriminated from baseline activity for the majority of AUs FACS coded for frequency. Thus, the social context of the present experiment may contribute to the differential findings.

DISCUSSION

Audience Effects

An “audience effect is confirmed if the displays of an actor (the referrer) toward an object (the referent, either animate or inanimate) vary as a function of an audience (the referee)” (Fridlund, 1994, p. 146). In general, the present experiment indicated that the displays of the participants (the referers) toward the cold pressor (the referent), vary as a function of an audience (e.g., implicit referee versus explicit male referee versus explicit female referee). The results of the present study indicate that pain response is affected by the presence of an explicit audience as assessed by certain self-report, behavioural and physiological measures of pain but not all of them. For those measures that were significantly different, the general pattern was for responses to be attenuated.

Self-reports of Pain

The results suggest that the presence of an explicit audience significantly influenced self-reports of pain unpleasantness, but not pain intensity. The general trend was for participants in the implicit audience condition to report pain as being more emotionally severe than participants who were observed by a male or female audience. Using a ratio scaled verbal descriptor scale, individuals in the male and female audience conditions
reported that their pain experience was less unpleasant than those in the implicit audience condition. There was no differential impact of being observed by a male or female explicit audience. This result is consistent with Kleck et al., (1976)’s finding that self-reports of shock painfulness were significantly lower when participants were in the presence of an explicit audience than when they were alone, and that there was no impact of audience gender. Although there was a similar trend, audience condition did not significantly influence self-reported pain intensity as assessed by the VAS. This result diverges from Kleck et al., (1976)’s finding that self-reports of shock painfulness were significantly lower when participants were observed than when they were alone. However, Kleck et al. (1976) did not attempt to separate the impact on intensity and unpleasantness as done in the present study. It is possible that the differences found by Kleck et al. (1976) reflected the unpleasantness component of pain. Utilization of separate pain measures aimed at eliciting self-reports of intensity and unpleasantness independently may indicate the measures most sensitive to social context.

Theoretically, it is plausible that the presence of an audience may have a greater impact on self-reports of pain unpleasantness than intensity. Midway through the 20th century, theories of pain came to distinguish between sensory components that were deemed primary, causal, and antecedent to secondary or reactive qualities that reflected distress and subjective feelings (Beecher, 1959). The reactive component was construed as subject to influence by more than the sensory component. Craig (1995) reminds us that in addition to the affect central to the experience of pain, there are also emotional components of the pain experience that are provoked by concurrent events or things which can be brought to the situation. It is possible that the sensory intensity component of pain is less participant to the
social influence of observer presence than is the affective component of the experience. This might account for the different pattern of findings for self-report of pain intensity and unpleasantness.

**Physiological Responses**

As with self-reports of unpleasantness, and certain behavioural measures, physiological arousal was affected by audience condition. Participants’ residualized change heart rate scores were lower in the male and female audience conditions than in the implicit audience condition. This pattern of attenuated physiological response is consistent with the general decrease in phasic palmar skin conductance responses during painful stimuli when being observed found by Kleck et al. (1976). Observer gender had no effect on heart rate in the present study nor phasic skin responses in the Kleck et al. (1976) experiment. Furthermore, the results are congruent with theories and studies that suggest the general rule is for consistency among the various components of arousal and that modulations in behaviour can instigate parallel changes in associated subjective and autonomic components (Izard, 1971; Laird, 1974; Lanzetta, Cartwright-Smith, & Kleck, 1976).

**Nonverbal Behavioural Responses**

The pattern of group differences found for self-report ratings and physiological measures paralleled the changes in behaviour observed. Either responses were attenuated in the explicit male and female audience groups as compared to the implicit audience group, or no significant differences were observed.

**Behavioural Pain Tolerance**

Audience condition did not appear to impact behavioural tolerance times. Although there were individual differences in the time people withstood the cold pressor pain, with
some participants immersing their hand for the full 3 minutes and others withdrawing their hand from the cold pressor sooner, the experimental variables did not appear to affect behavioural pain tolerance. This result is consistent with the lack of differences found in self-reported pain intensity. In addition, behavioural pain tolerance times were significantly negatively correlated with self-reported pain intensity with those reporting more intense pain, tolerating the cold pressor test for a shorter amount of time.

Facial Display

In general, all ratings based on facial display present a relatively coherent picture, with participants in the implicit audience group tending to be more expressive than participants in the male audience group or female audience group as assessed by facial display measures. The present results suggest that the presence of an audience influences the encoding of pain in facial display, as the overwhelming majority of measures used to assess expressiveness (e.g., trained coders objective ratings of the intensity of specific facial actions, as well as untrained judges’ subjective ratings of pain intensity, unpleasantness and global expressiveness) suggested an impact of social context. The general pattern was for individuals in the implicit audience condition to be described as more expressive, exhibiting more intense facial actions typically associated with pain, and being judged to be experiencing pain as more intense and unpleasant than participants observed directly by a male or female audience. These results are consistent with self-reports of pain unpleasantness indicating that individuals who are being observed report less pain than those who are alone. Observed differences clearly reflect an impact of social context on communication of the pain experience (e.g., participants may manifest evidence of pain differently, exaggerating or suppressing according to their beliefs, or demands of the social
situation), but, irrespective of these additional psychosocial factors, there are systematic differences in pain expression mediated by the presence of others. These differences dictate further research determining whether these variations reflect actual differences in pain experience.

Judges' ratings of expressiveness.

Audience condition was significantly related to judges' global ratings of expressiveness. In general, participants in the implicit audience condition were rated as more expressive than participants who were observed. As well, more participants in the implicit audience group were classified as very expressive, as compared to participants in the explicit male and female audience groups. Finally, fewer participants in the implicit audience group were classified as inexpressive compared to participants in the male and female audience groups. These results are congruent with those of self-reported pain unpleasantness, and residualized heart rate, as well as the general pattern of results found by other researchers (e.g., Kleck et al., 1976; Zeman & Garber, 1996).

Judges' ratings of pain unpleasantness and intensity.

Judges ratings of participants' pain followed a similar pattern, with participants in the implicit audience condition judged to be experiencing pain that was more severe than participants who were in the explicit male or female audience conditions. Using the VAS, participants in the implicit audience condition were judged to experience their pain as significantly more intense than participants in the explicit audience conditions. Although judges’ ratings of intensity were not in line with participants’ subjective self-reports of intensity, which indicated no differences between audience conditions, the findings are consistent with the participant’s self-reports of pain unpleasantness. Furthermore, the pattern
of attenuated response when observed, is congruent with the pattern of self-reported and judge-rated pain intensity found by Kleck et al. (1976).

