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FACIAL EXPRESSIVE BEHAVIOUR OF A CHRONIC LOW BACK PAIN POPULATION

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A DISSERTATION SUBMITTED IN PARTIAL FULFILLMENT OF

THE REQUIREMENTS FOR THE DEGREE OF

DOCTOR OF PHILOSOPHY

in

THE FACULTY OF GRADUATE STUDIES

(Department of Psychology)

We accept this thesis as conforming

to the required standard

THE UNIVERSITY OF BRITISH COLUMBIA

July 1985

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Date February 28, 1986

ABSTRACT

Assessment of the subjective experience of pain represents an ongoing concern in clinical, experimental and natural settings (Melzack, 1983). Previous laboratory studies (Craig & Patrick, 1985; Patrick, Craig & Prkachin, in press) using induced pain have suggested that facial expressive behaviour may provide a useful source of information additional to that offered by self-report in assessing the pain experience. There are, however, problems associated with the use of such behaviour, these being related to the issue of the voluntary and involuntary control that individuals have over their facial behaviour.

The present study attempted to extend the findings of the earlier analogue research using a clinical sample of chronic low back pain patients. Self-report of pain was also investigated as were several variables of clinical interest, i.e., duration of complaint and disability status. An attempt was made to overcome the tendency of people to attenuate their facial expressiveness in the presence of others scrutinizing the behaviour. Finally, the ability to control facial expression of pain was also investigated by requesting subjects to mask their facial expression during a painful movement and by requesting them to pose an expression of painful distress.

Subjects (60 male and 60 female patients at the Shaughnessy Hospital Back Pain Clinic) underwent a standardized physiotherapy protocol of four movements designed to induce low back or hip joint pain. Half of the subjects of each sex were given a set of instructions designed to enhance their overall global expressiveness. All subjects rated their acute discomfort as well as their more chronic discomfort as experienced on a "typical" basis. Subjects' facial expressions were videotaped during the standardized protocol and subsequently scored by two independent sets of coders using the Facial Action Coding System (Ekman & Friesen, 1978b) and using a global expressiveness rating system.

It was hypothesized that if the Instructional Set manipulation was successful then those subjects receiving the instructions would be rated as more globally expressive than those who did not receive instruction. It was also hypothesized that greater facial activity would be present in the posed expression of painful distress than in the genuine and masked displays.

A positive, albeit modest, relationship was found to exist between facial activity and self-report. This desynchrony between behaviour and self-report is common in the literature (Fordyce et al. 1984). The manipulation to enhance the global expressiveness of the subjects was unsuccessful. Males and females differed marginally, however, in terms of judges' ratings of global expressiveness with females being rated as more expressive. This difference was also discussed in light of the absence of a sex difference on the FACS variables.

Subjects were somewhat successful in deliberately attenuating their facial activity during a painful movement.

It was concluded that future research should focus on further investigation of the existence of configurations of facial actions expressive of pain, any one or more of which might be displayed, rather

than pursuing the existence of a prototypical pain expression. It was suggested that a prototypic expression might be more characteristic of a posed display and further research could investigate this possibility.

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ACKNOWLEDGEMENTS

I would like to thank my supervisor, Dr. K.D. Craig for his time, ideas, encouragement, patience and willingness to part, temporarily at least, with a great deal of valuable reference material. His continued enthusiasm for this project helped to ensure its completion.

I would also like to thank Doug Lee and Chris Patrick for their help, advice and encouragement with all phases of this project. I also extend my thanks to Brenda Gerhard and Cara Zaskow for enduring cheerfully the endless hours of FACS coding and to Joe Klancnik and Wendy Ross for doing the global ratings.

I am grateful to Dr. R. McMahon and Dr. R. Hakstian for serving on my dissertation committee, and for providing invaluable input during the various stages of this project.

I would also like to take this opportunity to thank Dr. Peter Wing, Faith Gagnon, the physiotherapists, and the staff of the Shaughnessy Hospital Back Pain Clinic without whose support and cooperation this project would not have been possible.

Finally, I would like to convey my heartfelt thanks to all my friends, but especially to Neal, Winnie and Bruno, and to my family for their patience and unflagging support.

INTRODUCTION

Assessment of the subjective experience of pain is a difficult task for both clinicians and nonclinicians. Traditionally, such assessments have been made on the basis of the patient's self-report and on observer judgements of the patient's behaviour. However, there are problems associated with both these methods of assessment. In the case of the observer, that individual may bring to the assessment a host of factors which will influence his or her judgement, for example, his or her personal and/or professional experience of pain, and his or her expectations about the level of pain to be expected with any given illness or injury (Bond, 1979; Teske, Daut & Cleeland, 1983). Self-report, while an extremely useful tool (Hilgard, 1969), is also subject to several limitations. The individual making the report may not have sufficient ability, skill or knowledge to be able to communicate the pain experience. In addition, the individual may, for a variety of reasons, exaggerate or conceal the amount of pain he or she is experiencing (Craig & Prkachin, 1983). Finally what people say they do and their actual behaviour may differ, because each type of behaviour is subject to different conditioning effects in the natural environment (Fordyce, 1983).

It would seem that additional sources of information are necessary in order to ensure more accurate assessment of the pain experience (Sanders, 1972; Tan, 1982). It is suggested that nonverbal expression, in particular facial expressive behaviour, may provide such additional information (Hjortsjo, 1970; Kleck et al., 1976).

However, there are several difficulties associated with the use of facial expressive behaviour. Even when attempts were made to generate systematic observational methods to study facial expression of pain, their use often required acceptance of theoretical assumptions about the underlying meanings of facial behaviour (Craig & Prkachin, 1983). In addition, problems of differential observer sensitivity arise. The various factors which influence observer sensitivity lead to erroneous judgements about the distress of others, and thus have detrimental effects on the individual being assessed (Jacox, 1980).

A major source of difficulty in the use of facial expressive behaviour lies in the fact that people appear able to exercise both voluntary and involuntary control over their facial expressions. Ekman and Friesen (1971) have suggested that a set of "display rules" governing emotional expression (and presumably expression of painful distress as well) is internalized during the socialization process. These "display rules" can serve to attenuate, neutralize or mask the distress felt by an individual. There is some evidence that facial behaviour is indeed influenced by these rules (Ekman, 1977; Kleck et al., 1976; Kraut, 1982; Lanzetta, Cartwright-Smith & Kleck, 1976).

The use of behavioural observational coding systems, in particular those involving microanalytic studies of filmed or videotaped material, may serve to overcome the difficulties posed by differential observer sensitivity and also describe display rules. Ekman and Friesen's Facial Action Coding System (FACS; Ekman & Friesen, 1976; 1978a; 1978b) has been demonstrated to be useful in the study of facial expressive behaviour associated with emotion. Recent studies (Craig & Patrick, 1985; Patrick, Craig & Prkachin, in press; LeResche, 1982) have shown the applicability of FACS to the study of the pain experience.

The work of Craig and his colleagues, employing induced pain with college student samples, has suggested overlapping sets of facial actions which seem to characterize the acute phase of noxious stimulation. The present study further defined this configuration of facial actions during clinical pain, using a more demographically heterogeneous sample, including both males and females with chronic low back pain. Use of a clinical sample provided the opportunity to examine relationships among several variables of clinical interest: duration of complaint, disability status, self-report of pain, and facial expressiveness.

It was suggested that the tendency to attenuate facial expressive behaviour in the presence of an observer might be influenced by an instructional set designed to encourage the individual to be as expressive of painful distress as possible. Thus half the subjects in the present study were given instructions of this type to examine whether this problem could be overcome. It was also suggested that the methodology of FACS would allow the observers to pick up "microdisplays" of facial behaviour that might remain for those individuals who were less expressive. These attenuated facial actions could also then be used in building the set of facial actions characteristic of painful distress.

A further attempt was also made to investigate the problems posed by the individual's voluntary and involuntary control of facial behaviour.

The individual's ability to attenuate facial behaviour was studied by asking the subjects to deliberately do so during a repetition of the painful movement. Subjects were also requested to deliberately pose an expression of painful distress in order to investigate the relationship that such an expression would have with a genuine facial expression of distress.

LITERATURE REVIEW

Assessment of the subjective experience of pain represents an ongoing concern for clinicians and researchers in the health care field (Gracely, 1979; Jacox, 1980; McCaffery, 1972; Melzack, 1983; Sternbach, 1974; Wolff, 1978). Traditionally, such assessment involves a judgment by a physician, nurse, physiotherapist or other health care professional about the patient's behaviour based upon evidence of tissue damage, verbal report and appearance. Unfortunately, many additional considerations make the judgment task complex and difficult. While the clinician attempts to be as objective as possible, the assessment process is influenced nonetheless by the observer's own professional and personal experience of pain, his or her endorsement of traditional socio-cultural beliefs about the level of pain to be expected in any given illness, and a variety of other factors such as the observer's personality and occupation (Bond, 1979; Dudley & Holm, 1984; Fordyce et al., 1978; Lenburg, Glass & Davett, 1970; Teske, Daut & Cleeland, 1983). In addition, the person experiencing pain has his or her attitudes toward how one should react to and report pain. Other factors such as the person's ethnic background, their response style, and states of anxiety or depression will also affect their pain behaviour (Teske, Daut & Cleeland, 1983).

Thus, while there is an urgent need to know the nature and severity of the pain patients are suffering, there is a continual risk of misunderstanding in communications between the clinician and the patient.

In addition, environmental pressures exist which can lead to purposeful or unwitting dissimulation of the pain experience on the part of the patient. These environmental pressures are generally thought of in terms of secondary gain. Such factors as financial benefits, avoiding an unpleasant work or personal situation, and increased attention from family and friends can all serve as inducements for the individual to exaggerate or even simulate pain. Other environmental pressures, however, can result in the patient trying to cover up the fact that he or she is in distress. Athletes, for example, may tend to minimize the seriousness of an injury in order to be able to continue to participate.

Use of Self-Report

Despite all of the aforementioned variables, clinicians and other individuals such as parents, teachers and employers must use some means to assess pain in both the clinical and natural settings in which it occurs. A rich variety of categories of expressive responses are available for use in assessment; for example, reflexes, startle response and posture (Melzack & Wall, 1965). However, if any weight is to be attached to the preponderance of investigations using verbal report in the scientific literature, then self-report has traditionally been the most heavily used category.

There are a number of reasons why this has been the case. It has been stated (Hilgard, 1969) that there are no physiological measures of pain which are as able to discriminate fine differences in stimulus conditions, are as reliable upon repetition or as responsive to changes in the patient's condition as self-report. Gracely (1983) has noted that language allows the separate assessment of the sensory-discriminative aspect of the pain experience and the motivational and emotional aspects. It has also been pointed out (Craig & Prkachin, 1983) that self-report requires minimal training or instrumentation and quantification is readily accomplished. This is apparently the case, at least for simple self-report scales of pain intensity based on unidimensional models of pain.

Current formulations of pain, however, are multidimensional and thus necessitate more complex measurement tools (Gracely, McGrath & Dubner, 1978; Melzack, 1975). The McGill Pain Questionnaire (MPQ; Melzack, 1975), for example, allows for the quantitative assessment of several dimensions of pain complaint and permits evaluation of the relative contributions of sensory, affective and evaluative factors to pain communication. Studies using the MPQ have indicated that it is reliable, valid and responsive to treatment of somatic or affective disturbances in both acute and chronic pain populations (Kremer & Atkinson, 1983).

Limitations of Self-Report Measures

Despite numerous advantages, self-report measures do have their limitations (Brena, 1983; Fordyce, 1976). It is possible that the respondent may simply not have sufficient knowledge or skill to be able to interpret or report the pain experience even though he or she may wish to do so. Requests for self-report are also highly obtrusive and sensitize people to situational demand (Craig & Prkachin, 1983). As a consequence, people may intentionally or unintentionally attempt to conceal or exaggerate the amount of pain they are feeling. In relation to this, Fordyce and his colleagues (Fordyce, 1983; Fordyce et al., 1984) have noted that what people say they do and their actual behaviour usually encounter quite different consequences in the environment and the two categories of behaviour are therefore subject to different conditioning effects. Thus "say" and "do" actions are free to diverge, without it being necessary to attribute discrepancies to any loss of the person's candor or truthfulness. A further limitation to self-report is that young children and certain disabled people are unable to use language as a medium of expression (Craig, 1980).

With regard to the relationship between chronic pain and self-report, Kremer, Block and Atkinson (1983) have concluded that self-report of pain intensity and other related pain behaviours are distorted by a number of variables. The authors reviewed a number of studies indicating that: (i) depression and the chronicity of the pain complaints were significantly related to the under reporting of activity; (ii) that the disclosure of pain information is a function of the age, sex and perceived professional stature of the target person; and (iii) that an, as yet, unclear relationship exists between self-report and whether or not the patient is receiving (or hoping to receive) compensation.

As a consequence of considering all the limitations of self-report, it is clear that additional components of the suffering individual's expressive repertoire must be used by observers in order to more accurately understand what is happening (Sanders, 1972; Tan, 1982). Indeed, in all likelihood the emphasis on self-report in the literature on pain misrepresents the importance of nonverbal expression to clinicians and observers in the natural environment.

Use of Nonverbal Expression in Assessment

Nonverbal expressive behaviour can serve as an additional source of information for those making judgments about someone who is suffering. Indicators of pain may include facial activity, movements of the limbs including reflexes, postural attitudes, paralinguistic vocalizations such as sighs and groans, and overt signs of autonomic activity. All apparently can be used to enhance these judgments (Craig & Prkachin, 1983). It has been observed (Wall, 1979) that verbal report comes into play late in the sequence of events during a pain episode, whereas other expressive channels play a more immediate role in communicating the experience. The importance of nonverbal signs of subjective distress was highlighted in a study (Jacox, 1980) in which nurses reported preferring and relying more heavily on physiological signs, body movements and facial expressions than on the patients' verbal complaints of pain. DiMatteo, Friedman and Taranta (1979) have reported that patients tend to prefer physicians who can understand their feelings even when the patient is unable or unwilling to express such feelings verbally. De Paulo et al. (1978) found that people attach greater credibility to nonverbal expression than to self-report when the two conflict (when making judgments of emotional expression). Finally, Kraut (1978) reported that the accuracy of judgments of others' attempts at deception is enhanced when the observers are provided with nonverbal as well as verbal expressive information.

Another advantage of using nonverbal expressive behaviour is that it seems to be less amenable to conscious distortion than self-reports of subjective states (Ekman & Friesen, 1969; 1974). It would seem that people do not monitor their nonverbal expressions, particularly bodily cues, to as great a degree as they do their verbal behaviour. This suggests that in some cases unobtrusive measurement of the former might provide more accurate information about subjective states, including pain.

Despite the importance of nonverbal behaviour as an index of the pain experience, "the systematic study of these phenomena has been sparse, occasionally erroneous and without substantial impact on the knowledge base in the field" (Craig & Prkachin, 1983). For example, Johnson, Kirchoff and Endress (1975) in a study involving children undergoing cast removal, investigated the frequency of a number of nonverbal behaviours. Behaviour was categorized as major (e.g., kicking, screaming) or as minor (e.g., grimace, frown), however, no explanation was provided as to why these particular behaviours were selected. Kendall et al. (1979) had judges rate a number of nonverbal behaviours (e.g., clenching fists, shaking or moving around "unnecessarily") while assessing the adjustment of patients during a cardiac catherization procedure. Again no explanation was given as to why these behaviours were selected. Nonverbal expression is not as easily measured as verbal behaviour and it is only recently that comprehensive, reliable measurement strategies for the former have begun to appear.

Keefe and Block (1982) developed an observation method of assessing pain behaviour in chronic low back pain patients. A variety of motor patterns such as bracing, rubbing, grimacing and sighing were demonstrated to be reliably observed and were correlated to patient's ratings of pain. Moreover, the frequency of these behaviours tended to decrease with treatment and these changes in behaviour also correlated with changes in pain ratings.

Facial Expressive Behaviour

One area that has seen rapid progress over the past few years is the study of facial expressions as indicators of emotional experience. In summing up the field of nonverbal communication, Harper, Weins and Matarazzo (1979) stated that the face, and facial expression in particular, may be the most important area of the body in nonverbal communication. The authors maintain that this is the case because of the amount of information the face can convey (especially in a short period of time) and the types of information conveyed, for example, emotional and attitudinal. The authors cite numerous findings in support of this claim (e.g., Dittman, 1972; Ekman, Friesen & Ellsworth, 1972; Weitz, 1974).

Although this field has a lengthy history, systematic attempts to measure facial expressive activity are a more recent development. Darwin's (1872) work on emotional expression represents one early attempt to study such activity. However, he focussed on the adaptive, evolutionary role of expressive behaviour and actually concluded "that in the case of the chief expressive actions they are not learned but are present from the earliest days and throughout life are quite beyond our control..." (p. 352), an assertion that would be debated today. Darwin argued for the universality of the "chief expressions" and provided detailed descriptions of expressions of happiness, anger, sadness, distress and so forth. Ekman, Friesen and Ellsworth (1982) in a review of the early laboratory studies using still photographs (e.g., Plutchik, 1962; Tomkins and McCarter, 1964; Woodworth, 1938) concluded that a minimum of seven categories of emotion could be discriminated by untrained observers on the basis of impressionistic judgments of facial features. The categories the authors identified were happiness, surprise, fear, anger, sadness, disgust/contempt, and interest.

Skilled clinicians have also demonstrated facility in identifying important patterns of nonverbal expression of painful distress. Ambeau (1982) suggested that pain disorders with greater contributions from psychological than organic determinants would be characterized by greater expressiveness in general, more verbal complaint and report, acute reactions when changing bodily position, groaning as opposed to sucking in the breath during pangs of distress, and tendencies to interrupt activities by stopping talking and averting the eyes when in particular distress. However, the observations were anecdotal and unsystematic and need to be validated before any conclusions can be drawn.

There is also evidence that observers, whether naive or trained, can have considerable success in using nonverbal cues in making judgments about the pain of others based upon observation of behaviours. Kleck et al. (1976) and Lanzetta, Cartwright-Smith and Kleck (1976) both reported that untrained judges could reliably assess the amount of distress expressed by subjects exposed to painful electric shocks. Prkachin, Currie and Craig (1983) found that naive judges were able to discriminate facial expressions for low, medium and high electric shock intensities delivered to volunteer subjects.

Other research efforts have been aimed at identifying specific behaviour patterns signifying pain to observers. Hjortsjo (1970) described facial changes brought about by the actions of the obicularis occuli and the masseter muscles that he believed represented a particular pain expression.

Leventhal and Sharp (1965) developed a system for coding the morphology of facial changes induced by childbirth labour and described facial correlates of apparent reductions in comfort and increases in distress which were related to the extent of cervical dilation. However, it has been pointed out (LeResche & Dworkin, 1984) that it was not possible to derive descriptions of facial expression of pain from this study as it was not clearly defined what was meant by distress; that is pain, fear, anxiety or some combination of these states. In addition, a methodological flaw resulted in uncertainty as to whether the observed facial behaviours occurred sequentially or in some configuration with one another.

Izard et al. (1980) recorded the facial expressions of 1 to 9 month old infants during innoculations or the taking of blood samples. They identified a facial pattern which, they thought, was a discrete expression of pain that was relatively specific to infants. This was described as a lowering of the brows, broadening of the nasal root, an angular squarish mouth and tightly closed eyes. (There is some dispute about the behavioural specifics however, as H. Oster (personal communication to K.D. Craig, 1982) has suggested the Izard coding system may be flawed as it is based upon similarities between infant's faces and the investigators' conception of adult's pain expressions. The Izard system apparently fails to take into account differences between infant's and adult's faces).

Other evidence involves developmental changes which have been observed in pain related expression. Izard et al. (1981) reported that facial expression of painful distress during innoculations decreased with age whereas anger expressions increased with age. These reports provide some evidence that pain relevant, possibly pain specific, information is encoded in expressive behaviour.

A broad range of behavioural differences in pain response associated with age in infants was observed by Craig, McMahon, Morrison, and Zaskow (1984). Coders used a time-sampling behavioural observation system to distinguish among vocal expressive categories (language, crying, screaming, etc.) and nonvocal expressive categories (activity in the face, torso and limbs) in expressive reactions to routine immunization injections in the first two years of life. The findings indicated that the reactions of children under one year were more spontaneous, global and linked to the tissue insult of the injection, whereas the children between 13 and 24 months displayed more anticipatory distress, used descriptive language during the session and engaged in self protective voluntary movements. Thus, expressions of pain were seen to change systematically during the first two years of life as infants accumulate experiences and acquire motor skills and the capacity to recognize and influence others.

<u>Difficulties With the Use of Facial Expressive Behaviour</u>

A. Differential Observer Sensitivity

The use of facial expression is not without its own difficulties. It seems (von Baeyer, Johnson & McMillan, 1982, unpublished manuscript) that the impact of nonverbal behaviour is mediated by individual differences in observer sensitivity to the nonverbal expression of pain. von Baeyer (1982) found that sensitizers assigned higher pain ratings than repressors when rating slides portraying low levels of non-verbal pain expression. In another study (von Baeyer et al., 1982, unpublished manuscript) involving an analogue patient/clinical relationship, the results indicated that the nurturance levels (as measured by the Adjective Checklist) of the raters interacted with the degree of nonverbal expressiveness exhibited by the "patients". Prkachin, Currie and Craig (1983) and Patrick et al. (in press) found that observers' judgments of the distress of others could be influenced by instructional set by affecting their willingness to attribute pain at varying levels of severity.

In natural settings, people may be relatively sensitive or insensitive to, or unwilling to respond to cues when making judgments about the amount of stress another person is experiencing. Parents of children suffering recurrent abdominal pain without known organic origin have been characterized as over-anxious, over-protective and fearful. These concerns appeared to make then unduly sensitive and possibly overreactive to minimal signs of physical distress (Craig, 1980). On the other hand, a nurse who expects patients experiencing pain to clearly communicate it verbally or nonverbally, will incorrectly assess a quiet patient as not being in any distress (Jacox, 1980).

Such erroneous judgments can have detrimental effects on the patient or individual being judged. In the former case pain behaviour will be reinforced, the child is likely to continue to suffer, and it is improbable that any change will be effected until the behaviour of the parents is altered. In the latter case the individual often endures needless suffering because the prescribed analgesics are not administered. Development of systematic, objective and sensitive measures of the nonverbal behaviour demonstrated to be associated with painful distress would aid in the more accurate assessment of that distress to the benefit of the patient and those around him or her.

B. Control of Facial Expression: Deception, Dissimulation and Display Rules.

One of the proposed advantages of nonverbal measures of pain is that they are less subject to conscious and unconscious control than are verbalizations. However, the various types of nonverbal expression of pain are familiar to most people and to some degree do seem to be subject to voluntary control. Children play at being ill and actors can express pain in varying degrees, as do certain individuals seeking the secondary gains of being ill. At a minimum, there are cultural conventions concerning stereotypic displays of pain that enable people to enact them with ease. (Whether these cultural stereotypes correspond to prototypical pain expressions or not is another matter.)

The process by which emotional expression comes to be under voluntary control has been the subject of several investigations. Ekman and Friesen (1971) noted that emotional experience comes to be under the control of "display rules" through the socialization process. Socially learned (culture specific) display rules can modify expression in a number of ways; for example, intensify, deintensify, neutralize and mask. Such rules are thought to be learned in childhood and become habits; that is, learned to the point of being automatic. It should be noted, however, that there may be limitations in generalizing from the literature on emotional expression to the expression of painful distress. It has been suggested (LeResche & Dworkin, 1984) that it remains unclear whether the facial expressions that accompany pain are indications of emotional response (e.g., startle, fear, anger) to the sensory aspect of the pain experience, or whether they represent one or more distinct pain states. In addition, different types of pain can be distinguished by different patterns of sensory, affective and evaluative verbal response (Melzack, 1975) and these pain types might conceivably be associated with different facial expressive behaviours.

There is some evidence that facial behaviour is indeed influenced by these display rules. Ekman (1977), for example, described a study in which subjects viewed a stressful film either alone or in the presence of an observer. Slow motion films of the subjects in the latter condition, revealed the presence of initial facial movements indicative of distress which were rapidly suppressed, and replaced by neutral or positive expressions such as smiles. Kleck et al. (1976) found that subjects undergoing electric shock in the presence of an age peer observer were judged as being less expressive or distressed than when alone. In addition the subjects were less physiologically responsive (as measured by skin conductance levels) and their self reported distress was lower when under observation. A further study (Lanzetta, Cartwright-Smith & Kleck, 1976) found that when instructed to deceive, subjects were successful in convincing judges that they had received a more or less intense shock than had in fact been delivered.

Kraut (1982) found that subjects smelling pleasant and disgusting odors were less successful communicators of the experience when aware that someone was in the room with them (despite the fact that the other person could not see the subject). When requested to hide their expressions they were similarly less successful when the same "unobserving" other was present; that is they "leaked" their evaluations more than when completely alone.

Ekman and Friesen (1969) have suggested that such leakage may indeed occur when subjects are deliberately trying to deceive an observer by attenuating facial behaviour. However, they also state that expert observers viewing facial behaviour on videotape may well be able to detect such leakage. While the authors do not specify the mechanisms of detection, one possibility may relate to their discussion of "micro affect displays". Micro displays are those facial behaviours which may be "fragments of a squelched, neutralized or masked display" (p. 98) or they may be extremely rapid versions of the macro display. When such micro displays are shown in slow motion they do convey emotional information which can be recorded by observers (Ekman & Friesen, 1969). In the case of faking painful distress, careful study of posed versus genuine displays of facial expressive behaviour associated with pain similar to that carried out by Ekman and Friesen (1982) with smiles, may provide the necessary clues to detect such behaviour.

Use of Behavioural Coding Systems

Craig and Prkachin (1983) have emphasized the need for the development of methodologies for decoding the behavioural repertoire of expressions of pain. Many of the studies on emotional expression and indeed, of pain expression, have suffered from the disadvantage of relying upon observational systems that require acceptance of strong theoretical assumptions about the underlying meaning of expressive acts. Judges appear to rapidly impose these assumptions on nonverbal expression that is, by nature, subtle and ambiguous (e.g., Johnson, Kirchoff & Endress, 1975; Kendall, Williams, Pechacek, Shisslak & Herzoff, 1979; Langer & Janis, 1975).

However, there are several recently devised behavioural observational coding systems that seem to offer some promise when there is insistence upon operational definitions of the target behaviours being observed and interobserver reliability. Unfortunately while these systems yield valuable information, they generally involve the use of real time observations and the speed and complexity of changes in facial expression can exceed the observer's capacity to encode them (Cataldo et al., 1979; Ekman, Friesen & Ellsworth, 1982; Melamed & Siegel, 1975). Microanalytic studies of filmed or videotaped material presented to judges in slow motion or on a frame by frame basis seem to be necessary to capture the complexity of visual displays. This has been demonstrated to be the case in studies of emotional expression.

The Facial Action Coding System

Perhaps the most sophisticated development to date in the measurement of facial expressive behaviour is the Facial Action Coding System (FACS; Ekman & Friesen, 1976, 1978a, 1978b). The system was designed to measure all visible facial behaviour, not just that presumably involved in emotional expression. It is based on an analysis of the anatomical basis of facial movement and an examination of how each muscle of the face acts to create a visible appearance change. FACS identifies 44 separate facial Action Units (discrete movements in the forehead, eye, cheek, nose, mouth, chin and neck regions) along with 20 additional Action Descriptors (e.g., changes in the orientation of the head). Any facial expression can be described in terms of the action unit (AU) or the combination of AUs that produced it. FACS can also be used to code the duration and intensity of facial movements. The system is very comprehensive and equally complex, requiring considerable time and practice to master.

The major advantage of FACS is that it is objective, reliable, and atheoretical since the trained observers are able to consistently use explicit definitions of the specific components of facial expression. Therefore, there is little opportunity to impose subjective judgments regarding supposed underlying psychological states. This nicely sidesteps the previously discussed problem of observer bias. Using FACS, the observer does not make inferences about what the facial behaviour means; rather the specifics of the behaviour present are simply recorded. The facial behaviours which are identified can be related to criterion variables of interest, for example self-report of an emotional state, psychophysiological measures, or other nonverbal indicators, and relationships with life history and environmental events can be explored. Studies utilizing the FACS system have recently begun to be carried out by various investigators.

For example, Ancoli (1979) and Ancoli, Kamiyua and Ekman (1980), compared female subjects' responses to pleasant and unpleasant films and found that a pattern of autonomic nervous system changes was found only when the face showed what FACS identified as positive or negative emotions. Ekman, Friesen and Ancoli (1980) found that FACS hypotheses about a number of aspects of emotional experience predicted the subject's report on multidimensional scales immediately after viewing pleasant and unpleasant films. Facial action (as measured by FACS) was found to provide accurate information as to which of two enjoyable experiences was enjoyed most. FACS also provided accurate information as to whether a subject was unhappy and the extent of the negative emotion. In addition, some evidence was found to differentiate unhappiness from disgust on the basis of the FACS data. These and other studies (e.g., Ekman, Friesen & Simons, 1982; Ekman, Hager & Friesen, 1981) provide the basis for considering FACS to be an important measurement tool for facial expressive action in association with a wide variety of emotional and even nonemotional states.

Use of FACS in Studies of Facial Expressive Behaviour of Pain

Recently, Craig and his colleagues have applied FACS to the study of facial expressive behaviour of pain. While pain is not considered to be an emotion, the pain experience embodies a significant emotional component (Craig, 1984) and there is reason to believe that specific facial movements may be associated with the experience of pain (cf. Hjortsjo, 1969). In a study of female facial expressive movement in response to the cold pressor experience, Craig and Patrick (1985) identified a number of specific facial actions associated with painful distress: narrowing of the eye aperture from below, raising the upper lip, pulling the lip corners, parting of the lips or dropping the jaw, and eyes closing or frequently blinking. These actions were strongly associated with the subject's report of subjective distress at the onset of the noxious stimulation, although they declined over time.

Patrick et al. (in press) obtained results consistent with the previous study when investigating facial expressive behaviour of females provoked by a range of painful and nonpainful electric shocks. In this study, narrowing of the eye aperture from below, raising the upper lip, and blinking were all demonstrated. However, several action units identified previously were not seen and one additional AU, brow lowering, was observed in this shock study. The authors attribute these differences to the different nature of the shock and cold pressor experiences; that is the former is a brief, noxious stimulus while the latter is a relatively more enduring, aching pain.

Limitations of the Previous Research Using FACS

The research of Craig and his colleagues is innovative and has yielded valuable and interesting results; however, it does suffer from several limitations. The first is that only female subjects were studied. This was largely due to the fact that, at least in studies of emotional expression, females have generally been found to be more accurate encoders or senders of information (Buck, Miller & Caul, 1974; Schwartz, Brown & Ahern, 1980). As it is thus unclear whether or not males would exhibit a similar set of facial behaviours when in pain, the results can only be generalized to other females.

Another, perhaps less serious limitation, is the homogenous nature of the two samples studied. Both samples were restricted to a university student population whose ages ranged from 17 to 28. Whether the results can be generalized to other or more heterogeneous populations is again unclear.

A further limitation is the fact that the previous research has attempted to define a facial topography of pain using artificially induced pain rather than studying clinical pain or pain induced in the natural environment. Analogue research is extremely valuable as it allows for the precise and systematic control of the painful stimulus. In addition, there are fewer logistical constraints in a laboratory setting, enabling the experimenter, for example, to administer rating scales concurrently with the stimulus or to take physiological measures. However, despite such advantages, there is always concern as to the generalizability of results outside the laboratory.

Laboratory induced pain presumably has less emotional weight attached to it and is therefore different from clinical pain (Beecher, 1959). Moreover, it is always an acute experience whereas clinical pain can be either acute, such as the pain experienced at the time of tissue injury or during a medical diagnostic procedure, or chronic in the sense that it persists or is recurrent over a long period of time, for example low back pain. As several prominent researchers have noted (Bonica, 1980; Fordyce, 1983), the physiological, emotional and behavioural responses to chronic pain can be quite different from those to acute pain. It may be that the facial behaviour of chronic pain patients undergoing an acute pain experience may be different from that of a nonclinical population.

Studying a clinical population has additional advantages beyond ecological validity. It allows for an exploration of the relationship between important clinical variables, such as chronicity of pain and behaviour. Another variable of interest in a clinical population is disability status. It is generally thought that if people are compensated for illness behaviour, the likelihood of repetition of that behaviour will increase. Thus, many behaviourally oriented pain programmes will not treat patients involved in litigation or with pending Workers' Compensation claims (e.g., Fordyce, 1976). In a review of the literature on the relationship between compensation status, self-report and pain behaviour, Kremer, Block and Atkinson (1983) concluded that at present the results are conflicting as to whether compensation perpetuates illness behaviour. Thus, it would be of interest to explore the relationship of disability status, facial behaviour and self-report of pain.

Purpose of the Study

In the present study, an attempt was made to define a facial topography of pain in a sample of chronic low back pain patients. The results were compared with those of previous research (Craig & Patrick, 1985; Patrick et al., in press) which employed nonclinical subjects in analogue situations. In addition, both males and females were studied in the present research to determine if differences existed in their facial expressive behaviour or self-report of painful distress.

As the clinical sample used was more heterogeneous in terms of demographic characteristics such as age, education and ethnic group than samples in the previous research, there was an opportunity to determine if the earlier findings could be cross-validated with a more diverse sample. Another opportunity provided by use of a clinical sample was that of examining the relationship of several variables of clinical interest (for example, duration of complaint, disability status) with self-report of pain and overall or global facial expressive behaviour.

An attempt was made to address the problems arising from the potential control that individuals can exert over their facial expressive behaviour. Two types of individuals present difficulty with regard to the accurate assessment of painful distress. The first is the one who attempts to maintain a stoical expression; the second, the individual who, for a variety of reasons, exaggerates or even fakes behaviour indicative of painful distress. It the case of the former, the FACS procedure, which allows for repeated viewings in real time, slow motion and frame by frame, should make it possible to pick up any of the "micro displays" discussed earlier.