Using the ratio scaled Pain Unpleasantness Scale, participants in the implicit audience condition were judged to experience their pain as significantly more unpleasant than participants in the explicit audience conditions. Judges’ ratings of participants’ unpleasantness were congruent with participants’ self-reports. This pattern of attenuated response is intuitively in line with the findings of Kleck et al. (1976). Considering the high correlation between judges’ ratings of intensity and unpleasantness, it is questionable whether judges are able to distinguish between pain intensity and unpleasantness given only visual cues. Gracely and colleagues (Gracely et al., 1978; Gracely et al., 1979) have discussed the theoretical distinctness of intensity and unpleasantness cues with respect to self-report measures. Prkachin et al. (1994) suggest that although observers can make coarse distinctions among pain states, they are not especially sensitive.

While untrained judges were sensitive to the experimental manipulation, and results for judgments of unpleasantness were congruent with participants’ self-reports, judges also observed differences in pain intensity between implicit and explicit audience conditions that were not self-reported by participants using the VAS. It is possible that judges were responding to aspects of the display representing unpleasantness, or were unable to judge intensity without being influenced by this dimension. It also is possible that they were coding a more general negative emotion or distress display which differentiated between groups. The one AU that appeared to be significantly affected by audience presence was AU 9/10 which has been associated with disgust in previous research (LeResche & Dworkin 1988). Judges may have been influenced by this as their ratings of pain were significantly
correlated with FACS intensity scores. It may also be that more general patterns of activity are meaningful to observers and that situation context of the judgments plays an important role. Specifically, because the judges were looking for evidence of pain in the present experiment, any atypical facial display pattern may have been meaningful for them. Indeed, a difficulty with observers' judgments, aside from biases, is that they are global or based on an unknown weighting of specific cues. On the other hand, the global and integrative nature of such judgments may be an advantage in that differences between the audience conditions were captured by this measure.

**Intensity of facial actions.**

The results from the multivariate analysis examining the intensity of specific facial actions support this general pattern of attenuation of response in the presence of an audience. The present results suggest that audience condition influenced the intensity of facial actions typically associated with pain. More specifically, levator contraction (AU 9/10) was rated as significantly more intense (e.g., the upper lip drawn up to a larger extent with the central portion being raised higher than the lower portions) during pain for participants in the implicit audience condition as opposed to those in the male or female audience conditions. Interestingly, AU 10 has been associated not only with pain in previous studies (e.g., Prkachin, 1992) but also with disgust (LeResche & Dworkin 1988). This is important in light of the finding that the pattern of group differences in pain unpleasantness is similar to that of pain intensity as assessed by FACS. Though self-reported unpleasantness ratings were not highly correlated with overall FACS intensity scores, they were significantly correlated with intensity of levator contraction (AU9/10), and with observer judgments. Although there was a trend toward a similar pattern, audience condition did not influence the
intensity of inner brow raiser (AU1), brow lowerer (AU4), orbital tightening (AU6/7), lip corner puller (AU12), chin raiser (AU17), lip stretcher (AU20) or mouth open (AU25/26/27).

Frequency of facial actions.

The present results suggest that audience condition did not influence the frequency of 10 facial actions typically associated with pain. Specifically, the frequencies of occurrence of inner brow raiser (AU 1), brow lowerer (AU4), orbital tightening (AU6/7), levator contraction (AU 9/10), lip corner puller (AU12), chin raiser (AU17), lip stretcher (AU20), mouth open (AU25/26/27), eyes close (AU43), or blink (AU45) were not affected. These results are consistent with the lack of differences found in self-report ratings of pain intensity in the present study. It is possible that objective FACS coding of frequency may be a more accurate tool for evaluating the sensory intensity of the pain experience than FACS coding of intensity, or judges global ratings of intensity, if self-reports are considered the standard of truth. This is not likely the case, as self-report ratings of pain intensity were not significantly correlated with FACS frequency scores for individual AUs or for a summary variable including 10 AUs associated with pain. The FACS frequency data results are also consistent with the lack of differences found in behavioural pain tolerance and the two variables were correlated. The absence of significant differences in FACS frequency coding as a result of the audience manipulation is divergent from the general pattern of attenuating impact of direct audience conditions on facial display found by the present study.

If a valid and reliable facial display of pain exists, it would be intuitively expected that there would be some relation between facial actions coded using FACS and judges’ ratings. As judges were provided with tapes of facial display only, and so made their decisions based on this, it would have been expected that any differences between groups
observed by judges, would have been captured by the FACS frequency data. Although no significant differences in frequency of occurrence of AUs occurred as a result of the audience manipulation which was in contrast to the pattern found for other measures of facial display, FACS frequency scores and judges’ ratings were significantly correlated. Although this finding is consistent with the observation made by Prkachin et al. (1994) that facial actions were related to observers’ ratings of pain, the present results were not consistent with their suggestion that specific facial actions were more likely linked to self-reports than observer ratings. Prkachin et al. (1994) found that on several occasions self-reports but not observers’ ratings were significantly related to facial actions. They concluded that these results suggest that either cues on which observers could base their judgments were present but did not influence observers, or that movements other than those examined determined their judgments. In the present study, self-reports were correlated with neither overall FACS intensity nor frequency data. A few individual AUs were significantly correlated but these did not distinguish between audience groups. Self-reported pain unpleasantness was correlated with judges’ ratings of pain but these correlations were not as high as those with FACS data. The present study suggests that observer ratings appear to be more strongly related to facial actions than self-reports of pain.

FACS frequency coding did not capture the subtle differences that untrained judges were capable of detecting suggesting intensity of activity in this set of AUs was the key to their judgments. It is possible that FACS frequency pain scores reflect the presence of the painful experience and that FACS intensity scores reflect communication of affective distress. It is possible that what the judges detected was based on intensity rather than frequency.
FACS frequency ratings, behavioural pain tolerance and self-reported intensity ratings may reflect primarily the sensory aspects of pain to a greater degree than affective qualities. On the basis of their facial behaviour, individuals were judged to be experiencing less intense and unpleasant pain when under observation than when alone. Individuals also self-reported less unpleasant pain, and showed less arousal when observed. These expressive changes may reflect an acquired inhibitory response linked to the presence of others or a specific display rule regarding the expression of pain when under observation or may simply reflect a social communicative act. While the experimental manipulation did not affect behavioural pain tolerance, self-reports of pain intensity or frequency of pain-related facial actions as measured by the objectively coded FACS, these findings do not rule out the idea of an inhibitory response on affective qualities or a purposeful, deceptive, communication of less pain. It is possible that there are aspects of the pain response that are not so easily voluntarily controlled. FACS frequency coding may have captured those elements of the facial display that are reflexive, spontaneous or difficult to wholly suppress. In essence, this would make FACS frequency data the superior measure for assessing the internal sensory experience, which may not be as participant to the impact of social factors as the affective component of pain. It is possible that FACS frequency data were more adept at capturing the sensory intensity of the pain experience. When comparing the findings from FACS frequency data, we see that they were congruent with the lack of differences between groups found in participants' self-reports of intensity and behavioural tolerance. On the other hand, they are not correlated at all with self-reports of intensity so it is more likely that the measures were mediated in a similar manner (e.g., by sensation) rather than the fact that they influence each other. Thus, it is possible that the untrained judges were responding more to
the subjective differences in the unpleasant aspect of pain encoded by the participants. It is possible that the dominant impact of social context versus internal pain experience differs depending on the measure used to assess pain.