An attempt was also made to determine if instructing subjects to be as expressive as possible of their distress would circumvent any display rules whose effect would be to attentuate facial behaviour expressive of pain. In order to judge the overall effect of this manipulation, non FACS trained coders were asked to make judgments as to the degree of global facial expressiveness of each subject. To further investigate the control individuals may be able to exert over their facial behaviour, all subjects were requested to deliberately attentuate such behaviour during a repetition of the previously identified most painful movement. To address the problem of the individual who may exaggerate or even fake facial behaviour indicative of painful distress, all subjects were asked to deliberately pose an expression presumably associated with such distress. FACS scoring was used first to identify the action units (AUs) associated with a painful movement and second, to identify the AUs associated with the masked and posed facial behaviour associated with pain.

It was hypothesized that greater facial activity, in terms of the number and/or frequency of AUs, would be present in the posed display than in the genuine one. It was also hypothesized that fewer and/or less frequent AUs would be present in the masked display as compared to the genuine and posed displays.

METHOD

Subjects

Subjects were 60 males and 60 females selected from among the patients undergoing assessment at the Shaughnessy Hospital Back Pain Clinic. The Back Pain Clinic is an assessment unit for chronic back pain patients; that is, those individuals with a history of back pain of 6 months duration or longer. Patients are referred to the Clinic by their family physician, by specialists (orthopedic, neurological, rheumatological and general surgery), by the Workers' Compensation Board and by the Insurance Corporation of British Columbia. Each patient is assessed by a specialist (orthopedic surgeon or rheumatologist), a general practicitioner, a physiotherapist and a psychologist. Only those patients whose referral information indicated a history of pain in the lower back and/or hips were approached to be in the study. A number of selection criteria were applied to those individuals approached for participation in the study; 1) the patient had to be experiencing pain at the time of the assessment; 2) the patient had to be able to understand written and spoken English; and 3) the patient could not be discernably under the influence of alcohol. Use of a prescribed medication was not an exclusion criterion as this is the case with the majority of chronic pain patients.

Descriptive information about the patients appears in Table 1. The mean age of the subjects was 42.7 years with a range of 17 to 78 years. The majority of the subjects (58.6%) had at least a high school diploma.

TABLE 1

Demographic Variables (Male and Females Combined)

Variable Name	M	SD	Percentage	Range	n[1]
Age (in years)	42.7	13.71	--	17-78	117
Education level					81
Grade school/junior high	--	--	41.4	--	--
High school diploma	--	--	28.7	--	--
Post secondary education	--	--	16.1	--	--
Technical school or skilled trade	--	--	13.8	--	--
Ethnic group					118
Caucasian-born in Canada or U.S., no recent ethnic influence	--	--	77.12	--	--
All other ethnic groups	--	--	22.88	--	--
Duration of complaint Chronic (in years)	8.42	10.33	--	.58-55.0	120
Duration of complaint Current (in years)	2.2	1.52	--	.25-8.0	120
Locus of complaint					120
Low back pain	--	66.7	--	--	--
Back and leg pain	--	25.0	--	--	--
Back and hip or hip only pain	--	8.3	--	--	--

Variable Name	M	SD	Percentage	Range	n[1]
<u>Prior Back Surgery</u> (38 subjects)	--	--	32	--	120
One operation			25		
Two operations or more			6.6		
<u>Disposition</u>					120
Further investigation and/or invasive procedures			6.9		
Noninvasive procedures or treatment recommended			93.1		
<u>Disability Status</u>					115
Receiving or hoping to receive benefits			46.1		
No benefits			53.9		

1. This figure represents the total number of subjects for whom the information on a particular variable was available

with the remainder having at least a grade school education. The ethnic background of the subjects was predominantly North American and Caucasian (75.8%) with the remainder representing a wide variety of nationalities or ethnic backgrounds.

The mean duration of complaint was 8.42 years. However as the standard deviation was large (<u>SD</u> = 10.33 years) the median, 4 years, is perhaps a more representative figure. For 35 of the subjects the current complaint differed from the chronic complaint. For example, an individual with a chronic, intermittent 10 years history of back pain had a current complaint of 8 months duration. The mean duration of the current complaint was 2.2 years with a standard deviation of 1.52 years. The locus of complaint was primarily the lower back (66.7%). A smaller proportion of subjects presented with back and leg pain (25%) while an even smaller group presented with lower back and hip pain or hip pain alone (8.3%). Thirty-two percent of the subjects had had at least one prior back operation. Of these, seven had had at least two operations and one unfortunate individual had had twelve operations.

Chi-square analysis for disability status ($2 \times 2\chi^2$) indicated that the distribution for sex over the categories of disability status was unequal $\chi^2_{(1)} = 9.41$, $p < .005$. More males than females were receiving or expecting to receive some form of financial compensation for their continuing pain problem. Conversely, almost twice as many women as men were not receiving or expecting to receive any benefits (see Table 2).

Each individual received at least one diagnosis, 69 received two and

TABLE 2

2 x 2 Contingency Table for Disability Status (Benefits or No Benefits) by Sex[1]

	Receiving or Hoping to Receive Benefits	No Benefits
Male	34	22
Female	19	40

$\chi^2 = 9.41, p < .005$

1. (missing data on five subjects)

17 received three. Of the 206 diagnoses or opinions given, 77 were based on hard physical signs such as evidence on an X-Ray or other diagnostic test. Twenty-two were attributed to "mechanical" problems and 20 were attributed to chronic benign pain syndrome. Twenty-six were attributed to life style problems such as obesity and the remaining diagnoses were too various to categorize meaningfully (see Appendix 1).

Each patient received at least one recommendation for disposition, 87 individuals received two, 32 received three, five received four and two individuals received five recommendations. Of the total of 242 recommendations for treatment only 35 (14.5%) were for further investigation or invasive procedures. The remainder were for noninvasive forms of treatment (e.g., physiotherapy, back education).

Experimental Setting

The physiotherapy assessments all took place in the same examination room in the Back Pain Clinic in Shaughnessy Hospital. A video-camera was mounted on a bracket in the upper left corner of the room directly over the head of the examination table. An adjacent room contained the videotape recording equipment. A wall with a window-sized, curtained, sliding glass door partition and a door separated the two rooms. A microphone was placed behind the curtain out of view of the subject.

Self-Report Measures

The McGill Pain Questionnaire (MPQ; Melzack, 1975) verbal descriptor scales consist of 20 groups of words which yield three measures of the affective, sensory and evaluative dimensions of pain (see Appendix 2). A fourth measure, number of words chosen (NWC) is also derived from the questionnaire. The MPQ has been shown to be a sensitive instrument in the assessment of pain control methods (e.g., Melzack, 1975; Melzack & Perry, 1975), has shown considerable diagnostic power (Dubuisson & Melzack, 1976) and is a sensitive descriptor of differences in pain experience (e.g., Agnew & Mersky, 1976; Brightman, 1977; Reading & Newton, 1977).

The MPQ was administered to each subject under two sets of instructions: 1) acute pain and 2) chronic pain. The "acute" pain instructions asked the subject to fill out the MPQ according to his or her recall of the pain experienced during the most painful movement of the experimental protocol. The "chronic" pain instructions asked the subject to fill out the MPQ according to his or her recall of the pain experienced on a typical or average day.

The Gracely (Gracely, 1979; Gracely, McGrath & Dubner, 1978, 1979) verbal descriptor scales consist of two scales of 15 items each and one scale of 12 items. The three scales assess sensory intensity, unpleasantness and painfulness (see Appendix 3). The scales were developed through the use of cross-modality matching and scaling procedures. They are reliable, objective and the sensory and unpleasantness scales have been demonstrated to be differentially sensitive to placebo, narcotic and tranquillizing drugs (Gracely, et al., 1978, 1979). While some controversy exists concerning their psychometric properties (Hall, 1981; Gracely & Dubner, 1981), the scales are considered to be reliable for use in describing naturally occurring acute and chronic pain. Reliability coefficients between groups of similar subjects have been reported as

0.96 for sensory intensity and 0.89 for unpleasantness. No reliability data has been reported for the painfulness scale.

Videotape Equipment

Subject facial expressions were recorded on Scotch T-120 video cassettes, using an RCA 2011/N high sensitivity black and white TV camera and a Panasonic 1/2 inch, VHS video-cassette recorder. An RCA video time/date generator, Model TC-1440-B, was connected to the video cassette recorder. It provided the videotapes with a digital time display (minutes, seconds, 60ths of a second) so they could subsequently be divided into segments for FACS coding. A Sony portable microphone was used to provide pickup for the audio portion of the videotaped record. For coding purposes, the tapes were played back on an RCA model JD-975 VW 19-inch television monitor.

Procedure

Subjects were approached by the experimenter to serve as volunteers for the study while they were waiting for their physiotherapy examination. The experimenter introduced herself, provided background information and had each person read the informed consent form which indicated they were to be videotaped (see Appendix 4). The study was described as a review of physiotherapy procedures and no mention was made of a particular interest in facial expression. After questions were answered, each subject was asked if he or she would be willing to participate in the study. Of those approached, a small proportion (10.4%) refused to do so. Of those consenting, a few were willing in theory, but were unsure if they would be in too much discomfort by the time the study began. In such cases the physiotherapist was specifically requested to enquire as to the amount of distress the patient was experiencing before proceeding. In addition, if the physiotherapist thought that the patient was in distress, despite the lack of any verbal indication, she would enquire as to whether the patient would prefer not to continue. Only two patients, both females, indicated that they would prefer not to continue because they were in too much pain. The physiotherapist subsequently agreed with both patient's assessments.

All subjects were assessed in the same examination room. The major component of the physiotheraphy exam involved determining the patient's ability to carry out a variety of range of motion tests. These tests were conducted while the patient was standing, sitting and lying down. When the last section was completed, that is, when the patient was lying in a supine position, the physiotherapist announced the commencement of the study procedure. The physiotherapist then consulted with the experimenter (who was seated in the adjacent room, near the glass partition) as to the correct positioning of the patient's head as shown on the video monitor. When this was accomplished satisfactorily, videotaping began.

Half of the subjects, selected randomly, were first read a set of instructions designed to enhance the nonverbal expressiveness of the subject. The importance to the assessment of a variety of nonverbal cues was emphasized and subjects were requested to be as expressive as possible of their distress (see Appendix 5). The other half of the subjects received no such instructions. Other than this initial procedural difference there were no further ones in the subsequent procedures for the two groups. The physiotherapist then commenced with the first of a series of four activities involving both active and passive movements of the legs (see Appendix 5). At least one of these movements was likely to induce either low back or hip joint discomfort. These movements were presented in the same order for all subjects.

After completing the standardized protocol the physiotherapist asked the subject to identify which of the four movements had been the most distressing. The subject was told that this movement would be repeated under two sets of instructions: 1) genuine and 2) masked. The former involved a repeat of the painful movement and the latter another repeat of the movement with the additional instruction that the subject was to try to express as little discomfort as possible. In addition, each subject was asked to pose an expression of pain. During this condition, the physiotherapist repeated a movement which had not caused the subject any discomfort, in order for the subject to have an event to which to relate the posed expression (see Appendix 5). All subjects began with the repeat of the most painful movement, but the order of the masked and posed instructions was counterbalanced randomly across subjects.

After the subjects had completed the procedure they were asked to get dressed and to meet with the experimenter. The subjects then viewed the portion of the videotape involving the presentation of the standard protocol and were requested to indicate the point at which they had felt the most pain. This frequently involved several reviews of the section to pinpoint accurately the precise moment. Once this was accomplished the experimenter copied down the time/date generator (TDG) number sequence which corresponded to this moment. The subject was then requested to fill out the MPQ and the Gracely scales to characterize the acute distress experienced during the most painful movement. The subject then filled out the MPQ scales again to characterize the chronic pain they typically experienced on a daily basis. The experimenter sat with the subjects as they filled out the questionnaires and answered any questions the subjects had regarding specific items.

After the questionnaires were completed the subjects were thanked for their participation and any further questions regarding the study were answered. In addition the subjects were informed as to the actual purpose of the study, that is, a study of the facial expressiveness of pain rather than a response to physiotherapy assessment per se.

When the physiotherapist had completed her assessment on the patients (up to three) that she was able to see on that particular occasion she viewed the appropriate portion of the videotape of the patients who had participated in the study. After this initial viewing, the physiotherapist was then asked to indicate the point where she recalled having judged the subject as being in the most distress. In order to facilitate recall, the physiotherapists were asked to make note of this point immediately after completing the standardized protocol with each subject. Thus, the physiotherapist would note, for example, that the patient seemed to experience the most distress during the left straight leg raise. The portion of the tape involving that particular movement would then be reviewed and the physiotherapist would attempt to pinpoint the exact moment of the most severe distress. The judgment therefore was based on both the physiotherapist's recall of the subject's verbal and nonverbal behaviour and the information recorded on the tape. Once the precise moment was identified the experimenter noted the corresponding TDG time.

Experimental Design

There were four groups. Within each of the two Instructional Set Conditions half the subjects were female and half were male. Thus, there were 60 subjects in each instructional set condition, 30 males and 30 females. All subjects were requested to provide a genuine, a masked and a posed expression of pain. The design was therefore a 2 x 2 x 3 factorial: Type of Instruction (nonverbal expressiveness enhancing, no nonverbal expressiveness enhancing) x Sex x Type of Facial Expression (genuine, posed, masked).

FACS Data Coding

Eight 6-second segments from each subject's videotape were selected for scoring. The 6 seconds represented a "window" around a particular point in time; i.e., 3 seconds preceding and 3 second succeeding a particular event as indicated on the videotape by a TDG number.

The first of these (Segment 1) was a "neutral" segment, in which the subject's face was expressionless and he or she was at rest. The segment was taken from the beginning section of the session when the subject was waiting for the commencement of the standardized protocol. If the subject's face was not neutral during this period, a search was made throughout the videotape until a 6 second segment which met the same criteria could be found. The neutral segment served as a reference for the coders when coding other segments and provided information about individual facial structure, lines, wrinkles, etc. which might otherwise influence the rater's judgments of the presence or absence of particular action units.

The second segment (Segment 2) was a baseline segment taken from the first 6 consecutive seconds which were scorable of each subject's videotape. (It was possible for the baseline and neutral segments to overlap.) This segment was selected to provide a record of spontaneous facial expression (if any) which would be compared with facial behaviour during other segments.

The third segment (Segment 3) corresponded to the 6 second "window" around the instant identified as marking the point the subject had identified as the peak of the discomfort he or she had felt during the most painful movement of the standardized protocol. This segment was chosen so that it could be compared with the experimenter's and the physiotherapist's judgment of the same moment.

The fourth segment (Segment 4) corresponded to the 6 second "window" around the moment which marked the point the physiotherapist had identified as the peak (in her judgment) of the discomfort experienced by the patient during the most painful event. This segment was chosen to be compared with the experimenter's and the subject's judgment of the same moment.

The fifth segment (Segment 5) corresponded to the 6 second "window" around the time which represented the experimenter's judgment of the moment of greatest facial activity. In order to make this judgment the experimenter reviewed the section of each subject's videotape involving the standardized protocol. After ascertaining which diagnostic movement the subject had identified as being the most painful or uncomfortable, the complete section of the tape involving that particular movement was viewed until the experimenter could identify the point at which the greatest amount of global facial activity was taking place.

This segment was chosen to be compared to the subject's and the physiotherapist's judgments of the same moment. The purpose of ascertaining the moments that the subject and the physiotherapist would identify was to validate the experimenter's choice. Thus, it was assumed that the three segments would overlap substantially or be identical. Visual inspection of the data revealed that this seemed to be the case. Preliminary analyses were planned to determine if, nonetheless, any differences in AU type or frequency existed among the three segments.

The sixth segment (Segment 6) corresponded to the 6 second "window" around the time which represented the exprimenter's judgment of the moment of greatest facial activity during the repeat of the movement previously identified by the subject as being the most painful. This segment was chosen to be compared to the subject's, physiotherapist's and experimenter's judgments of the initial presentation of the most painful movement. The purpose was to determine if repetition of the painful stimulus would result in any habituation effect as measured by reduced facial activity.

The seventh segment (Segment 7) corresponded to the masked expression of the subject. As almost all subjects were quite successful in substantially attenuating or even eliminating most facial activity under the masked instructions, it was difficult, if not impossible to determine where the peak of the painful experience occurred. In order to produce a 6 second segment which would be most likely to encompass this peak the following procedure was followed: As the movement involved was completed the physiotherapist would always say "okay". The tape was therefore stopped as close to the beginning of the verbalization of "okay" as possible and the accompanying TDG number sequence noted. Six seconds counted back from this number sequence provided the segment. Reviewing the entire section revealed that this 6 seconds included most of the movement sequence for all subjects. The masked segment was compared with the baseline, pain and posed segments.

The eighth segment (Segment 8) corresponded to the posed expression of the subject. The 6 second window was placed around the moment that represented the experimenter's judgment of the greatest amount of global facial activity during the pose. This segment was chosen for comparison to the baseline, pain and masked segments.

Segments 1 through 7 were then reordered randomly for each subject for coding purposes. The FACS data coders were blind as to the nature of each segment (other than the neutral and baseline segments) as well as to the group membership (i.e., Instructional Set) of each subject.

The data coders were a full-time research assistant who coded 40% of the subjects, a part-time undergraduate researcher who coded 60% of the subjects and a graduate research assistant who did the reliability coding. All three individuals were thoroughly trained and experienced in the use of FACS, and had successfully met the reliability criteria for scoring required by the authors (Ekman and Friesen, 1978a) for certification as proficient FACS coders.

Each segment of the videotape (i.e., 2-8) was scored for all 44 facial action units (AUs) and one action descriptor (AD) specified by the FACS system. For each AU or the AD scored in a particular segment, two types of information were derived. First, frequency or number of occurrences of each AU/AD in a segment was recorded. Second, the onset and offset of each AU/AD appearance was scored so that the duration of a facial action in a segment could be calculated. In order to do this, a procedure known as apex scoring was used. According to Ekman and Friesen (1978a), the apex of an AU/AD refers to "the period during which the movement was held at the highest intensity that it reached" (p. 145). There are several reasons why scoring the onset/offset of the apex is preferable to scoring the first indication of appearance/complete decay: First, reliability is likely to be better with apex scoring. Second, Ekman and Friesen suggest that apices may be more critical for defining emotional expression than absolute onset/offset. For example, they suggest that two or more AUs may be regarded as elements of a unitary expression when their apices are observed to overlap in time.

The duration scoring was used in the calculation of the reliability of the coders. A complete list of the facial action units and the action descriptor specified by the FACS system and used in the present study may be found in Appendix 6.

Global Expressiveness Ratings

The primary rater was a male, part-time research assistant who rated 100% of the subjects. The secondary rater was a female, part-time research assistant who did the reliability coding, rating 50% of the subjects. Both coders were well trained, having spent 10 hours in training sessions and a further 8 hours in practice rating and were able to reach a high level of reliability. (Neither coder had any familiarity with FACS.)

In making the ratings, the raters were informed that all the subjects to be judged had, indeed, experienced pain and that the task of the rater was to judge the degree to which each subject expressed that pain. The raters were blind as to the group membership (i.e., Instructional Set) of the subjects. The ratings were made on a 3 point scale (inexpressive, somewhat expressive, very expressive) according to the presence and intensity of particular signs (see Appendix 7). The rating was to be based on the subject's facial expression during the most painful movement of the standardized protocol. The TDG number sequence for segment 5 (the experimenter identified pain segment) was provided for each subject so that the raters could identify the peak of the expression. In order for the raters to have a more general context in which to place each subject's expression of pain, the TDG number sequences identifying the beginning and the end of the entire standardized protocol were also provided. In those instances where a decision between adjacent points on the scale was particularly difficult, the raters were instructed to view the section of the tape involving the repeat of the painful movement.

RESULTS

The results of the study are presented in five separate sections. First, the reliability figures are given for the global judgments of facial expressiveness and the FACS scoring of subject facial expressions. Second, descriptive statistics are given for the demographic variables. The third section outlines an analysis of the effects of the independent variables (Sex, Instructional Set) on the various self-report measures of pain sensitivity and on the ratings of Global Expressiveness. The purpose of these analyses was to determine the effect of sex on self-report and of sex and instructional set on the ratings judges made of overall facial expressiveness.

The fourth section presents an analysis of the FACS data. An analysis was performed to determine which segment from among the subject, physiotherapist and experimenter identified segments would be designated as the "pain" segment and whether any habituation had occurred during the repeat of the painful movement segment. A subsequent analysis examined the effects of sex, instructional set, and segment type on the occurrence of AUs during the pain, masked, posed and baseline segments. A factor analysis was conducted to determine if any meaningful combinations of AU's existed.

The fifth section presents the regression analyses performed to examine the relationships among selected demographic variables, the self-report variables and selected FACS variables.

Due to the large number of analyses performed in the study the issue of making Type I errors arose. While an experimentwise error rate of .01 was not used, this more stringent criterion was applied to certain of the more complex analyses in an attempt to reduce the likelihood of making such errors. Thus the MANOVA involving the demographic, self-report and global expressiveness variables; the FACS analyses (excluding the factor analysis); and the multiple regressions all required that the .01 level of significance be reached before rejecting the null hypothesis.

Reliabilities

Judges' Ratings of Global Expressiveness

A reliability check of the ratings of global expressiveness was conducted. The reliability coder scored a random sample (subject to the constraint that equal numbers of each sex and each instructional set were represented) of 50% of the data set scored by the primary coder. In order to determine interrater reliability two types of correlations were used: Pearson's "*r*" and an intraclass correlation procedure (Haggard, 1958). Haggard suggests that the intraclass correlation statistic, *R*, is the appropriate measure when only one variable is involved, such as judges ratings of some factor, whereas *r*, the Pearson correlation coefficient, should be used when two variables (e.g., height and weight) are to be correlated. Thus *R* is well suited to be used in determining reliability, where the purpose is to determine the similarity of scores, each of the same kind, from a number of individuals. However, as *r* is the more commonly used statistic, it was calculated as well.

The intraclass correlation was calculated according to the following formula:

$$R = \frac{\text{Between Class Mean Square - Within Class Mean Square}}{\text{Between Class Mean Square + (k-1) Within Class Mean Square}}$$

The resultant intraclass correlation figure was .92 which was well within acceptable limits.

The resultant Pearson r figure was .87, again well within acceptable limits.

FACS Scoring of Subject's Facial Expressions

Reliability scoring was performed on a random sample of 14% of the data coded by the primary coder, subject to the constraint that all subjects were represented in the reliability check. To meet this criterion, an independent "blind" coder scored one segment chosen at random from the seven videotape segments obtained from each of the 120 subjects. Percent Agreement was calculated according to the formula recommended by Ekman and Friesen (1978a):

$$\text{Percent Agreement} = \frac{\text{No. of Agreements x 2}}{\text{Total no. of AU's scored}}$$

(This form of percent agreement was used rather than one which utilized both occurrence and nonoccurrence agreement. Had the latter been used the reliability would have been inflated as the nonoccurrence of many of the 44 AUs was often far more frequent than the occurrence;

cf. House, House & Campbell, 1981.) An agreement was scored only if two coders reported the AU/AD as occurring at the same point in a segment as defined below. For the one AD scored, and the majority of AU's, an agreement was scored if the time during which an AU/AD was said to have occurred overlapped with that reported by the other scorer. For AU 45 (blink), which is, by definition, brief in duration, the two scorers had to concur within .2 seconds on the time of occurrence for an agreement to be scored. Under this requirement, the overall percent agreement figure was 76%. This is within the range of the figures reported in most other FACS papers. Ekman and Friesen (1978a) reported a frequency reliability figure of 76% as did Ekman, Friesen and Ancoli (1980). The figure reported by Ekman, Hager and Friesen (1981) was high (87%) but this figure was based on very limited set of deliberately performed actions which probably showed less ambiguity. Kappa was lower, i.e., .63. Craig and Patrick (1984) reported an overall percent aggreement figure of 71% and Patrick et al. (in press) reported a figure of 74%. Thus it can be seen that the reliability figure obtained in the present study lies well within the acceptable range.

Demographic Data

In order to determine whether any differences existed between males and females on the uncontrolled subject variables (see Table 1), the sex distributions on the variables were examined. A two-way (Sex x Instructional Set) multivariate analysis of variance (MANOVA), which included selected demographic variables, showed that the two groups did not differ significantly in terms of age, duration of chronic and/or acute complaint or the number of back operations ($p < .05$) (see Appendix 8a). Chi-square analyses of sex and education level ($10 \times 2\ \chi^2$); ethnic group ($18 \times 2\ \chi^2$); locus of complaint ($4 \times 2\ \chi^2$); disposition ($16 \times 2\ \chi^2$) or diagnosis ($19 \times 2\ \chi^2$) did not yield any significant results. However, the chi-square analysis for disability status ($2 \times 2\ \chi^2$) did show an uneven distribution over the two groups; $\chi^2(1) = 9.41$, $p < .005$ as previously noted. The males were receiving or hoping to receive financial benefits more often than the females.

Self-Report Variables

Subject responses to the McGill Pain Questionnaire subscales for both acute and chronic pain and to the Gracely pain descriptor scales for induced, acute pain were included as dependent measures in a 2 x 2 (Sex x Instructional Set) Multivariate Analysis of Variance (MANOVA). Judge's ratings of global expressiveness were also included as dependent variables in this analysis. However, the results will be discussed in a separate section. The subscales on the McGill questionnaire consist of the number of words chosen and the sensory, affective and evaluative scales. The Gracely consists of three scales, measuring sensory intensity, unpleasantness and painfulness. The four scores from the "acute pain" administration of the MPQ and the three from the Gracely verbal descriptor scales corresponded to the pain which the patient indicated he or she felt during "the most painful movement" of the physiotherapy protocol. These scores were based on the subject's recall of the pain about twenty minutes after the actual event. The four scores from the "chronic pain" administration of the MPQ corresponded to the subject's report of the amount of pain he or she experienced during an average or typical day.

The multiple omnibus F indicated a marginally significant difference for the main effect of Sex, $F_{(16,101)} = 2.098$, $p < .05$. To determine which of the dependent measures were responsible for the overall Sex effect, individual multiple comparisons were conducted at the $\alpha = .01$ level using the Bonferroni (BON) procedure on the univariate analyses of each of the dependent variables for the sex effect. (That is, each univariate analysis was tested at the .01/16 or .0006 level for significance.) Results of the BON tests showed that the two sexes differed only on judges' ratings of global expressiveness, $F(1,116) = 13.53$, $p < .0001$) The two sexes did not differ significantly on any of the other self-report variables included in the analysis. The overall tests for the Instructional Set main effect, $F_{(16,101)} = .590$, $p > .50$ and the Sex x Instructional interaction effect, $F_{(16,101)} = .943$, $p > .50$ were not significant. This analysis is summarized in Appendix 8a, and group means for the dependent measures appear in Table 3.

As there were no significant differences between males and females on the self-report data the scores of the two groups were combined in all further analyses. The combined scores of the "chronic" MPQ were compared to the normative data on the MPQ provided by the Shaughnessy Hospital Back Pain Clinic (F. Gagnon, personal communication, 1984). Single sample t-tests were used to make the comparisons as the combined study scores were not completely independent of the clinic data. The scores

TABLE 3

Group Means and Standard Deviation (in Parentheses) for Self-Report Measures

Measure	No Non Verbal Enhancing Instructions				Non Verbal Enhancing Instructions			
	Males		Females		Males		Females	
	M	SD	M	SD	M	SD	M	SD
Acute MPQ NWC	10.57	(4.33)	9.23	(4.45)	9.10	(4.35)	7.90	(4.27)
Acute MPQ Sensory Scale	14.77	(6.09)	14.50	(7.02)	13.57	(7.21)	12.27	(7.68)
Acute MPQ Affective Scale	2.00	(2.24)	1.60	(1.96)	1.67	(2.12)	1.40	(2.47)
Acute MPQ Evaluative Scale	2.60	(1.65)	2.77	(1.56)	2.37	(1.56)	2.07	(1.48)
Gracely Sensory Scale	11.33	(2.93)	11.23	(2.70)	10.90	(2.94)	11.00	(2.89)
Gracely Un-pleasantness Scale	8.73	(4.40)	6.97	(4.05)	7.37	(4.30)	7.37	(4.23)
Gracely Painfulness Scale	8.13	(3.43)	7.20	(3.03)	7.57	(2.65)	7.93	(2.78)
Chronic MPQ NWC	12.03	(3.89)	11.43	(4.41)	10.17	(4.38)	10.43	(4.77)
Chronic MPQ Sensory	15.53	(6.88)	17.47	(8.12)	15.77	(7.46)	14.00	(7.11)
Chronic MPQ Affective Scale	3.10	(2.52)	2.57	(2.22)	2.50	(2.13)	2.23	(2.37)
Chronic MPQ Evaluative Scale	2.70	(1.26)	2.57	(1.38)	2.60	(1.04)	2.17	(1.29)

TABLE 4

Means and Standard Deviations (in parentheses) for the "Acute" and "Chronic" MPQ scale scores and for the Normative Data from the Shaughnessy Hospital Back Pain Clinic

Measure	Acute		Chronic		Back Pain Clinic (n = 134)	
	M	SD	M	SD	M	SD
Number of words chosen (NWC)[1,2]	9.2	(4.40)	11.17	(4.36)	12.37	(4.03)
Sensory[1,2]	13.78	(7.00)	15.54	(7.42)	17.20	(7.50)
Affective[1,2]	1.67	(2.19)	2.60	(2.31)	4.07	(4.30)
Evaluative[2]	2.45	(1.57)	2.51	(1.24)	3.20	(2.00)

1. The difference between the "acute" and "chronic" administation of this scale was significant at the $p < .005$ level.

2. The difference between the "chronic" score and the Back Pain Clinic normative data of thhis scale was significant at the $p < .01$ level.

for all four scales of the MPQ were significantly lower for the combined study sample than for the clinic normative data. (NWC $t(1,119) = -7.86$, $p < .01$; Sensory $t(1,119) = -5.33$, $p < .01$; Affective $t(1,119) = -11.97$, $p < .01$; Evaluative $t(1,119) = 9.78$, $p < .01$).

An Hotelling T^2 analysis was conducted to determine if any significant differences existed between the scores on the "acute pain" MPQ and the "chronic pain" MPQ. The overall test was significant $F(4,116) = 13.15$, $p < .0001$ (see Appendix 8b). Multiple comparisons at the .05 level using the BON procedure indicated that for three of the dependent variables, the NWC, Sensory and Affective scales, the scores were significantly lower for the "acute" MPQ as compared to the "chronic" MPQ. There was no significant difference between the two types of MPQ administration for the Evaluative Scale. These results are presented in Table 4.

Intercorrelations Among the Self-Report Measures

As the test for homogeneity of variance was not significant (Box's M, $F(198,28955) = 1.03$, $p < .10$) the self-report data was collapsed across sex and instructional set in order to construct a correlation matrix designed to investigate the relationships among the scores on the "acute pain" MPQ, the "chronic pain" MPQ and the Gracely. (See Table 5). The correlations among the scales of the two self-report measures of the subject's acute pain felt during the physiotherapy protocol (i.e., the "acute MPQ" and the Gracely) all showed significant positive correlations with one another. However, the two sensory scales correlated more highly with the other scales measuring affective distress and subjective overall

TABLE 5

a. Correlations Between the Acute MPQ and the Gracely

		Gracely		
		Sensory	Unpleasantness	Painfulness
Acute MPQ	NWC	.40*	.46*	.36*
	Sensory	.29*	.37*	.31*
	Affective	.45*	.50*	.46*
	Evaluative	.58*	.59*	.57*

*$p < .001$

b. Correlations Between Acute MPQ and the Chronic MPQ

		Chronic MPQ			
		NWC	Sensory	Affective	Evaluative
Acute MPQ	NWC	.70**	.59**	.53**	-.04(ns)
	Sensory	.65**	.63**	.40**	-.03(ns)
	Affect-ive	.50**	.40**	.58**	-.01(ns)
	Evalu-ative	.21(ns)	.17(ns)	.27**	.23*

* $p < .05$
** $p < .005$

intensity than they did with one another. This suggests that each of the two scales is measuring a rather different aspect of the sensory experience than the other. The McGill items have been analyzed to yield as many as five factors, for example, Crockett, Prkachin & Craig, 1977. In such analyses the sensory scale often loads on two factors. Thus, it is possible that had a four or five factor solution been employed in the present study, the correlation between the Gracely sensory scale and one or other of the refactored McGill sensory scales would have been higher.

The correlations among the scales of the "acute pain" MPQ and the "chronic pain" MPQ showed, for the most part, significant positive correlations. The two evaluative scales correlated only modestly with one another in comparison to the relatively substantial correlations between the two sensory scales, the two affective scales and the number of words chosen (NWC) on each administration of the questionnaire.

Global Expressiveness Analysis

As previously noted, the main effect for Sex was marginally significant in the 2 x 2 (Sex x Instructional Set) MANOVA which included the variable of global expressiveness. The multiple comparisons for the Sex effect revealed that it was this variable which was statistically significant $\underline{F}(1,116) = 13.53$, $\underline{p} < .0001$.

The mean rating for males was 1.93 whereas that for females was 2.40. An analysis of proportions (Glass and Stanley, 1970) clarified the picture. More males than females, $\underline{Z} = 3.47$, $\underline{p} < .01$ were rated as inexpressive and more females than males, $\underline{Z} = -2.48$, $\underline{p} < .05$ were rated as very expressive. There was no significance in the numbers of males and females rated as somewhat expressive (see Table 6).