The overall pattern of findings implies that direct measurement of frequency of facial actions and behavioural pain tolerance may provide a more sensitive encoding of the subjective state of sensory pain intensity, while the subjective state of affective pain unpleasantness is better represented by global judgments of pain made by observers, FACS intensity scores, and heart rate. Further research examining relationships between specific facial actions and subjective ratings of unpleasantness versus intensity would be merited. That way, it might be possible to determine whether observers weigh the individual components of pain expression so as to be able to predict patients’ pain consistently.

**Audience Gender**

A second purpose of the present study was to explore whether pain response varied as a function of the gender of the explicit audience. Audience gender did not have a differential impact on participants’ pain responses. This finding was consistent with the lack of impact of observer gender on males’ pain responses found by Kleck et al. (1976) and with Izard’s (1971) proposition of a generalized socialized inhibition of expressive activity, which suggests that audience gender does not have a differential impact on the tendency to suppress responses to pain. It does not appear that male and female peer observers elicit different pain display strategies (Ekman & Friesen, 1969). While there appears to be no differential impact of audience gender when the observers are peers, this result may not be generalizable to all audiences. For example, audience gender may be more salient in certain situations (e.g., clinical, family) or may interact with other variables (e.g., professional status of the observer)
to impact responses. The results of the present study replicated the findings of Kleck et al. (1976) and extended them to female participants as well as males.

**Participant Gender**

One main effect of participant gender was observed. Specifically females' self-reports of pain intensity were higher than males' ratings. This is consistent with a general constant in the literature that, compared to females, males tend to rate experimentally applied stimuli as either less or equally painful (Kupers, 1997). An observed effect of gender can be interpreted in several ways. One interpretation is that there are gender differences in sensitivity to pain. Given the same pain stimulation, females appear to experience more pain than males. Berkley (1997) stressed that biological differences in reproductive organs constitute an additional route to trauma, infection and hyperalgesia for women, warranting sex differences in pain perception systems. It is also possible that pain sensitivity is the same for males and females, and psychosocial variables impact the way they communicate their experience. In the present study, the gender difference in self-reported pain intensity more likely reflects how pain is interpreted and reported in a particular social context rather than an underlying difference in the experience of the cold pressor test as no gender differences were observed in measures other than self-reported pain intensity. The gender difference may be related to the main effect of participant gender on self-monitoring that was found indicating that males had significantly higher self-monitoring scores than females. However, it would be expected that, if differences in self-monitoring were meaningfully involved, then differences in expressive behaviour would also have been observed. For example, males may have shown more attenuated behaviour than females. Although this was not borne out in the present study, this may have been due to a floor effect in that both males and females
inhibited nonverbal activity to such a great extent in the presence of an explicit audience that there was no room for gender differences to be observed.

The present study suggests that there are no gender differences in the actual pattern of facial display in response to pain (as assessed by objective FACS coding and observer ratings of pain based on facial display). These results are consistent with those of Craig et al. (1991) who observed no differences between male and female chronic lowback pain patients reacting to a movement exacerbating persistent pain using FACS. Both biological mechanisms and psychosocial factors should be studied further to explain differences in the experience and the meaning of pain between males and females (Unruh, 1996).

**Interactions Between Participant Gender and Audience Condition**

No interactions between participant gender and audience condition were observed. In the present experiment gender was classified according to participants' identification of themselves as male or female. It is possible that classification of gender using a more specific measure such as the Bem Sex Role Inventory (Bem, 1974) might reveal gender differences and their interaction with social context. In addition, the sample studied was a relatively homogenous group of young adults. If a more diverse group of individuals had been sampled, including people of varying ages, socioeconomic status, and education levels, interactions between gender and audience condition may have been observed. Furthermore, only female research assistants were available to collect the data. It is possible that a 3 way interaction between audience condition, participant gender, and experimenter gender would have been observed if the latter variable had been available for study. Future research is needed to determine whether the present findings, which indicated that participant gender did
not interact with the audience conditions examined, can be generalized to other samples, audiences, and situations.

**Self-monitoring**

A final goal of the study was to control for individual differences in nonverbal expressions of pain as a function of social context through random assignment to groups. A manipulation check indicated there were no significant differences in self-monitoring between the audience groups. Furthermore, the trait factor of self-monitoring (as defined by Snyder, 1974) showed no statistically significant correlation with any of the dependent measures used in the present study. These results converge with the lack of impact of self-monitoring classification on pain responses found by Kleck et al. (1976). Either no true difference exists, or the measure employed in this report is not psychometrically adequate. This is not to say the degree to which an individual wants to please an experimenter or monitors their behaviour in response to a social situation never influences pain response. Since instructions provided along with the cold pressor test can influence behavioural tolerance time (Hirsch & Liebert, 1998), it is possible that future research examining how the degree to which the experimenter or audience expresses desire for the subject to respond in particular ways influences pain responses could elicit trait differences. However, in general, self-monitoring does not appear to be an important predictor of pain responses.

**Theoretical Implications**

The present results contribute to, but do not resolve, the debate about whether facial displays are better viewed as symptoms of inner states or communications of intent mediated by the presence of others and independent of a concurrent emotional state. This debate is primarily fueled by its relation to emotion. While pain has an emotional component, it also
has potent sensory aspects. Thus, findings relating to pain can contribute to but never resolve
the discussion over facial expressions of emotion. The results of the present study bear on
the more general issues about effects of audiences on pain responses. The study of pain
behaviour was initiated in part to shed light on these broader issues, and in that context the
results of the present study are relevant. However, it would be overzealous to take our
laboratory findings as a basis for making direct predictions about facial expression in general.

It is apparent that the presence of an observer does impact how the individual in pain
encodes their experience in behaviour. Untrained observers were able to distinguish
participants in the three audience conditions based on observing their facial displays.
However, although the presence of an audience clearly affected the communication of pain, it
is difficult to ascertain at what point in the social transmission of information its influence
was exerted. Because pain is a subjective experience (Bonica, 1979), we only ever have
access to indirect measures of it. Even self-report measures are not direct pipelines into inner
experience and are subject to biases and demand characteristics just as nonverbal measures
are (some would say, self-report measures are even more amenable to impression
management). Thus, having measures from various domains of pain communication is
useful in trying to determine how the presence of an audience impacts pain.

We propose several possible reasons different audiences affect certain responses to
acute pain, although these explanations are not mutually exclusive. Firstly, the presence of
an observer may shape the internal experience of pain, which leads to differences in the
encoding of pain and eventually the decoding of pain. In this case, the measures influenced
by audience condition would be interpreted to reflect changes in the participants’ actual
internal experience of pain. For example, it is possible that audiences make performers more
self-aware (Butler & Baumeister, 1998). With increased self-awareness, the participant may easily imagine watching himself or herself from the audience's perspective, so the outcome is doubly significant to the participant. Greater pressure could set off stress-induced analgesia which might lead to reduced internal pain experience (Vaccarino, Marek, & Liebeskind, 1992) and eventually less manifest evidence of pain. However, if this pattern of threat and pressure were operating in our experimental situation, we would have expected to find some evidence of decreased pain intensity in the conditions where participants were being observed and increased negative feelings associated with audiences. Instead, our data showed that participants rated the cold pressor experience as less unpleasant in the presence of an audience, and no differences in intensity as assessed by subjective self-report or frequency of facial actions coded using FACS were noted. It is possible that, rather than increasing self-awareness, the audience was distracting which can be an effective coping strategy in certain acute pain situations (McCaul & Malott, 1984). Thus, the difference could be explained by decreased internal pain as a result of some aspect of the sociality of the situation, which then impacted the encoding of the pain experience, and eventually the decoding of the pain.

Although individuals' subjective ratings of pain unpleasantness were attenuated in the presence of an explicit audience, and this pattern was paralleled in a number of other measures, it is impossible to definitively conclude that the social context directly impacted the pain experience itself (regardless of whether it impacted the sensory or affective qualities). Another interpretation of the findings is that the presence of an audience directly impacts the encoding of pain but does not affect the internal experience of pain. In this case, the internal experience of the sufferer would not be affected by the social context, but they
would communicate their experience differently because of the demands of the social context. Such an explanation would accommodate the present findings in that not all of the measures obtained were affected by the social context. It would be expected that if the encoding of pain was merely a readout of internal states, then all the measures would be similarly affected by an underlying change.

Finally, it is possible that the presence of an audience impacts the encoding of pain first, and then indirectly affects internal experience through a feedback loop. For example, the facial feedback hypothesis of emotional experience (Adelmann & Zajonc, 1989), if generalized to pain, suggests that attenuation of facial display reduces the subjective experience of painful distress (Lanzetta, Cartwright-Smith, & Kleck, 1976). It is possible that the presence of an explicit audience directly impacted the way pain was encoded (e.g., led to the attenuation of facial behaviour as measured by judges’ ratings of pain and FACS intensity ratings) which then influenced the internal experience of pain. Although decreased severity of pain as assessed by facial display was not related to decreased self-reported pain intensity, it was related to decreased pain unpleasantness. This is interesting because measures of unpleasantness reflect the more affective component of pain, and empirical evidence to support the facial-feedback hypothesis has focused on emotions.

Lanzetta et al. (1976) found that individuals instructed to intensify or attenuate facial responses to painful stimuli showed parallel changes in autonomic and subjective indicators of distress. Kleck et al. (1976) replicated the attenuation effects found by Lanzetta et al. (1976) under conditions in which the participants were not instructed to alter their expressive behaviour. It appears that expressive behavioural changes, regardless of the origin of their production (e.g., produced by voluntary compliance with instructions or induced by
modifications in social cues), can evoke congruent changes in autonomic arousal and subjective reactions to pain stimuli. The facial feedback hypothesis provides a plausible explanation for the results of earlier studies as well as the present data. At the very least, it must be underscored that the communication of pain is not merely a simple, linear transfer of information from the person in pain, through encoding, to the social environment. The process can be affected by various internal and social factors, and feedback loops are likely operating. Thus, the process of pain communication is complex, and pinpointing where audience effects intervene in the process is a difficult task.

The results of the present study suggest that regardless of when in the process of pain communication observer presence has the most impact (e.g., does it affect internal experience or encoding of that experience), it appears that measures attempting to quantify the emotional aspects of pain (e.g., verbal descriptors of pain unpleasantness) may be more reliably affected by the social context than measures of the sensory component (e.g., VAS ratings of pain intensity). The sensitivity of pain behaviour to the immediate context of a situation implies subtle variations in the individual’s emotional reaction. The operant perspective (Fordyce, 1976; Keefe & Dunsmore, 1992) illustrates the shaping impact of social influence and reinforcement mechanisms on pain behaviour. The evolutionary perspective suggests that the pain system has the capacity to interrupt ongoing activity, and demands and maintains attention, with affective distress its most salient feature (Craig, 1995). The captured attention should allow the organism to solve the urgent crisis through defensive behaviour, escape, and efforts to recuperate. From this perspective, the sensory changes instigated by noxious stimuli operate to capture the attention of the organism, and the emotional responses would reflect dispositions to defensive action (Craig, 1995). Certainly, if sensation serves to focus
the organism's affection, emotional responses may serve as social signals to others. Following this logic, it seems likely that manifest evidence of pain might be linked to the underlying affective (unpleasant) dimension. While studies have shown that variations in facial display of pain have been associated with the severity of pain experienced (Patrick et al., 1986; Prkachin & Mercer, 1989), it is still possible that manifest behavioural responses reflect the potential increase in affective distress that may accompany increases in pain severity or intensity. The sensory experience may give rise to the emotional distress with pain, but the emotional distress may also impact the sensory experience. More research is needed to determine what factors differentially influence the various qualities, and what their separate and interactive contributions are to the overall experience of pain. Identification of such factors could contribute to the development of interventions that selectively modify features of the overall pain experience (Craig, 1995). It appears that the affective distress so integral to the experience of pain, is influenced by the presence of an audience, and reflected in self-reports of pain unpleasantness, judges' ratings of pain and certain facial actions. Addressing emotional features of the individual's experience of pain could lead to greater understanding of the substantial individual differences and varying needs for treatment in response to apparently similar nociceptive events.

Summary

In sum, these results indicate that the subjective quality of participants' pain experiences was influenced by the sociality of the situation (e.g., presence versus absence of an observer), and that this effect impacted the translation of the subjective experience into manifest evidence of pain, as assessed by certain measures of pain. Despite this, other measures appeared to be unaffected by the social context in which pain was experienced.
It could be argued that FACS frequency scores, and behavioural pain tolerance may be the least influenced by social context. No differences between groups were observed on either of these measures. Similarly, no effect of social context on self-reported intensity was observed, which might suggest that these measures may be more related to a common component of the pain experience (e.g., the sensory component). The measures that reflected change as a result of audience presence may be mediated more by the affective component of pain.