Analysis of FACS Data

Identifying the Principal Pain Related Action Units

As mentioned previously, each of the seven video segments was coded for the 44 AUs and one of the 20 ADs specified by the FACS system. Before proceeding with the statistical analysis of these data it was necessary to identify within this large quantity of dependent measures those specific to the phenomena of major interest.

First the one AD (talking) was eliminated because it was of no interest in the study. Then the infrequently occurring AUs were removed from further consideration. The inclusion criterion for AU frequency was an average of more than six occurences of an AU averaged over all seven segments for all 120 subjects (i.e., more than 6/840). An AU was eliminated if it showed a lower average frequency than this when occurences for all 120 subjects were summed and then averaged over all segments. Of the 44 scorable actions specified by the FACS system, 14 remained after these exclusion criteria were applied (see Table 7).

As noted, seven videotape components were identified for each subject: baseline, subject identified pain, physiotherapist identified pain, experimenter identified pain, repeat of the painful movement, masked pain and posed pain. Two forms of agreement were calculated for the subject, physiotherapist and experimenter identified pain segments. The first was agreement on the most painful movement and the second was agreement on the moment of greatest distress within the chosen movement

TABLE 6

Facial Expressiveness Rating Frequencies

	Inexpressive	Somewhat Expressive	Very Expressive	Total
Sex				
Male	19	26	15	60
Female	4	28	28	60
Total	23	54	43	120

TABLE 7

Action Unit (AU) Categories Remaining After Application of Exclusion Criteria; Frequency Means and Standard Deviations (in Parentheses) per Subject for Baseline, Pain, Masked and Posed Segments

AU	Baseline		Pain		Masked		Posed	
	M	SD	M	SD	M	SD	M	SD
1(inner brow raise)	.108	(.338)	.183	(.41)	.05	(.219)	.225	(.493)
2(outer brow raise)	.117	(.371)	.192	(.436)	.05	(.219)	.225	(.476)
4(brow lowerer)1	.067	(.250)	.292	(.509)	.167	(.417)	.592	(.642)
6(cheek raise)1	.075	(.295)	.233	(.463)	.050	(.254)	.475	(.621)
7(lids tight)1	.008	(.091)	.142	(.416)	.10	(.328)	.158	(.389)
10(upper lip raise)1	0.0	(0.0)	.108	(.384)	.008	(.091)	.15	(.496)
12(lip corner pull)1	.133	(.429)	.258	(.572)	.117	(.371)	.725	(.84)
17(chin raise)	.042	(.239)	.083	(.18)	.042	(.239)	.83	(.278)
18(lip pucker)	.025	(.203)	.075	(.295)	.017	(.129)	.05	(.314)
20(lip stretch)	.050	(.219)	.083	(.278)	.008	(.091)	.125	(.401)
25(lips part)1	.342	(.667)	.575	(.729)	.208	(.428)	.567	(.753)
26(jaw drop)1	.292	(.640)	.35	(.617)	.25	(.53)	.35	(.644)
43(eyes closed)1	.100	(.363)	.358	(.547)	.142	(.373)	.475	(.733)
45(blink)1	4.242	(2.948)	4.033	(3.07)	3.008	(2.627)	2.95	(2.863)

1Consistent with Craig and Patrick's (1985) and/or Patrick, et al.'s (in press) findings.

section of the tape. Agreement in the latter case was considered to exist if the 6 second segments overlapped. At least two of the three individuals (subject, physiotherapist and experimenter) agreed 96 percent of the time on which movement was the most painful. At least two of the three individuals agreed on the 6 second segment 95 percent of the time.

A one-way MANOVA (subject, physiotherapist, experimenter identified segments, repeat of the painful movement segment) using, as dependent variables, the 14 AUs remaining after the exclusion criterion was performed. The overall F test was not significant indicating that there were no significant differences among the four segments. Segment 3 (experimenter identified pain segment) was chosen for use in the subsequent analysis.

Group Comparisons

A 2 x 2 x 4 (Sex x Instructional Set x Segment) repeated measures MANOVA was performed using, as dependent variables, the 14 AUs remaining after the exclusion criteria were applied. The first two factors in the analyses were the male/female and instruction/no instruction dimensions. The third factor was the repeated measures factor: the MANOVA compared facial activity of the different groups during the four segments; pain, masked, posed and baseline expressions. The only significant main effect was the segment effect, $F_{(42,944)} = 6.83$, $p < .0001$; none of the interactions was significant (see Appendix 9). BON comparisons for the segment effect ($\alpha = .01/14$ level) revealed a significant difference on nine of the dependent measures: AUs 2, 4, 6, 7, 10, 12, 25, 43, and 45. (See Table 8)

Tukey comparisons were then carried out for each of the dependent measures at the .0007 level (i.e., .01/14). (A linear interpolation based on tables by Harter (1960) was used to generate the values for the .0007 level.) Only two AUs (4 and 43) occurred significantly _more_ frequently in the pain segment than in the baseline segment. No AUs occurred _more_ frequently during the masked segment than in the baseline segment but one AU (45) occurred significantly _less_ frequently. Four AUs (4, 6, 12 and 43) occurred significantly _more_ frequently and two AUs (7 and 10) were marginally more frequent in the posed segment than in the baseline segment. One AU (45) occurred significantly _less_ frequently during the posed segment.

One AU (25) occurred significantly _more_ frequently in the pain than in the masked segment. In addition two AUs (43 and 45) occurred marginally _more_ frequently in the pain segment. Three AUs (4, 6 and 12) occurred significantly _less_ frequently in the pain than in the posed segment. One AU (45) occurred significantly _more_ frequently in the pain segment (See Table 9 and Appendix 10).

Factor Analysis of FACS Data

The 14 AUs remaining after the application of the frequency criterion (i.e., those which occurred an average of greater than six times for all subjects over all seven segments) were used as dependent variables in the factor analysis. The purpose of the analysis was to explore the possibility that some underlying pattern of relationships might exist for the AUs. In particular, it was of interest to

TABLE 8

AU's Appearing More Frequently During Painful Movement, Masked and/or Posed Segments: Frequency Means and Standard Deviations (in Parentheses) for Baseline, Masked and Posed Segments

AU	Baseline		Pain		Masked		Posed	
	M	SD	M	SD	M	SD	M	SD
2(outer brow raise)	.117	(.371)	---	---	---	---	---	---
4(brow lower)	.067	(.250)	.292	(.509)	---	---	.592	(.642)
6(cheek raise)	.075	(.295)	---	---	---	---	.475	(.621)
7(lids tight)	.008	(.091)	---	---	---	---	.158	(.389)[2]
10(upperlip raise)	0.0	(0.0)	---	---	---	---	.150	(.496)[2]
12(lip corner pull)	.133	(.429)	---	---	---	---	.725	(.84)
25(lip part)	.342	(.667)	---	---	---	---	---	---
43(eyes closed)	.100	(.353)	.358	(.547)	---	---	.475	(.733)
45(blink) [1]	4.242	(2.948)	---	---	3.008	(2.627)	2.95	(2.863)

1. AU 45 occurred less frequently in the masked and posed segments than during the baseline segment.

2. This AU occurred marginally more frequently as compared to baseline.

TABLE 9

Post Hoc Comparisons (Tukey procedure) of the Segment Effect
Dependent Measures: AUs 2, 4, 6, 7, 10, 12, 25, 43 and 45

	Comparison				
AU	Segment 5[b] vs 2[a]	Segment 7[c] vs 2	Segment 8[d] vs 2	Segment 5 vs 7	Segment 5 vs. 8
2	9(4,347)=2.34	9(4,347)=-2.09	9(4,347)=3.38	9(4,347)=4.44	9(4,347)=-1.03
4	9(4,347)=6.08*	9(4,347)=2.70	9(4,347)=14.19*	9(4,347)=3.38	9(4,347)=-8.11*
6	9(4,347)=4.27	9(4,347)=0.68	9(4,347)=10.81*	9(4,347)=4.95	9(4,347)=-6.54*
7	9(4,347)=4.79	9(4,347)=3.29	9(4,347)=5.36**	9(4,347)=1.50	9(4,347)=-0.57
10	9(4,347)=3.72	9(4,347)=0.28	9(4,347)=5.17**	9(4,347)=3.45	9(4,347)=-1.45
12	9(4,347)=2.50	9(4,347)=0.32	9(4,347)=11.84*	9(4,347)=2.82	9(4,347)=-9.34*
25	9(4,347)=4.48	9(4,347)=2.58	9(4,347)=4.33	9(4,347)=7.06*	9(4,347)=-0.15
43	9(4,347)=6.0*	9(4,347)=0.98	9(4,347)=8.72*	9(4,347)=5.02**	9,4,347)=-2.72
45	9(4,347)=0.21	9(4,347)=-6.47*	9(4,347)=-6.34*	9(4,347)=5.37**	9(4,347)=5.68*

a = Baseline Segment
b = Pain Segment
c = Masked Segment
d = Posed Segment

* $p > .0007$
** = marginal

determine if the AUs found to be of interest in previous research (Craig & Patrick, in press; Patrick et al., in press) would group together in any meaningful way.

The correlation matrix of the 14 AUs was subjected to a principal-component analysis and to a maximum-likelihood common factor analysis. The purpose of the component analysis was to obtain the latent roots of the correlation matrix for use in deciding on the correct number of factors to retain. The Kaiser-Guttman rule of retaining as many factors as there are latent roots of the correlation matrix which exceed 1.0 suggested that six factors be retained. Cattell's (1966) scree test on the latent roots gave no clear indication as to the number of factors to be retained. The results of the likelihood ratio tests associated with the maximum-likelihood common factor analysis yielded the following results: For three factors, $\chi^2(52) = 76.32$, $\underline{p} < .05$; for four factors, $\chi^2(41) = 49.90$, $\underline{p} < .10$. From these results it was decided to test hypotheses that either three or four factors might provide the most meaningful interpretation of the data.

An unweighted least-squares common-factor solution was obtained for each of the two previous solutions. Each solution was rotated (using the Kaiser-Harris procedure) to the oblique simple structure which allowed the clearest interpretation. The four factor solution transformed using the Kaiser-Harris procedure (with the power parameter, $\underline{c}$, set to .50) yielded the optimal results. This solution is presented in Table 10 and the intercorrelations among the four factors are shown in Table 11.

The four factors were tentatively labelled according to the AUs loading most heavily on them or on the basis of a subjective impression of the underlying expression. The labels are as follows: Factor I - eye brow raise; Factor II - smile; Factor III - pain; Factor IV - lower face actions probably related to speech.

Relationships Among the Variables

Relationship of Selected FACS AUs and Global Expressiveness

A full stepwise multiple regression was performed to examine the relationship between judges' ratings of global expressiveness and facial activity in the pain segment. The predictor variables were the six AU frequency variables which showed the greatest difference in the expected direction between baseline and the genuine pain segment: AUs 4, 6, 7, 10, 25 and 43. The criterion was the judge's rating of global expressiveness assigned to each subject. As males and females differed only marginally on the criterion variable of global expressiveness a combined regression analyses was performed for both groups.

The regression coefficient was significant up to the second "step" of the analysis, $F(2, 117) = 21.16$, $p < .0001$, at which stage AUs 43 and 6 had entered the equation (see Appendix 11a). Judge's ratings of global expressiveness were significantly predicted by the frequency of AU 43. AU 6 significantly improved the prediction, but AUs 4, 7, 10 and 25 were irrelevant.

Relationship of Selected FACS AUs and Self-Report

A series of full stepwise multiple regressions was performed to

TABLE 10

Oblique Primary Factor Pattern Matrix at Optimal Position of Simple Structure

AU	C-1	C-2	C-3	C-4
01	0.985	0.104	0.048	0.036
02	0.914	0.064	-0.009	-0.030
04	0.371	0.095	0.685	-0.097
06	-0.092	-0.968	0.103	0.136
07	0.140	-0.060	0.160	-0.031
10	-0.150	0.011	0.563	-0.040
12	0.141	-0.613	0.022	-0.041
17	0.053	-0.013	0.109	0.278
18	-0.001	0.013	0.097	0.683
20	-0.054	-0.018	-0.080	0.307
25	-0.069	-0.060	0.291	0.324
26	0.022	0.085	-0.050	0.227
43	0.141	0.024	0.193	0.000
45	0.082	0.135	-0.098	-0.050

TABLE 11

Intercorrelation Matrix Among the Primary Factors

	1	2	3	4
1	1.000			
2	0.101	1.000		
3	-0.004	0.130	1.000	
4	-0.027	0.058	0.039	1.000

examine the relationship between the self-report variables and facial activity in the pain segment. The predictor variables were again the six "pain" AUs. The criterion variables were the four McGill scales (acute instructions) and the three Gracely verbal descriptor scales. As there were no significant differences between males and females on these variables the analyses were performed on the combined data for the two groups. Only those analyses which resulted in at least one significant regression coefficient will be reported.

Relationship of the "Pain" AUs and the McGill Scales

Evaluative Scale

The regression coefficient was significant only at the first "step" of the analysis, $F(1,118) = 15.16$, $p < .0005$, at which stage only AU 6 had entered the equation (see Appendix 11b).

Relationship of the "Pain" AUs and the Gracely Scales

Painfulness Scale

The regression coefficient was significant only at the first "step" of the analysis, $F(1,118) = 11.72$, $p < .001$, at which stage only AU 6 had entered the equation (see Appendix 11c).

Relationship of Selected Demographic Variables, Self-Report of Chronic Pain and Global Expressiveness

Two further full stepwise multiple regressions were performed to examine whether the judges' ratings of global expressiveness were related to two demographic variables and the self-report of chronic pain. The predictor variables were disability status, duration of complaint, and the four scales of the MPQ (chronic pain). The criterion was the judge's rating of global expressiveness assigned to each subject. As noted previously, males and females differed only marginally significantly on the criterion variables of global expressiveness. However, as they differed significantly on the predictor variable of disability status separate regression analyses were performed for each group.

There was no relationship between the demographic variables, self-report and global expressiveness for either males or females. The inclusion limits ($p < .01$) were reached at the first step of the analysis for each group.

DISCUSSION

The demographic data are discussed first followed by a discussion of the findings for the self-report variables. The results of the global expressiveness ratings are discussed next, together with a discussion of the relationship between these ratings and several demographic variables. This is followed by a discussion of the FACS analysis of the facial behaviour in the genuine pain, masked and posed segments and a discussion of the factor analysis of the FACS data from the genuine pain segment. A discussion of the relationships of the six AUs, which showed the greatest difference between the genuine pain segment and baseline, and global expressiveness and between the same AUs and the self report variables follows. Finally, a summary and an analysis of the implications for future research completes the discussion.

Demographic Variables

The characteristics of the sample used in the present study were similar to those used in several other studies of low back pain populations (e.g., Garron & Leavitt, 1979; Keefe & Block, 1982) in terms of age and education level. There were no sex differences on the demographic and clinical variables with the exception of disability status. The difference between males and females in terms of who was receiving or hoping to receive financial benefits was not unexpected as it reflected the situation of the general Back Pain Clinic patient population. The proportions were somewhat different as only approximately twice as many males as females were being or hoping to be financially compensated in the present study, as compared to almost three times as many males as females in the general clinic population (F. Gagnon, personal communication, 1984).

Self-Report Measures

McGill Pain Questionnaire

There were no differences between males and females on either the "acute" or the "chronic" administration of the MPQ verbal descriptor scale (Sensory, Affective and Evaluative scales and the Number of Words Chosen scale). It was difficult to find published data with which to compare the MPQ scale scores obtained in the present research. Most of the published studies of low back pain have focussed on refactoring the individual items on the questionnaire and have not reported the scores on the three factors suggested by Melzack (1975). Melzack (1975) does report data on a very small (n = 14) sample of low back pain patients and the scores were similar to those of the present study on the "chronic" administration of the MPQ.

It was possible to compare the scores of the "chronic" MPQ to the data collected by the Back Pain Clinic (F. Gagnon, personal communication, 1984). The scores provided by the clinic were significantly higher than those obtained in the present study. A possible source of this discrepancy was the differing demand characteristics of the two administrations of the MPQ, that is, the clinic's versus the present study's. In filling out the MPQ for the clinic assessment it seemed the individual would likely wish to emphasize his or her discomfort as part of an overall strategy to obtain help.

1

When filling out the MPQ for research purposes there would be no additional hope of potential treatment, thus the patient would tend to present a more candid picture of their discomfort. In partial support of this explanation, Dworkin (1970), in a study of absolute pain thresholds and pain tolerance, found that measures of these three variables were accompanied by significantly lower stimulus intensity measures in a dental setting compared to the laboratory. More studies need to be done on the impact of demand on reports of pain in clinical settings.

Another possible source of discrepancy was the method of administration. In the clinic the patient either sat down at a computer terminal and typed in the responses or filled out a form. In either case there was no immediate help available to answer questions or to emphasize the instructions that words need not be chosen from each of the 20 groups. In the present study the experimenter sat with the subject as he or she filled out the questionnaires, clarified the instructions, answered questions about the meaning of certain words, etc. It was possible that this latter procedure resulted in subjects choosing only those words they were sure described their discomfort. The clinic procedure may have resulted in additional words being chosen because the patient had a "better be safe than sorry" approach to filling out the questionnaire.