Limitations

Several qualifications to the present findings should be noted. Firstly, our pain measures as well as our theorizing were all linked to acute pain experience. Although the ability of the cold pressor test to model the human painful experience has been well demonstrated (see Chen et al., 1989), its ability to elicit the same emotional and cognitive mediators has not been firmly established. Participants in the present experiment knew that their painful stimulus would terminate and that no harm would come to them. Although we found consistent evidence that the presence of an audience may reduce the amount of subjectively experienced pain unpleasantness, it is entirely plausible that those same audiences would not change subjective reports of chronic pain. Thus, our conclusions about the impact of an audience on pain response may not generalize to all types of pain or clinical settings.

The specific procedures used in the present study may also limit generalizability. For example, the instructions given prior to the cold pressor test could influence pain response. Thorn and Williams (1989) found that subjects given specific time goals on an acute pain task demonstrated increased pain tolerance and lower pain ratings. Hirsch and Liebert (1998)
showed that the words used to describe the test (e.g., discomfort, pain, vasoconstriction pain) could influence pain response. Finally, the pain measures chosen, frequency with which ratings were obtained (Mikail, Vandeursen & von Baeyer, 1986), and the time ratings were elicited could all impact the results. Moreover, once obtained, the measures do not reflect differences in terms of the duration of the pain stimulus. However, behavioural pain tolerance did not differ significantly between groups so the effects should be balanced out across groups.

In addition, although we found evidence consistent with previous research indicating that the presence of an audience may attenuate certain pain responses (Kleck et al., 1976; Zeman & Garber, 1996), it is entirely plausible that different audiences would impact pain behaviour differentially. The role and status of the observer in the situation relative to the encoder are important variables. In the present study, the effect of being observed by a same- or opposite-sex peer on pain behaviour was investigated. Peers were chosen as observers to establish a foundation on which future studies could build; a reliable age, sex, and status matched sample needs to be established before other variables which are more difficult to quantify and convey in an experimental session can be explored. However, in the implicit condition, the exact nature of the audience was not controlled. The person could have been thinking about anyone or anything during the cold pressor test. For example, the implicit audience may have been the experimenter or a peer. Fortunately, in the present study, the experimenters were both students within the age range of participants studied so this should not present too large of a confound. Studies by Schachter (1959) have suggested that similarity affects the tendencies to choose to affiliate with others under stress, and the stress-reducing power of the other. Similarity may also mediate the effects of others' presence
upon pain behaviour. In the audience effects literature on emotional expression, interesting research has been conducted exploring the differences between strangers and friends (Hess, Banse & Kappas, 1995). Future research must examine audience variables such as status, ethnicity, social relationship, and support (e.g., supportive versus neutral versus hostile audience).

Finally, the interaction of different audience conditions with participant variables needs to be further examined. Given that healthy undergraduate students between the ages of 18 and 29 were used, the results may not be generalizable to other samples such as community subjects or individuals of different ages. Moreover, the ethnicity of participants in the present sample is different from the largely Caucasian samples that have been studied previously. Unfortunately, adequate power was not available to examine the impact of ethnicity on pain response, or investigate the interactions between participant, audience, and observers' ethnicity. Although the pattern of results are mostly consistent with those of previous studies (e.g., Kleck et al., 1976), the present findings may not generalize to all audience, participant or observer populations. Random assignment resulted in a balanced number of participants from various ethnic backgrounds within each of the groups. However the proportion of individuals from different ethnic backgrounds within groups (e.g., more Asians than Caucasians) could impact the comparability of the present study to other research. There exists a diversity of opinion in research on pain regarding whether various aspects of pain are universal (i.e., inherent and immutable) or predominantly cultural (Craig, 1995). It has been proposed that the experience of pain has elements of social construction (Craig, 1986), thus it is possible that cultural determinants may be important in pain. Future
studies would benefit from detailed examination of the role of ethnicity in the communication of pain.

**Future Directions**

More research is necessary as failure to consider social context, including who is present, when assessing pain could lead to inaccurate perception of the person in pain (false negatives and false positives), which may result in a number of undesirable consequences including unnecessary suffering and medical complications, as well as fear and distrust of health care providers (Ross, Bush & Crummette, 1991). Consequently, examining how the presence of audiences of different ages, attractiveness, gender, status, ethnicity, relationship to the individual in pain, among other variables, may influence the encoding of pain could lead to improved care for suffering individuals.

**Conclusion**

People are often faced with the need to report their pain in public settings where observers are present. Moreover, clinicians, researchers, and lay people must frequently evaluate the pain of individuals who are integrated in a social context. The results from the present study provided insight into the impact of audience on pain responses and explored the validity of the measurement of the pain state offered by its behavioural referents, heart rate and self-reports. Different audiences appeared to have an impact on how pain unpleasantness was self-reported. Furthermore, untrained observers appeared to be sensitive to the differences in participants' facial display between conditions. Despite this, no differences in self-reports of intensity, or frequency of facial display as assessed by FACS were found. Females reported the pain experience to be more intense than males, but other than this, no gender differences or interactions with audience condition were observed. The results of the
present study and previous research provide some insight into how social context and gender can confound or provide clues to measurement issues.

Understanding how gender and audience affect the transmission from internal experience to pain behaviour to interpretation of that behaviour by an observer is especially crucial for those who have a stake in understanding the regulation and consequences of pain behaviour. The communications model of pain which has room to include such influences can provide a basis for education and other interventions aimed at improving health care providers’ assessment and management of pain. In sum, explication of the variables that influence the encoding, display and decoding of pain has implications for biopsychosocial theories of pain as well as current clinical practice. In the future, the information gleaned from this project may be used to extend the current focus on biological parameters of pain to incorporate psychological and social parameters, to provide further details of the encoding level of processing in the communications model of pain, and to improve pain assessment and management techniques.
REFERENCES


<table>
<thead>
<tr>
<th>Facial Action Unit</th>
<th>Description</th>
<th>Percent</th>
<th>Coding</th>
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<tbody>
<tr>
<td>1</td>
<td>Inner brow raiser</td>
<td>4.52 b</td>
<td>Intensity</td>
</tr>
<tr>
<td>4</td>
<td>Brow lowerer</td>
<td>4.28 b</td>
<td>Intensity</td>
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<td>6/7</td>
<td>Orbital tightening</td>
<td>5.76</td>
<td>Intensity</td>
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<td>9/10</td>
<td>Levator contraction</td>
<td>5.33</td>
<td>Intensity</td>
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<tr>
<td>12</td>
<td>Lip corner puller</td>
<td>10.36</td>
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<td>17</td>
<td>Chin raiser</td>
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<td>25/26/27</td>
<td>Mouth open</td>
<td>11.61</td>
<td>Intensity</td>
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<td>43</td>
<td>Eyes closed</td>
<td>5.36</td>
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<td>45</td>
<td>Blink</td>
<td>38.37</td>
<td>Frequency</td>
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\(^a\) Percent denotes the percentage coded of the occasions on which the action could have been observed among all participants and pain segments.

\(^b\) Action included because of prior evidence of an association with pain
Table 2

Means (Standard Deviations) of Scores on the Various Dependent Measures as a function of Audience Condition and Participant Gender

<table>
<thead>
<tr>
<th>Pain Measure</th>
<th>Participant Gender</th>
<th>Implicit (n = 40)</th>
<th>Male (n = 40)</th>
<th>Female (n = 40)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Self-reported intensity</td>
<td>Males (n = 60)</td>
<td>6.76 (1.72)</td>
<td>5.36 (2.24)</td>
<td>6.15 (1.90)</td>
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<td></td>
<td>Females (n = 60)</td>
<td>7.40 (1.41)</td>
<td>7.27 (.78)</td>
<td>6.65 (1.59)</td>
</tr>
<tr>
<td>Self-reported unpleasantness*</td>
<td>Males (n = 60)</td>
<td>21.14 (11.28)</td>
<td>14.78 (10.20)</td>
<td>17.02 (9.41)</td>
</tr>
<tr>
<td></td>
<td>Females (n = 60)</td>
<td>24.36 (12.17)</td>
<td>17.97 (10.35)</td>
<td>17.99 (8.13)</td>
</tr>
<tr>
<td>Judges’ ratings of intensity*</td>
<td>Males (n = 60)</td>
<td>5.60 (2.13)</td>
<td>3.83 (1.62)</td>
<td>3.59 (1.43)</td>
</tr>
<tr>
<td></td>
<td>Females (n = 60)</td>
<td>5.13 (2.15)</td>
<td>3.55 (1.56)</td>
<td>3.54 (1.39)</td>
</tr>
<tr>
<td>Judges’ ratings of unpleasantness*</td>
<td>Males (n = 60)</td>
<td>13.49 (7.30)</td>
<td>6.97 (3.88)</td>
<td>7.57 (4.18)</td>
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<tr>
<td></td>
<td>Females (n = 60)</td>
<td>13.11 (9.27)</td>
<td>9.40 (5.73)</td>
<td>6.70 (3.96)</td>
</tr>
<tr>
<td>Heart Rate Residualized Change*</td>
<td>Males (n = 60)</td>
<td>2.72 (7.63)</td>
<td>-.41 (8.79)</td>
<td>-.26 (8.91)</td>
</tr>
<tr>
<td></td>
<td>Females (n = 60)</td>
<td>3.40 (8.81)</td>
<td>-2.82 (6.60)</td>
<td>-.19 (8.14)</td>
</tr>
<tr>
<td>Heart Rate Raw Scores</td>
<td>Males (n = 60)</td>
<td>101.65 (13.22)</td>
<td>97.80 (15.17)</td>
<td>91.30 (14.17)</td>
</tr>
<tr>
<td></td>
<td>Females (n = 60)</td>
<td>Males (n = 60)</td>
<td>Females (n = 60)</td>
<td></td>
</tr>
<tr>
<td>---------------------</td>
<td>------------------</td>
<td>----------------</td>
<td>------------------</td>
<td></td>
</tr>
<tr>
<td>Behavioural Pain Tolerance</td>
<td>104.10 (10.58)</td>
<td>167.11 (55.59)</td>
<td>174.68 (51.25)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>100.30 (16.63)</td>
<td>160.08 (60.21)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>98.40 (11.99)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*p < .05
Table 3

Means (Standard Deviations) of Scores on the Various Dependent Measures as a function of Audience Condition

<table>
<thead>
<tr>
<th>Pain Measure</th>
<th>Audience Condition</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No Observer (n = 40)</td>
</tr>
<tr>
<td>Self-reported intensity</td>
<td>7.08a (1.56)</td>
</tr>
<tr>
<td>Self-reported unpleasantness*</td>
<td>22.75a (11.70)</td>
</tr>
<tr>
<td>Judges’ ratings of intensity*</td>
<td>5.37a (2.13)</td>
</tr>
<tr>
<td>Judges’ ratings of unpleasantness*</td>
<td>13.30a (8.24)</td>
</tr>
<tr>
<td>Heart Rate Residualized Change*</td>
<td>3.06a (8.14)</td>
</tr>
<tr>
<td>FACS intensity summary score</td>
<td>9.88a (8.29)</td>
</tr>
<tr>
<td>Behavioural Tolerance</td>
<td>144.47a (70.46)</td>
</tr>
</tbody>
</table>

Note. Means in the same row that do not share subscripts differ at p < .05 in the Student Newman Keuls post hoc comparisons.
* p < .05, ** p < .01, *** p < .001
Table 4

Number of participants in each audience condition rated by judges to be inexpressive, somewhat expressive, or very expressive

<table>
<thead>
<tr>
<th>Audience Condition</th>
<th>Judges' Ratings of Expressiveness</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Inexpressive</td>
</tr>
<tr>
<td>Implicit</td>
<td>9</td>
</tr>
<tr>
<td>Male</td>
<td>18</td>
</tr>
<tr>
<td>Female</td>
<td>15</td>
</tr>
</tbody>
</table>
Table 5

Means (Standard Deviations) of FACS Intensity Scores as a function of Audience Condition and Participant Gender