The scores on the "acute" and the "chronic" administrations of the MPQ differed significantly. The Number of Words Chosen, the Sensory and the Affective scale scores were all lower for the acute administration.

One possible explanation was that the pain suffered during the most painful movement was indeed less than that usually experienced on a day to day basis. As regards the Affective scale score it seemed likely that the pain experienced during a movement designed specifically to induce low back pain discomfort (if that was the problem area) may have had quite a different emotional impact from that experienced during more mundane activities. The patient may not have been too surprised that certain movements in the clinic assessment elicited pain and emotional factors may not have been too important. However, when an action that is frequently performed causes pain, for example, the forward extension of leaning over the sink, or counter, it is probably more distressing to the patient because it interferes with the ability to carry out normal activities.

McGill Pain Questionnaire and the Gracely Scales

The relationship between the "acute" administration of the MPQ (Melzack, 1975) and the Gracely scales (Gracely et al., 1978; 1979) was also examined. This comparison was of interest as the two were developed using different procedures. The MPQ was developed using category scaling procedures whereas the Gracely scales were developed using cross modality matching procedures. All the scales correlated positively and significantly with one another (see Table 5), but close inspection reveals that the correlations ranged only from .29 to .59. The lowest correlation was between the two scales measuring the sensory aspect of the pain experience and the highest was between the MPQ evaluative scale and the Gracely unpleasantness scale (a measure of affective distress).

The MPQ and Gracely measures of affective distress correlated at the .50 level and the MPQ Evaluative scale and Gracely Painfulness Scale correlated at the .57 level. While there is some overlap between the MPQ and the Gracely Scales there is some indication that they are also measuring different facets of each aspect of the pain experience.

Global Expressiveness

The manipulation to influence overall or global facial expressiveness of painful distress was not successful; that is, the instructions to try to be as expressive as possible of painful distress did not influence measured expressiveness. Previous research (Ekman, 1977; Kleck et al., 1976; Kraut, 1982) has shown that people tend to attenuate their facial expressiveness in the presence of an observer due to display rules or other factors. It was thought that by emphasizing the desirability of being as nonverbally expressive of painful distress as possible, the attenuation problem might be circumvented. There were several possible explanations as to why this manipulation was ineffective. First, it was possible that the particular instructions used were simply not powerful enough to overcome the effect of the display rules. Alternatively, it may have been that the demand characteristics of the situation were such that all the subjects were already as expressive as possible. However, this seemed unlikely given that 23 subjects were rated as inexpressive. Had the manipulation been a powerful one, presumably the individuals who received the nonverbal enhancing instructions would have been rated as being at least somewhat expressive. It may have been that the display rules which govern facial expressiveness of pain are so overlearned that the brief instructions employed here failed to circumvent them. However, only further research utilizing a more powerful manipulation than that employed in the present study would be able to address the question.

The present study found that judges rated women as marginally more expressive of painful distress than the men. Almost twice as many women were rated as being very expressive whereas almost five times as many men were rated as being very inexpressive. These results were consistent with the findings of previous research which found that judges correctly categorized slides of emotional expression exhibited by females more often than those of males (Buck, Miller & Caul, 1974) and that women evidence more facial electromyographic activity than men while imagining several different emotion eliciting situations (Schwartz, Brown & Ahern, 1980).

The relationship of global expressiveness to self-report of pain ("chronic" MPQ), duration of complaint and disability status was also examined. The results indicated that no consistent relationship existed for either the males or the females.

It is of particular interest that no consistent relationship between the predictor variables and the criterion variable was found for the males. An examination of the correlation matrix revealed that all six predictor variables correlated at a low level with the criterion variable. The lack of a relationship between disability status (that is, compensation) and global expressiveness was noteworthy because slightly over half of the males were receiving or expecting to receive financial compensation. Receiving or hoping to receive financial benefits may be a factor which serves as a reinforcer of pain behaviour although the evidence regarding the effect of compensation on pain behaviour is conflicting (Kremer, Block & Atkinson, 1983). It would seem that, for this particular group of males at least, reinforcement for pain behaviour (in the form of global facial expressiveness) does not bear any relation to whether compensation is involved thus adding to the aforementioned conflict in the literature.

FACS Analysis of Facial Expressive Behaviour

The 14 AUs remaining after the exclusion criteria were applied were used as dependent measures in a global analysis. The purpose of the analysis was to determine whether facial expressions were systematically influenced by the two independent variables in the study (Sex, Instructional Set) or differed during the four segments of interest (baseline, genuine, masked and posed).

The two independent factors (Sex, Instructional Set) were found to have no effect on the occurrence of the 14 AUs, either singly or interactively. Only the repeated measures variable "Segment", had any effect, with nine of the 14 AUs being significant.

It was not expected that the instructional set manipulation would have a particular effect on the FACS variables. The manipulation was aimed at enhancing overall or global expressiveness and it was not known whether this might be achieved by means of an increase in the absolute amount of facial activity, by increased intensity or by both. As the manipulation was unsuccessful in terms of altering global facial expressiveness, the absence of results for the specific FACS variables was not surprising.

It was interesting that sex had no effect on the frequency of the AUs, particularly as males and females differed (at least marginally) in judges' ratings of global expressiveness. It would seem, therefore, that the judges' ratings of males and females were based on some factor other than a difference in frequency of the 14 AUs as investigated here . One possible explanation would be that the global judgments were based on the occurrence of different combinations of the AUs exhibited by the two groups. For example, some AU combinations might conceivably be perceived as "more expressive" and these might be displayed more often by females. Alternatively, any combination of AUs might have been perceived as more expressive than any single AU and perhaps females exhibit more combinations than males. Another possibility may be differences in the intensity of the AUs with females exhibiting AUs of greater intensity than males. Unfortunately intensity ratings have been unreliable due to difficulties with the scoring criteria, so an analysis was not undertaken. Another possibility was that the duration of single AUs or combinations of AUs may have differed between males and females.

There may also have been a systematic sex bias for the judges. Regardless of the sex of the judge, males may have been evaluated differently than females even when the same scoring criteria were used. While the judges were not informed by the experimenter that women have been shown to be better encoders of emotion than men (e.g., Buck et al., 1974), they may have held this expectation. If so, any display of facial activity on the part of a female may have led them to assign a rating of "somewhat" or "very expressive" whereas a male would have had to demonstrate more activity to obtain such ratings.

A further possible explanation related to the issue of individual differences. Subjects varied widely in the manner in which AUs were exhibited and how often a particular AU was displayed when it was present. The majority of the AUs were eliminated as being too infrequent to be of interest. It was possible that females might have shown a greater variety of these more infrequently occuring AUs, albeit unsystematically and, hence, were rated as more expressive.

It was likely that judges' global ratings were based on a number of the aforementioned factors and future research may be able to clarify the situation.

The segment factor was significant as noted. Post hoc comparisons were made using as dependent variables the nine AUs which reached significance in the MANOVA. The following comparisons will be discussed: Genuine versus Baseline; Masked versus Baseline; Posed versus Baseline; Genuine versus Masked; and Genuine versus Posed.

Genuine Pain Expression

This comparison was aimed at identifying the AUs associated with the experience of pain (those AUs significantly more prominant during the administration of the most painful movement as compared to baseline). Only two AUs were found to occur more frequently during the most painful movement: AU 4 (brow lower) and AU 43 (eyes closed). Even these two AUs were not displayed universally by all 120 subjects during the pain segment. Only 45 percent of the subjects exhibited one or both of these two AUs.

It was surprising that so few AUs were found to be prominent during the pain segment (relative to baseline) given the results of the previous studies. Craig and Patrick (1985) found AUs 6/7, 10, 12, 25, 26/27 and 43/45 to be associated with cold pressor pain, and Patrick et al. (in press) found AUs 4, 6, 10, 45 and 7 (the later only marginally significant) to be associated with pain induced by a brief electric shock. Even LeResche (1982), in a study utilizing FACS to score a series of candid photographs that were less than optimal quality for rating purposes, found evidence of AUs 4, 6, 7, 11, 20, 25, 26, 27 and 43.

A possible explanation for the relative lack of results in the present study would be that they were due to differences in the nature of the samples used. Factors such as the use of both sexes versus females only, the wide range of ages and education levels versus more narrow ones, the use of chronic pain patients versus college students, the use of different types of stimuli to induce distress and the different settings used might all account for the difference in the results of the present study. Another possible explanation for the relative lack of results is that the large number of analyses performed in the present study necessitated the adoption of a more stringent criterion of statistical significance to guard against Type I errors. The earlier studies involved a limited number of analyses and thus were able to employ a less stringent level of alpha.

A methodological difference made comparison with the first study in this series difficult. Craig and Patrick (1985) used combined AU "categories" in an attempt to reduce the overall number of AUs for the purposes of statistical analyses. For example, AU 6 (cheek raise) and AU 7 (lids tight) were combined into one category. The use of combined categories was not necessary in the present study because of the substantial sample size. The most notable difference between the results of the present study and the earlier ones was the failure of AU 45 (blink) to distinguish between the pain segment and baseline in the present study. Despite AU 45 being the most frequently occurring of all the AUs (93 percent of the subjects exhibited it, with a range of occurrence per subject of one to 21 times), it occurred less frequently during painful stimulation, albeit nonsignificantly, than during baseline. Craig and Patrick (1985) have postulated that AU 45 may "represent a form of reflexive coping behaviour which appears with increased frequency during any ordeal, independent of other facial activity." Thus, blinking would signal forms of distress other than pain.

If the assumption is made that the administration of the most painful movement qualified as "an ordeal", then it can only be speculated as to why AU 45 did not occur with a greater frequency during this segment. Awaiting the series of range of motion tests could be construed as an ordeal that provoked blinking. Alternatively, a cognitive-based explanation has some plausibility. In the shock study, the subject waited for the shock but had nothing in particular to focus on. In the present study the subject often watched the physiotherapist (despite instructions to look at the ceiling) as she guided the limb through a movement. If this focussing of attention were to be considered a cognitive activity then it might account for the reduced frequency of AU 45, during the painful movement, making it comparable to the baseline frequency. That is, individuals tend to blink less frequently during cognitive activities than when not actively engaged in cognition (Holland & Tarlow, 1972, 1975).

Another plausible explanation has to do with the presence of AU 43 (eyes closed). If the eyes of the subjects were closed more often during exposure to the current painful stimulus than during the previous studies, this would account for the reduced number of AU 45s (AU 43 and AU 45 cannot be scored simultaneously). AU 43 was exhibited by 40 subjects a total of 44 times. The average duration of AU 43 was 1.61 seconds although the range was large (.58 to 6) seconds. It was possible that having one third of the subjects holding their eyes closed an average of one quarter of the time during the pain segment served to decrease the overall number of AU 45s.

Another possible explanation related to the nature of the noxious stimulus in the previous studies as compared to the present study. The cold pressor experience appears to be one of a progressive mounting of pain until the subject signals that it can no longer be tolerated. The electric shock experience is one of brief duration and the intensity can be precisely determined. In the Patrick et al. (in press) study five different precisely controlled current intensities were used. In the present study, the intensity of the noxious stimulus could not be measured independently of self-report and the duration of the stimulus probably varied from subject to subject. For some subjects (judging from both their verbal and nonverbal behaviour) the pain appeared to have a very abrupt onset whereas for others it appeared to onset more gradually. Perhaps these differences in intensity and duration resulted in the "most painful movement" experience being qualitatively different from the cold pressor and shock experiences such that the "reflexive coping" function of AU 45 was not elicited.

Masked Expression

An attempt was made to determine whether any AUs would be associated with the subject's endeavour to attenuate his or her facial expression of pain as compared to the subject's baseline behaviour. None of the AUs occurred more or less frequently than during baseline, with the exception of AU 45 which occurred significantly less frequently. The reduced frequency of AU 45 might be explained with reference to the cognitive explanation put forth in discussing the similar finding in the genuine pain versus baseline comparison. If the conscious effort involved in attempting to control one's facial expression is conceived of as a cognitive activity then it would be predicted that the frequency of blinking would be reduced (Holland & Tarlow, 1972, 1975).

Generally, it appeared that subjects were quite successful in suppressing facial activity (as compared to baseline) while experiencing a movement previously identified as being the most painful of the four making up the protocol.

Posed Expression

Subjects were also requested to pose an expression of painful distress. No model or instructions were provided, so the resulting facial expressions presumably represented either the subjects' impressions of what they looked like when in pain or their impression of how other people look when in pain. Four AUs were found to occur more frequently in the posed segment as compared to baseline: AU 4 (brow lower), AU 6 (cheek raise), AU 12 (lip corner pull) and AU 43 (eyes closed). Two AUs occurred marginally more frequently: AU 7 (lids tight) and AU 10 (upper lip raise). AU 45 again occurred less frequently than during baseline; perhaps again due to the increased frequency of AU 43, or due to cognitive activity related to thinking about a pain face.

The presence of AU 12 may be related to the fact that a number of subjects appeared to be rather self-conscious about posing an expression or expressed amusement after completing the pose. AU 12 plus AU 6 or AU 7 is the combination associated with "felt" smiles (Ekman & Friesen, 1982). When AU 12 appears in the absence of AU 6 or 7 it is considered to be a "false" smile. Apparently false smiles do, however, occasionally occur in the presence of AU 6 or 7. When this is the case, the cue then used to determine if the smile is indeed false, is the duration of AU 12, that is, when the duration is less than two thirds of a second or more than 4 seconds, the smile is considered to be false. Ekman and Friesen (1982) suggested that these false smiles fall into two categories: the "phony" smile where nothing much is felt but the individual endeavors to appear as if a positive emotion is felt; and the "masking" smile in which a strong negative emotion is felt and an attempt is made to conceal such a feeling by seeming to feel positively.

In the present study, according to the aforementioned criteria for felt and false smiles, 35.5 percent of the smiles were felt and 65.5 percent were false. It seemed most likely that the felt smiles were ones of amusement exhibited by subjects after completing the pose. The false smiles seemed to fit the category of the masking smile, that is, those covering up a negative emotion. In the present instance, the most probable negative emotion being covered up would seem to be embarrassment.

Craig and Patrick (1985) reported that AU 12 was one of the set of AUs which differentiated between the cold pressor exposure segments and baseline. This was not the case in the present study or in the results reported by Patrick et al. (in press). In the Craig and Patrick study, AU 12 was most prominent during the first 10 seconds of cold pressor exposure. It would be of interest to determine if these action units represented felt smiles, perhaps associated with laughter at the initial shock of the temperature of the water, or false smiles associated with an attempt to mask some experience of distress. Alternatively, these smiles may fall into a final category labelled by Ekman and Friesen (1982) as "miserable" smiles. The criteria for such smiles were not as well delineated, but apparently appear to be "superimposed" on a clear negative expression rather than appearing as an attempt to mask such an expression.

Up to this point, the assumption has been made that it is valid to consider that hypotheses about action units such as AU 12, made in the context of studies of emotional expression were applicable to studies of expressions of painful distress. While the pain experience has a significant emotional component, it is not an emotion *per se*, having sensory and motivational components as well. The exact nature of the relationship between pain and emotion is unclear and any discussion as to the meaning of an action unit such as AU 12 must be considered as tentative.

Genuine Pain Expression Compared to the Masked and Posed Expressions

The first comparison to be discussed will be that of the Genuine Pain versus the Masked expression. Of the nine AUs serving as dependent variables, only one, AU 25, occurred significantly less frequently during the masked than in the genuine pain segment. Two AUs, 43 and 45, were marginally less frequent in the masked segment. Thus it would seem that the subjects were only somewhat successful in attenuating their facial expression (relative to the pain segment) when requested to do so. LeResche and Dworkin (1984) have noted the importance of ascertaining whether individuals can conceal facial behaviour. The results of the present study seem to indicate that at least partial concealment is possible. Perhaps a more complete concealment could be achieved if the individual had more to gain by doing so than merely complying successfully with a set of instructions.

With regard to the comparison between the genuine and the posed segments, three AUs occurred significantly *more* often in the posed segment: AUs 4, 6 and 12. AU 45 occurred significantly *less* often in the posed segment. The presence of AU 12 in the posed segment relative to baseline has been discussed and the same conclusions are relevant here.

Examination of the raw data revealed that AU 6 occurred with AU 12, 63 percent of the time in the posed segment. Thus, the majority of AU 6s occurred with a smile of some type and, since smiles were evident only in segment 6, this may well have accounted for the increased frequency of AU 6 as compared to the genuine pain segment.

A possible explanation for the greater frequency of AU 4 in the posed segment may be that it is very salient when present in a naturally occurring expression of painful distress. Hence when asked to pose "a pain face" it may be one of the main facial behaviours that comes to mind and is thus exhibited more often even though the individual might not exhibit it in their own spontaneous facial behaviour. The decreased frequency of AU 45 in the posed segment might again be reasonably attributed to cognitive activity. In the posed expression the subject had to visualize a "pain face" and then consciously execute it, all of which would seem to plausibly constitute a cognitive process.