<table>
<thead>
<tr>
<th>Facial Action</th>
<th>Implicit (n = 40)</th>
<th>Male (n = 40)</th>
<th>Female (n = 40)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 (Inner brow raiser)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Males (n=60)</td>
<td>.80 (.95)</td>
<td>.73 (.94)</td>
<td>.75 (.97)</td>
</tr>
<tr>
<td>Females (n=60)</td>
<td>.50 (.89)</td>
<td>.70 (.98)</td>
<td>.55 (.83)</td>
</tr>
<tr>
<td>4 (Brow lowerer)*</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Males (n=60)</td>
<td>.95 (1.10)</td>
<td>.43 (.79)</td>
<td>.80 (1.01)</td>
</tr>
<tr>
<td>Females (n=60)</td>
<td>.60 (.94)</td>
<td>.20 (.62)</td>
<td>.71 (.99)</td>
</tr>
<tr>
<td>6/7 (Orbital tighten)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Males (n=60)</td>
<td>.98 (1.15)</td>
<td>.49 (.87)</td>
<td>.68 (.95)</td>
</tr>
<tr>
<td>Females (n=60)</td>
<td>.80 (1.01)</td>
<td>.80 (1.01)</td>
<td>.88 (1.12)</td>
</tr>
<tr>
<td>9/10 (Levator contraction)*</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Males (n=60)</td>
<td>1.38 (1.49)</td>
<td>.50 (.95)</td>
<td>.55 (1.05)</td>
</tr>
<tr>
<td>Females (n=60)</td>
<td>1.13 (1.47)</td>
<td>.68 (1.10)</td>
<td>.63 (.99)</td>
</tr>
<tr>
<td>12 (Lip corner pull)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Males (n=60)</td>
<td>.68 (.96)</td>
<td>.60 (.94)</td>
<td>.84 (1.13)</td>
</tr>
<tr>
<td>Females (n=60)</td>
<td>.72 (1.04)</td>
<td>1.10 (1.09)</td>
<td>1.22 (1.22)</td>
</tr>
<tr>
<td>17 (Chin raiser)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Males (n=60)</td>
<td>.55 (1.15)</td>
<td>.30 (.73)</td>
<td>.10 (.45)</td>
</tr>
<tr>
<td>Females (n=60)</td>
<td>.10 (.45)</td>
<td>.30 (.73)</td>
<td>.14 (.62)</td>
</tr>
<tr>
<td></td>
<td>Males (n=60)</td>
<td>Females (n=60)</td>
<td></td>
</tr>
<tr>
<td>----------------</td>
<td>--------------</td>
<td>----------------</td>
<td></td>
</tr>
<tr>
<td>20 (Lip stretcher)</td>
<td>0.55 (1.28)</td>
<td>0.23 (0.71)</td>
<td></td>
</tr>
<tr>
<td>25/26/27 (Mouth open)</td>
<td>1.02 (0.85)</td>
<td>0.82 (0.83)</td>
<td></td>
</tr>
</tbody>
</table>

*p < .05
Table 6

Means (Standard Deviations) of FACS Intensity Scores as a function of Audience Condition

<table>
<thead>
<tr>
<th>Facial Action</th>
<th>Audience Condition</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Implicit (n = 40)</td>
</tr>
<tr>
<td>1 (Inner brow raise)</td>
<td>.58 (1.25)</td>
</tr>
<tr>
<td>4 (Brow lower)*</td>
<td>.78 (1.42)</td>
</tr>
<tr>
<td>6/7 (Orbital tighten)</td>
<td>.67 (1.04)</td>
</tr>
<tr>
<td>9/10 (Levator contraction)*</td>
<td>1.20 (2.21)</td>
</tr>
<tr>
<td>12 (Oblique lip pull)</td>
<td>.94 (2.25)</td>
</tr>
<tr>
<td>17 (Chin raise)</td>
<td>.12 (.43)</td>
</tr>
<tr>
<td>20 (Lip stretch)</td>
<td>.18 (.65)</td>
</tr>
<tr>
<td>25/26/27 (Mouth open)</td>
<td>1.15 (1.65)</td>
</tr>
<tr>
<td>43 (Eyes close)</td>
<td>.71 (1.56)</td>
</tr>
<tr>
<td>45 (Blink)</td>
<td>3.56 (2.42)</td>
</tr>
</tbody>
</table>

Note. Means in the same row that do not share subscripts differ at p < .05 in the Student Newman Keuls post hoc comparisons.

*p < .05, **p < .01, ***p < .001
Table 7

Means (Standard Deviations) of FACS Frequency Scores as a function of Audience Condition and Participant Gender

<table>
<thead>
<tr>
<th>Facial Action</th>
<th>Implicit (n = 40)</th>
<th>Male (n = 40)</th>
<th>Female (n = 40)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 (Inner brow raiser)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Males (n=60)</td>
<td>.28 (.51)</td>
<td>.20 (.35)</td>
<td>.29 (.46)</td>
</tr>
<tr>
<td>Females (n=60)</td>
<td>.32 (.74)</td>
<td>.17 (.36)</td>
<td>.10 (.15)</td>
</tr>
<tr>
<td>4 (Brow lowerer)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Males (n=60)</td>
<td>.40 (.70)</td>
<td>.10 (.21)</td>
<td>.13 (.24)</td>
</tr>
<tr>
<td>Females (n=60)</td>
<td>.37 (.74)</td>
<td>.03 (.12)</td>
<td>.26 (.67)</td>
</tr>
<tr>
<td>6/7 (Orbital tighten)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Males (n=60)</td>
<td>.39 (.60)</td>
<td>.11 (.21)</td>
<td>.42 (.76)</td>
</tr>
<tr>
<td>Females (n=60)</td>
<td>.27 (.43)</td>
<td>.38 (.91)</td>
<td>.16 (.24)</td>
</tr>
<tr>
<td>9/10 (Levator contraction)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Males (n=60)</td>
<td>.45 (.67)</td>
<td>.09 (.28)</td>
<td>.15 (.52)</td>
</tr>
<tr>
<td>Females (n=60)</td>
<td>.38 (.78)</td>
<td>.38 (.97)</td>
<td>.14 (.28)</td>
</tr>
<tr>
<td>12 (Lip corner puller)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Males (n=60)</td>
<td>.38 (.66)</td>
<td>.22 (.49)</td>
<td>.68 (1.47)</td>
</tr>
<tr>
<td>Females (n=60)</td>
<td>.49 (1.20)</td>
<td>.98 (1.55)</td>
<td>.37 (.52)</td>
</tr>
<tr>
<td>17 (Chin raiser)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Males (n=60)</td>
<td>.08 (.20)</td>
<td>.07 (.20)</td>
<td>.01 (.04)</td>
</tr>
<tr>
<td>Females (n=60)</td>
<td>.01 (.04)</td>
<td>.03 (.07)</td>
<td>.03 (.15)</td>
</tr>
<tr>
<td></td>
<td>Males (n=60)</td>
<td>Females (n=60)</td>
<td></td>
</tr>
<tr>
<td>-----</td>
<td>--------------</td>
<td>----------------</td>
<td>-----</td>
</tr>
<tr>
<td>20  (Lip stretcher)</td>
<td>.06 (.16)</td>
<td>.08 (.34)</td>
<td>.06 (.28)</td>
</tr>
<tr>
<td>25/26/27 (Mouth open)</td>
<td>1.02 (1.47)</td>
<td>.53 (.89)</td>
<td>.58 (.99)</td>
</tr>
<tr>
<td>43  (Eyes closed)</td>
<td>.48 (.84)</td>
<td>.32 (1.11)</td>
<td>.19 (.42)</td>
</tr>
<tr>
<td>45  (Blink)</td>
<td>1.78 (1.31)</td>
<td>1.78 (1.13)</td>
<td>1.78 (1.56)</td>
</tr>
</tbody>
</table>
Table 8