In general, it would seem that the attempts to mask and pose expressions of painful distress were at least partially successful. Even when considering all the AUs exhibited in each segment (that is those AUs other than AU 45, but including those that were eliminated as infrequent or failing to discriminate between a particular segment and baseline) the pattern remained. In examining the raw frequency data it was evident that over twice as many AUs were exhibited in the genuine pain segment than in the masked segment. The overall difference between the genuine and posed segments was less notable, but even so almost half again as many AUs were seen in the posed expression. Posed pain faces displayed a more caricatured pattern than the genuine expression. Including AU 45, the most frequently occuring AU, blurs the pattern, but even here one and a half times more AUs were evidenced in the genuine expression than were seen in the masked.

Factor Analysis of the Genuine Pain Segment

The factor analysis was based on the data from the genuine pain segment. The fourteen AUs remaining after the exclusion criteria were applied to the total data base, served as the variables in the analysis. Four factors emerged from the analysis and were labelled either according to the type of AUs loading most heavily on each or else by some apparent underlying construct. Factor one was labelled "eye brow raise" as AUs 1 and 2, whose joint action results in the raising of the inner and outer corners of the brows, loaded most heavily on this factor. Examination of the raw data reveals that the two AUs co-occurred virtually 100 percent of the time. Given that AUs 1 and 2 were not pain-related this factor would not seem to characterize pain expressions.

Factor two was labelled "smile" due to the fact that AUs 6 and 12 showed the greatest loadings on the factor. AU 6 actually co-occurred with AU 12 sixteen of the 28 times (or 57 percent) it appeared during the pain segment. The prominence of this expression during both the genuine and posed pain expressions emphasizes the interpersonal qualities of pain behaviour and the sensitivity to others that people display even when in pain.

Factor three was labelled "pain" as two of the AUs which were most prominent on the factor (AU 4 and AU 10) were among those postulated by Patrick et al. (in press) to represent a possible prototypical pain face.

AU 43 also loaded on this factor although not to as great a degree as AUs 4 and 10. Patrick et al. (in press) have suggested, on the basis of the intercorrelation among a more limited set of AUs, that AUs 4 and 10 in combination with AU 6 or AU 7 might represent "a common reaction to acute noxious stimulation". An examination of the factor pattern matrix (see Table 10) shows that AU 6 loads very lightly on Factor three as does AU 7. AU 6 is more closely associated, as noted, with AU 12 and, as discussed previously, it is questionable whether AU 12 represents a facial movement expressive of pain.

It should be noted that the pattern of correlations revealed by the factor analysis is not an index of co-occurrence, that is the extent to which the occurrences of two or more AUs overlap in time. The factors simply reflect the extent to which these different facial movements occurred together within the same 6 second segment. Thus, it is of interest to examine the actual co-occurrences of the AUs which load on the different factors.

With examination of the raw data it can be seen that AUs 4, 10 and 43 occurred in some combination with one another a total of 22 times in the pain segment. (Note that AU 4 appeared on 35 occasions, AU 10 on 13 and AU 43 on forty three). These co-occurrences were limited to 18 of the total of 120 subjects; thus once again the lack of universality is underscored. While AUs 6 and 7 did not load in any significant way on Factor three, an examination of their co-occurrences with AUs 4, 10 and 43 does present a somewhat altered picture. AU 6 co-occurred in combination with one or more of AUs 4, 10 and 43 (and in the absence of

AU 12) 36 percent of the time it appeared in the pain segment. AU 7 co-occured in combination with one or more of these AUs 59 percent of the time it appeared. If the two AUs were considered as a category (bearing in mind that they could not co-occur with one another) they appeared in combination with one or more of AUs 4, 10 and 43 forty-four percent of the time. Thus while AU 6 in particular appears more often in combination with AU 12, there remains some support for Craig and Patrick's suggestion that the combination of AUs 4, 10 and 6 or 7 may represent a configuration associated with pain.

AU 25 loaded most heavily on Factor four which was labelled "lower face AUs associated with speech". However, it also loaded to a lesser degree on Factor three . An examination of the raw data showed that AU 25 occurred either immediately before or after AU 50 (mouth movements specifically associated with speech) on approximately 32 percent of occasions it appeared. It co-occurred with one or some combination of AUs 4, 10 and 43 (in the absence of AU 50) 28 percent of the time it appeared. Thus it could be seen that in the case of AU 25, the factor loadings are reflected in the actual co-occurrences.

While the factor analysis and the examination of the co-occurences of the various combinations of AUs provided information relevant to the consideration of a possible "prototypical" pain face, it must be pointed out again that individual differences rather than communalities seemed to be the most prevalent. While 88 subjects exhibited one or more of AUs 4, 6, 7, 10, 25 and 43, only 54 of those subjects exhibited at least one of the three AUs most prominent on Factor three (AUs 4, 10, and 43). In fact only 18 subjects actually exhibited two or more of AUs 4, 10 and 43 in combination with one another. Thus it seemed that this attempt to define a prototypical expression was a failure. Rather, delineating a constellation of AUs seems to be the more useful endeavour.

Relationship between the "Pain" AUs and Global Expressiveness

In order to examine the relationship between the specific facial expressive behavior obtained from the FACS analysis and judges' ratings of general or global facial behaviour associated with pain a stepwise multiple regression was performed. The predictor variables were the six AUs which showed the greatest difference in the expected direction between baseline and the genuine pain segment: AUs 4, 6, 7, 10, 25 and 43. The criterion variable was the rating of overall or global expressiveness of pain assigned to each subject by a judge. The results are not discussed separately for males and females as the groups differed only marginally in judges' ratings of global expressiveness.

A positive significant relationship was found between some of the predictor variables and the judge's ratings of global expressiveness. The magnitude of the multiple R was .52 with two variables participating in the equation. These were, in descending order of weight AUs 43 and 6. The correlation between each of the predictor variables and the criterion was positive (see Table 12). The other AUs were missing from the equation, possibly due to their relatively low correlations with the criterion.

In considering the results of the regression analysis, it seems noteworthy that a relationship was indicated between even two of the

TABLE 12

Correlations between Judges Ratings of Global Expressiveness and Facial Activity During the Pain Segment

AU	Rating
4	0.37
6	0.41*
7	0.09
10	0.34
25	0.06
43	0.44*

* $p < .0001$

predictor variables and the criterion given the relatively stringent level of alpha (.01) used as an inclusion criterion in the analysis. In addition the magnitude of the relationship was striking. It should be emphasized that the ratings of global expressiveness were based on the subject's facial behaviour during the entire standardized physiotherapy protocol (albeit with particular attention to be paid to the genuine pain segment) whereas the six predictor variables were obtained from only the 6 second genuine pain segment. Even if only the genuine pain segment had been considered, the judges' ratings were to have been based on more than just the six AUs found to discriminate between the segment and baseline, thus allowing for more consideration of individual differences. Despite these differences however, two of the FACS variables were able to predict to a significant degree the more global ratings.

Relationship of the "Pain" AUs and Self-Report

To examine the relationship between subjective distress and facial expression a series of stepwise multiple regressions were performed. The predictor variables were again the six AUs whose frequencies which showed the greatest difference in the expected direction between baseline and the genuine pain segment: AUs 4, 6, 7, 10, 25 and 43. The criterion variables were the magnitude of subject self-report associated with the most painful movement, that is the scores on the three scales of the MPQ "acute" as well as the total number of words chosen, and the scores on the three Gracely scales. The results are discussed in terms of the measures of sensory intensity (MPQ and Gracely Sensory Scales), affective distress (MPQ Affective and Gracely Unpleasantness scales), subjective overall intensity (MPQ Evaluative scale) and the Gracely Painfulness Scale (a measure intended to approximate the information usually solicited by a clinician).

No significant relationship was found between either of the measures of sensory intensity and facial expressive behaviour or for either measure of affective distress and the criterion.

A positive, significant relationship was found between the MPQ Evaluative scale and one of the predictors and between the Gracely Painfulness scale and one of the predictor variables. The magnitude of the multiple R for the MPQ Evaluative scale was .34 with only one variable (AU 6) participating in the equation. The correlations were positive with the exception of that for AU 25 which was negative (see Table 13). The magnitude of the Multiple R for the Gracely Painfulness scale was .30 with only one variable (AU 6) participating in the equation. The correlations were all positive with the exception of AU 7 which was negative (see Table 13). Thus a significant, albeit very limited, positive relationship existed between the subjective report of the overall intensity of the pain experience (as measured by the MPQ evaluative scale) and facial activity and between the Gracely Painfulness scale and facial activity.

Effectiveness of the Painful Stimulus

An issue relevant to the differences in the AUs found in the present study as compared to previous research relates to the question of whether the subjects in the present study were actually in pain. Unlike electric shock, the intensity and duration of which can be precisely controlled,

TABLE 13

Correlations between the McGill and Gracely Scales and Facial Activity During the Genuine Pain Segment

AU	MPQ Evaluative Scale	Gracely Painfulness Scale
4	.20	.14
6	.34*	.30*
7	.08	-.002
10	.06	.16
25	.02	.08
43	.01	.07

* $p < .0005$

and the cold pressor experience where duration can be controlled and at least the initial discomfort, is well documented, there was no control over the duration and intensity of the painful stimulus in the present research. Moreover, as the pain could be elicited through any of the four movements (depending on the locus of the patient's complaint) the nature of the pain could vary from individual to individual. However, the four movements used in the protocol were chosen because the physiotherapists judged they would produce low back or hip (sacroilliac joint) pain (and would fulfill the requirement that subjects be lying down while they were performed).

Despite all the steps taken to ensure that the subjects in the study were, indeed, those individuals who experienced pain, the possibility does remain that some individuals exaggerated their distress. Although it was repeatedly emphasized that the protocol (including the subsequent masked and posed instructions), was part of a study, the procedure was embedded in the clinic's physiotherapy assessment, and some subjects may have exaggerated their distress as part of their overall attempt to obtain help. If this were the case, it might provide an alternate explanation for the similarity between the genuine and the posed expression. It might also account for the relatively modest relationship between the six most frequent AUs from the genuine pain segment and the self-report variables (although discontinuities between behaviour and self-report are quite common, for example, Fordyce et al., 1984). It is rare for a patient to be referred to the Back Pain Clinic as a suspected malingerer (C. Solyom, personal communication, 1983) and, even more rarely, does the clinical team which assesses each patient come to the conclusion that a patient is malingering. Any individuals who might have been suspected of malingering according to the referral information were screened out and only one subject was considered to be a possible candidate after the team assessment.

Summary and Conclusions

The demographic characteristics of the sample were similar to those reported in other studies of low back pain patients. The only variable which differentiated between males and females was disability status, that is, receiving or hoping to receive financial compensation. The results of the self-report analysis failed to find any differences between the two sexes, the two instructional groups or any interactive effects. The chronic MPQ scores were significantly lower in comparison to the Back Pain Clinic norms, perhaps due to the subjects being more objective in their assessment of their pain for research purposes. The acute and chronic MPQ scores differed significantly and it was hypothesized that this might be due either to the chronic pain indeed being more intense, or being evaluated as such because of the greater impact it had for the patient due to its being elicited by mundane movements.

The manipulation to influence global expressiveness was unsuccessful. The most likely explanation was that the instructional set used was not powerful enough to overcome the implicit display rules in effect for the assessment. An instructional set emphasizing more clearly the importance of being expressive of distress with closer questioning of the subject to confirm understanding of the instructions might provide a better test of whether the inhibiting effect of having observers present could be circumvented.

Women were rated as being marginally more globally expressive than men consistent with previous research (Buck, et al., 1974; Schwartz, et al., 1980). The relationship of a number of self-report and demographic variables was examined with the result that no relationship was found to exist for either sex. It was somewhat surprising that no significant relationship was found for disability status for the men, given the large proportion of men receiving or hoping to receive financial compensation. This contributes to the conflicting results in the literature regarding the role financial benefits play in reinforcing pain behaviours (Kremer, Block and Atkinson, 1983).

The instructional set manipulation failed to influence the frequencies of the FACS variables. Sex also did not affect the type or frequency of AUs observed. The latter finding was of particular significance as the two sexes did differ marginally in terms of the ratings of global expressiveness. A number of possible explanations for this discrepancy between the FACS data and the judges' global ratings were put forth. Among these was the possibility that differences between males and females in terms of the configuration or intensity of the AUs might account for the judges' ratings, or the possibility that females exhibited a greater variety of AUs (including those eliminated as being too infrequent for analyses). Further research investigating a possible systematic sex bias on the part of the judges might clarify the results.

The repeated factor (segment) was significant and post hoc comparisons elucidated the differences. Analysis of the genuine pain segment (as compared to baseline) resulted in only two AUs being identified as being more frequent in the former: AUs 4 and 43. It was important to point out that these AUs did not occur universally, either alone or in combination with each other. That so few AUs were found to distinguish between the pain and baseline segments was in contrast to the results of the previous research (Craig & Patrick, 1985; Patrick et al., in press). Several possible explanations were discussed including that of differences between the present study and the earlier ones and the use of a more stringent criterion for rejection of the null hypothesis. The other major difference was the failure of AU 45 (blink) to discriminate between the pain and baseline segments in the present study. Several explanations were discussed, the most likely being that the greater frequency of AU 43 (eyes closed) in the pain segment might account for the reduced number of 45s as the two cannot be scored simultaneously.

The relative paucity of results in the present study is of interest given the query (e.g., LeResche & Dworkin, 1984) as to whether chronic and acute pain populations would differ in terms of facial expressive behaviour. Chronic pain patients have been shown (e.g., Fordyce, 1976) to evidence a frequency and/or variety of behaviours not generally seen in acute patients. The results of the present study seem to contradict this evidence as less facial activity (as measured by FACS) was observed than in the previous studies which used an acute pain stimulus with a nonchronic sample.

Analysis of the masked expression as compared to baseline revealed that the subjects were successful in attenuating their facial expressive behaviour when instructed to do so. In fact, one action unit (AU 45) occurred significantly less frequently than during baseline.

Analysis of the posed expression as compared to baseline revealed a constellation of AUs including those found in the pain segment. The presence of one of these, AU 12 (lip corner pull), was tentatively explained by reference to Ekman and Friesen's (1982) research on "false" and "felt" smiles. It was suggested that the presence of AU 12 in the Craig and Patrick (1985) study might be explained in the same way.

One AU (25) occurred significantly less frequently and two marginally less frequently in the masked segment as compared to the genuine pain segment. These results provided limited support for the position that subjects could attenuate facial activity on a voluntary basis.

Three AUs (4, 6 and 12) occurred significantly more frequently and one AU (45) significantly less frequently during the posed segment as compared to the genuine segment. The increased frequency of AU 6 appeared to be related to the presence of AU 12 in the posed segment. It was suggested that the increased frequency of AU 4 was possibly due to its being particularly salient to an observer and thus more easily remembered when posing an expression. This would suggest that a posed expression might be more stereotypic or caricatured than a genuine, "felt" expression. Further research, perhaps contrasting each subject's personal genuine "pain face" with his or her posed "pain face" might substantiate this possibility. If so it would provide a clue as to whether an individual is simulating distress or not. The decreased frequency of AU 45 was again attributed to the cognitive activity presumably involved in producing a facial expression indicative of pain. This decreased frequency, in combination with the increased frequency of other AUs might serve as an additional clue in the assessment of possible deception.

The factor analysis of the AUs remaining after the initial exclusion criterion was applied resulted in a four factor solution. Factor three was of the greatest interest as two of the AUs which loaded heavily on it had been suggested (Patrick et al., in press) as forming part of a "prototypical pain expression". Analysis of the actual co-occurrences of the AUs in the pain segment did lend some support to this hypothesis. However, further examination of the co-occurrences of the Factor three AUs revealed that they were limited to a small number of subjects. Little evidence was found to suggest that the pain AUs combined with any regularity into a unitary, prototypic pain expression. Rather, the evidence suggests the existence of a constellation of AUs, any one of which might be displayed by an individual in pain.

The relationship between the six AUs which showed the greatest difference in the expected direction between the pain and the baseline segments and the judges' ratings of global expressiveness was examined. A positive relationship was found between two of the AUs and the criterion. The magnitude of the relationship between the predictor variables and the criterion was striking considering that the global ratings were made on a wider range of facial actions over a longer period of time.

The relationship of the pain AUs to the self-report measures was also discussed. Only the relationships between the two measures of subjective overall intensity and one of the six pain AUs were significant. The magnitudes of both relationships were modest, further underlining the tendency, noted in the literature (e.g., Fordyce, 1984) for pain behaviour and self-report to be discontinuous. Patrick, et al., (in press) found a similar discrepancy between facial behaviour and self-report. They suggested that the two measures might represent different aspects of a "common reaction pattern" at least in the case of acute noxious stimulation and the results of the present study seem to support this.

The final issue discussed was whether or not the subjects in the study were actually in pain. It was concluded that sufficient precautions had been taken to ensure that they were. However, it was also suggested that the possibility remained that some subjects might have exaggerated their facial behaviour as part of an overall strategy to obtain help. If this were the case it would provide an alternate explanation for the similarity between the posed and genuine pain segments. But then this need to present oneself as in need of help may characterize most situations in which pain is observable by others (Craig & Prkachin, 1980) and thus may not be unique to the present study.