Means (Standard Deviations) of FACS Frequency Scores as a function of Audience Condition

<table>
<thead>
<tr>
<th>Facial Action</th>
<th>Audience Condition</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Implicit (n = 40)</td>
</tr>
<tr>
<td>1 (Inner brow raise)</td>
<td>.30 (.63)</td>
</tr>
<tr>
<td>4 (Brow lower)</td>
<td>.38 (.71)</td>
</tr>
<tr>
<td>6/7 (Orbital tighten)</td>
<td>.33 (.52)</td>
</tr>
<tr>
<td>9/10 (Levator contraction)</td>
<td>.42 (.72)</td>
</tr>
<tr>
<td>12 (Oblique lip pull)</td>
<td>.44 (.96)</td>
</tr>
<tr>
<td>17 (Chin raise)</td>
<td>.04 (.15)</td>
</tr>
<tr>
<td>20 (Lip stretch)</td>
<td>.07 (.26)</td>
</tr>
<tr>
<td>25/26/27 (Mouth open)</td>
<td>.78 (1.23)</td>
</tr>
<tr>
<td>43 (Eyes close)</td>
<td>.40 (.98)</td>
</tr>
<tr>
<td>45 (Blink)</td>
<td>1.78 (1.21)</td>
</tr>
</tbody>
</table>

Note. Means in the same row that do not share subscripts differ at \( p < .05 \) in the Student Newman Keuls post hoc comparisons.

\*\( p < .05 \), \**\( p < .01 \), \***\( p < .001 \)
Table 9
Pearson correlations between dependent measures

<table>
<thead>
<tr>
<th>Measure</th>
<th>SR-I</th>
<th>SR-U</th>
<th>JR-I</th>
<th>JR-U</th>
<th>FACS-I</th>
<th>FACS-F</th>
<th>BPT</th>
<th>RHR</th>
</tr>
</thead>
<tbody>
<tr>
<td>SR-I</td>
<td>1.00</td>
<td>.46***</td>
<td>.04</td>
<td>.14</td>
<td>-.03</td>
<td>.13</td>
<td>-.217*</td>
<td>-.17</td>
</tr>
<tr>
<td>SR-U</td>
<td>.46***</td>
<td>1.00</td>
<td>.22**</td>
<td>.31***</td>
<td>-.06</td>
<td>.11</td>
<td>-.46***</td>
<td>-.19*</td>
</tr>
<tr>
<td>JR-I</td>
<td>.04</td>
<td>.22**</td>
<td>1.00</td>
<td>.85***</td>
<td>.45***</td>
<td>.50***</td>
<td>-.40***</td>
<td>.08</td>
</tr>
<tr>
<td>JR-U</td>
<td>.14</td>
<td>.31**</td>
<td>.85***</td>
<td>1.00</td>
<td>.32***</td>
<td>.48***</td>
<td>-.63***</td>
<td>-.02</td>
</tr>
<tr>
<td>FACS-I</td>
<td>-.03</td>
<td>-.06</td>
<td>.45***</td>
<td>.32***</td>
<td>1.00</td>
<td>.66***</td>
<td>.02</td>
<td>.11</td>
</tr>
<tr>
<td>FACS-F</td>
<td>.13</td>
<td>.11</td>
<td>.50***</td>
<td>.48***</td>
<td>.66***</td>
<td>1.00</td>
<td>-.28**</td>
<td>-.06</td>
</tr>
<tr>
<td>BPT</td>
<td>-.28*</td>
<td>-.43***</td>
<td>-.40***</td>
<td>-.63***</td>
<td>.02</td>
<td>-.28**</td>
<td>1.00</td>
<td>.28**</td>
</tr>
<tr>
<td>RHR</td>
<td>-.17</td>
<td>-.19*</td>
<td>.08</td>
<td>-.019</td>
<td>.11</td>
<td>-.06</td>
<td>.28**</td>
<td>1.00</td>
</tr>
</tbody>
</table>

*** Correlation is significant at the 0.001 level (2-tailed).
**  Correlation is significant at the 0.01 level (2-tailed).
*   Correlation is significant at the 0.05 level (2-tailed).

SR-I = Self-reports of Intensity
SR-U = Self-reports of Unpleasantness
JR-I = Judges' reports of intensity
JR-U = Judges' reports of unpleasantness
FACS-I = FACS intensity
FACS-F = FACS frequency
BPT = Behavioural pain Tolerance
RHR = Residualized Change Heart Rate
Appendix IV  FACS Action Units Description

**AU 1 Inner Brow Raiser:** AU 1 causes the brows to take on an oblique shape and the skin in the centre of the forehead to wrinkle horizontally. These wrinkles may be curved, raised more in the centre than at then ends, rather than horizontal.

**AU 4 Brow Lowerer:** AU 4 pulls down the eyebrows, pulls them closer together and produces deep vertical wrinkles between the eyebrows. An oblique wrinkle or bulge running from the middle of the forehead above the middle of the eyebrow down to the inner corner of the brow may also be produced.

**AU 6/7 Orbital Tightening:** AU 6/7 pulls the skin from the cheeks and temple toward the eyes, narrowing the eye opening, raising the cheeks, deepening the infraorbital furrow, and causing bags or pouches in the skin below the eyes.

**AU 9/10 Levator Contraction:** AU 9/10 pulls the skin along the side of the nose upward causing wrinkles to appear along the sides and across the root of the nose. It also raises the nostril wings and central part of the upper lip causing an angular bend in the shape of the upper lip.

**AU 12 Lip Corner Puller:** The upper lip is pulled slightly upward and laterally just inward from the corners, and the upper lip appears to flatten. The middle portion of the nasolabial furrow is deepened, and the infraorbital triangle is raised slightly.

**AU 17 Chin Raiser:** AU 17 pushes the chin boss and lower lip upward and may cause wrinkles to appear on the chin boss as the chin is stretched.

**AU 20 Lip Stretcher:** It pulls the lips and the skin beyond the lip corners back laterally. The lips, and particularly the lower lip, become stretched and flattened by the lateral pull. The chin and the area just below and adjacent to the lip corners may appear to be stretched and flattened. The mouth is widened, and the lips are elongated horizontally. The lower portion of the nasolabial furrow is pulled laterally.

**AU 25/26/27 Mouth Open:** Combination of AU 26 (lips part), AU 26 (jaw drop) and 27 (mouth stretch) as they are increasing intensities of the same action, opening of the mouth.

**AU 43 Eyes Closed:** The upper eyelid is relaxed completely, the lids touch, and the eyes close.

**AU 45 Blink:** Eyes close and open very quickly with no pause or hesitation in the closed position.