It is difficult to assess whether or not the case which has been made by previous studies (Craig & Patrick, 1985; LeResche & Dworkin, 1984; Patrick et al., in press) for using facial expressive behaviour as a tool in assessing the painful distress of others, has been strengthened by the results of the present study. A very limited, albeit congruent, set of AUs was found to distinguish the pain and baseline segments, compared to the more extensive sets found in the earlier studies. More research with chronic pain patients will be needed in order to determine if FACS is as useful a tool with clinical as it has been shown to be with nonclinical populations.

It was hypothesized that use of the FACS procedure would provide clues to identify distress in the stoical individual because of the system's ability to identify subtle facial behaviours. The subjects were somewhat successful in voluntarily attenuating their facial behaviour (which provides indirect support for the notion that display rules can serve the same function). The results of the FACS analysis also supported the hypothesis that more frequent and/or varied facial activity would be evident in the posed expression than in the genuine expression, again providing possible clues in assessing the genuineness of an individual's distress.

Given the results of the present study and the work of Craig and his colleagues, it would appear that future research might continue to investigate the existence of a constellation of pain AUs and its variability among different populations rather than pursuing the search for a prototypic pain expression. In fact, the results of the analysis of the posed expression suggest that a prototypic or stereotypic expression ought to be more common when people are simulating painful distress rather than when they are genuinely in such distress.

When acceptable reliability is achieved for the FACs intensity scoring, a number of other questions could also be addressed. Among these would be that of possible sex differences in the intensity of the "pain" AUs and the existence of differences in intensity among the AUs differentiating posed, masked and genuine pain faces. In the case of the posed expression in particular, informal viewing of the videotapes suggests that there may be a considerable difference in the intensity scores of the AUs as compared to the genuine pain segment. Such a finding would provide additional information which could be used when attempting to assess the genuineness of a pain complaint. With regard to the relationship between self-report and facial behaviour, it would be of interest to determine if the relationship would be stronger if more immediate assessment of self-report took place. While the memory for pain, as measured by the MPQ at least, has been shown to be fairly reliable (Hunter, Phillips, & Rachman, 1979) it is still possible that the delay in assessing the subject's report of his or her distress resulted in an attenuated relationship.

In general, the results of the present study provide further support that FACS represents a tool with which to utilize the rich variety of facial expressive behaviour. With further research the system may well provide information which will reliably increase the accuracy of judgments about painful distress with both clinical and nonclinical populations.

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APPENDIX 1

Diagnostic Categories

Category	Frequency
Disc degeneration	22
Disc space narrowing	3
Disc protrusion	4
Discogenic low back pain	7
Nerve root irritation	12
Facet joint syndrome	5
Spinal stenosis	2
Spondylolithesis	5
Post operative pain	7
Soft tissue injury/strain	10
Mechanical low back pain/ Postural problems	22
Fibrocytis	3
Chronic benign pain syndrome	20
Inactivity	8
Obesity	13
Drug dependency/Alcoholism	5
Secondary pain/Psychological overlay	15
Other	43

APPENDIX 2

McGill Pain Questionnaire
Verbal Descriptor Scales

What Does Your Pain Feel Like?

Circle ONLY those words that best describe the type of pain you have been asked to evaluate. Leave out any category that is not suitable. Use only a single word in each appropriate category - the one that applies best.

1	2	3	4
1 Flickering	1 Jumping	1 Pricking	1 Sharp
2 Quivering	2 Flashing	2 Boring	2 Cutting
3 Pulsing	3 Shooting	3 Drilling	3 Lacerating
4 Throbbing		4 Stabbing	
5 Beating		5 Lancinating	
6 Pounding			
5	**6**	**7**	**8**
1 Pinching	1 Tagging	1 Hot	1 Tingling
2 Pressing	2 Pulling	2 Burning	3 Itchy
3 Gnawing	3 Wrenching	3 Scalding	3 Smarting
4 Cramping		4 Searing	4 Stinging
9	**10**	**11**	**12**
1 Dull	1 Tender	1 Tiring	1 Sickening
2 Sore	2 Taut	2 Exhausting	2 Suffocating
3 Hurting	3 Rasping		
4 Aching	4 Splitting		
5 Heavy			
13	**14**	**15**	**16**
1 Fearful	1 Punishing	1 Wretched	1 Annoying
2 Frightful	2 Gruelling	2 Blinding	2 Troublesome
3 Terrifying	3 Cruel		3 Miserable
	4 Vicious		4 Intense
	5 Killing		5 Unbearable
17	**18**	**19**	**20**
1 Spreading	1 Tight	1 Cool	1 Nagging
2 Radiating	2 Numb	2 Cold	2 Nauseating
3 Penetrating	3 Drawing	3 Freezing	3 Agonizing
4 Piercing	4 Squeezing		4 Dreadful
	5 Tearing		5 Torturing

APPENDIX 3

GRACELY SCALES

One word or word-pair on each of the scales below describes the most severe pain you experienced during the examination. Circle the word or word-pair on each scale that best describes it. Use only a single word or word-pair on each scale.

1. Sensory	2. Unpleasantness	3. Painfulness
Extended Intense	Excruciating	Not Painful
Very Intense	Unbearable	Faintly Painful
Intense	Intolerable	Mildly Painful
Strong	Agonizing	Somewhat Painful
Slightly Intense	Horrible	Slightly Painful
Clear-Cut	Dreadful	Moderately Painful
Barely Strong	Frightful	Rather Painful
Moderate	Miserable	Quite Painful
Slightly Moderate	Distressing	Decidedly Painful
Mild	Upsetting	Pretty Painful
Very Mild	Irritating	Very Painful
Weak	Unpleasant	Unusually Painful
Very Weak	Uncomfortable	Extremely Painful
Faint	Annoying	
Extremely Weak	Distracting	

APPENDIX 4

CONSENT FORM

We are interested in studying how physiotherapists carry out their various procedures and how a variety of clients respond to them. For our study we are requesting your permission to videotape a short segment of the physiotherapy assessment you are about to undergo. In addition we will be asking you to repeat certain movements under different instructions and to fill out several brief questionnaires related to the pain (if any) you experience during those movements and more generally on a day-to-day basis. All of this information will be confidential, and you will be identified only by number to ensure your anonymity. We would greatly appreciate your cooperation; however, you are free to refuse and doing so will in no way affect your assessment at the Back Pain Clinic. Thank you.

Susan Hyde, M.A.

Kenneth D. Craig, Ph.D.
Department of Psychology
University of British Columbia

I agree to participate in this study.

______________________ ________________Signature

Date

APPENDIX 5

Nonverbal Expressions Enhancing Instructions

It is important for you to know that in trying to accurately assess your pain we rely heavily on nonverbal information as well as on what you tell us. By nonverbal information I mean the expression on your face, any sounds you make like "ouch" or groaning and movements of your body. Sometimes people feel they ought to cover up such indications that they are in pain. We are asking you to try to avoid doing this. Instead we want you to try to express as much as you can how you are really feeling. Do you understand what I'm asking you? ... Fine.

Physiotherapy Protocol

Okay. First I'm going to try to pull your feet towards me. I'd like you to try to prevent me from doing that by trying to pull your feet towards you. Fine, now I'm going to bend your right knee, Okay, now I'm going to move your knee inward towards the middle of the table, tell me when to stop. Now I'm going to repeat that movement with your left leg. Okay, now I'd like you to bend your right knee again, lock your hands around it, and pull it up towards your chest as far as you can. Okay, now I'd like you to do the same thing with your left knee. Okay, now keeping your legs straight, I'm going to life your right leg straight up until you tell me to stop. Okay, now I'm going to do the same thing with your left leg.

Appendix 5 (cont'd)

Now I'd like you to tell me which of the movements we just went through created the most discomfort for you. Okay, we're going to repeat that movement but this time I'm going to give you some additional instructions.

Instructions for Generating Genuine, Masked, and Posed Facial Expressions

Genuine

I am going to/I'd like you to repeat movement X.

Masked

Again I am going to/I'd like you to repeat movement X. This time I would like you to try to pretend that it doesn't bother you at all, no matter how much it does. Try to cover up the fact that you find it painful or distressing.

Posed **Use a Nonpainful movement.**

Now, I'm going to repeat movement Y which you said did not bother you. This time I want you to act (behave, pretend) as if movement Y is really causing you a lot of pain. Let me know by looking at you that it is painful. Make a "pain face".

APPENDIX 6

Scoring Units for the Facial Action Coding System (Ekman & Friesen, 1978b)

Upper Face

AU	Name
1	Inner Brown Raise
2	Outer Brow Raise
4	Brow Lower
5	Upper Lid Raise
6	Cheek Raise
7	Lids Tight
41	Lids Droop
42	Slit
43	Closed
44	Squint
45	Blink
46	Wink

Lower Face

AU	Name
9	Nose Wrinkle
10	Upper Lip Raise
11	Nasolabial Deepen
12	Lip Corner Pull
13	Cheek Puff
14	Dimpler
15	Lip Corner Depress
16	Lower Lip Depress
17	Chin Raise
18	Lip Pucker
20	Lip Stretch
22	Lip Funnel
23	Lip Tight
24	Lip Press
25	Lips Part
26	Jaw Drop
27	Mouth Stretch
28	Lip Suck

Miscellaneous Actions

AU	Name	AU	Name
8	Lips Toward	33	Blow
19	Tongue Show	34	Puff
21	Neck Tighten	35	Cheek Suck
29	Jaw Thrust	36	Tongue Bulge
30	Jaw to Sideways	37	Lip Wipe
31	Jaw Clench	38	Nostril Dilate
32	Bite	39	Nostril Compress

Other

AD	Name
50	Mouth Movement

Note: AU = Action Unit; AD - Action Descriptor

APPENDIX 7

GLOBAL CODING MANUAL

Look for These Signs:

Eyes

1. Narrowed or tightly closed eyes
2. Eyebrow raise, i.e.
3. Frown, i.e., eyebrows lowered with a bulge or crease between them

Nose

1. Wrinkled

Mouth

1. Tightened lips or upper lip raise
2. One or both corners of the mouth pulled back
3. Jaw drop or stretch (as if gasping or saying ow!)

Rate on the 3 Point Scale

Rule of Thumb

. If you are having trouble deciding between a 1 or 2 or a 2 or 3, keep viewing the tape to observe how the individual reacts to the repeat of the painful movement.

Appendix 7 (cont'd)

Global Coding (cont'd)

1	2	3
very inexpressive	somewhat expressive	very expressive

DEFINITIONS

INEXPRESSIVE:
- the face remains with a neutral expression throughout even though there may be evidence of jaw and throat tension.

SOMEWHAT EXPRESSIVE
- one or more of the signs are present in a mild to a somewhat moderate form.

  E.g., a sign occurs to a mild degree but appears fairly frequently - 2-4 times OR a sign occurs to a moderate degree but occurs only once or twice.
- the face can be observed moving from neutral to expressive.
- there may be signs of jaw and throat tension

VERY EXPRESSIVE
- one of the signs is present in an extreme, i.e., close to maximum form.
- two or more signs are present in a moderate, i.e.,

Appendix 7

Global Coding (cont'd)

obvious but not maximum form and occur frequently, i.e., more than once or twice

- there may be evidence of jaw and throat tension
- the face can be observed moving from neutral to expressive.

  E.g., a person whose face is fairly expressionless, apart perhaps from some jaw and/or throat tension, until the movement(s) of pain when a definite moderate to maximum expression is visible

  OR

- an individual whose face is constantly in motion (unrelated to talking) with frequent moderate or maximum grimaces.

APPENDIX 8

a) Summary of Demographic, Self Report and Global Expressiveness Data Analysis

Dependent Measures: Age, Duration of current complaint; Duration of chronic complaint; Number of prior operations; McGill Pain Questionnaire (MPQ) - acute pain instructions: Number of words chosen, sensory, affective, evaluative scales; MPQ-chronic pain instructions: number of words chosen, sensory, affective, evaluative scales; Gracely verbal descriptor scales: sensory, unpleasantness, painfulness; Global Expressiveness ratings.

Wilkes Summary Table

Source	Wilkes Lambda	Approx. F	df	Prob.
Sex	0.7506	2.0976	16,101	.014
Instructional Set	0.9146	0.5895	16,101	.885
S x I	0.8701	0.9425	16,101	.524

b) Summary of the Analysis of the "Acute" versus the "Chronic" MPQ

Hotellings T2 - Dependent measures: The four scales of the McGill Pain Questionnaire (MPQ)

Wilkes Summary Table

Source	Wilkes Lambda	df	Approx. F	df	Prob.
Subjects	5.5519E-03	4,119,119	2.6369	476,444	0.00
Type of Administration	6.8797E-01	4,1,119	13.1530	4,116	.000

APPENDIX 9

SUMMARY FACS DATA ANALYSIS

Group Comparison

The following analysis was a 2 x 2 x 3 (Instructional Set x Sex x Segment) MANOVA with repeated measures on one factor (Segment) using as dependent measures the 14 AUs which remained after the initial exclusion criteria were applied.

Wilkes Summary Table

Source	Wilkes Lambda	df	Approx. F	df	Prob.
Instructional Set	9.0630E-01	14,1,117	0.7680	14,104	0.7008
Sex	8.8894E-01	14,1,117	0.9281	14,104	0.5317
Is x Sex	9.3590E-01	14,1,117	0.5088	14,104	0.9234
Segment	4.7251E-01	14,3,347	6.8253	42,944	0.0000
Is x Segment	8.7764E-01	14,3,347	1.0621	42,944	0.3669
Sex x Segment	8.9524E-01	14,3,347	0.8973	42,944	0.6587
Is x S x Seg.	8.8813-01	14,3,347	0.9633	42,944	0.5391
Subjects	0.0000+00	14,117,0	0.0000	0,0	0.0000
Subjects x Seg.	0.0000+00	14,3,347	0.0000	0,0	0.0000

APPENDIX 10

Post Hoc Comparisons of Segment Effect Using Tukey Procedure for Repeated Measures on One Factor

I. Dependent measure: AU 2

Summary Table

Source	SS	df	MS	F	Prob.
Segment	2.21	3	7.361E-01	5.95	0.0007
Seg x Sub	42.91	347	1.236E-01		

2. Dependent measure: AU4

Summary Table

Source	SS	df	MS	F	Prob.
Segment	18.68	3	6.225	38.77	0.0000
Seg x Sub	55.71	347	1.601E-01		

3. Dependent measure: AU6

Summary Table

Source	SS	df	MS	F	Prob.
Segment	13.75	3	4.58	28.46	0.0000
Seg x Sub	55.88	347	1.610E-01		

4. Dependent measure: AU7

Source	SS	df	MS	F	Prob.
Segment	1.62	3	5.410	5.93	0.0007
Seg x Sub	31.65	347	9.122E-02		

Appendix 10 (cont'd)

5. Dependent measure: AU10

Summary Table

Source	SS	df	MS	F	Prob.
Segment	1.98	3	6.611E-01	6.70	0.0003
Seg x Sub	34.23	347	9.866-02		

6. Dependent measure: AU12

Summary Table

Source	SS	df	MS	F	Prob.
Segment	29.22	3	9.75	32.09	0.0000
Sex x Sub	105.31	347	3.035E-01		

7. Dependent measure: AU25

Summary Table

Source	SS	df	MS	F	Prob.
Segment	11.57	3	3.86	11.86	0.0000
Sex x Sub	112.87	347	3.253E-01		

8. Dependent measure: AU43

Summary Table

Source	SS	df	MS	F	Prob.
Segment	11.43	3	3.81	17.37	0.0000
Seg x Sub	76.08	347	2.192E-01		

9. Dependent measure: AU45

Summary Table

Source	SS	df	MS	F	Prob.
Segment	163.82	3	54.61	12.42	0.0000
Seg x Sub.	1525.47	347	4.40		

APPENDIX 11

Relationships Among the Variables

a. Relationship Between "Pain" AUs and Global Expressiveness

Each of the following was a stepwise multiple regression analysis examining the relationship between judges' ratings of global expressiveness and the frequency of "pain" AUs, (i.e., the six AUs which showed the greatest difference in the expected direction between baseline and the genuine pain segment).

Variables in the Equation

						F test for Mult. R		
Variable	Mult. R.	RSQ	RSQ Change	B	Beta	df	F	p
AU 43	0.4411	0.1946	0.1946	0.447	0.337	1,118	28.51	.0000
AU 6	0.5154	0.2656	0.0710	0.449	0.286	2,117	21.56	.0000

Variables not in the Equation

AU 4, 7, 10, 25

b. Relationship Between the "Pain" AUs and the "Acute" MPQ Evaluative Scale

The following was a stepwise multiple regression analysis examining the relationship between the subjects' scores on an "acute" MPQ scale and the frequency of the "pain" AUs (i.e., the six AUs which showed the greatest difference in the expected direction between baseline and the genuine pain segment).

Variables in the Equation

						F test for Mult. R.		
Variable	Mult. R.	RSQ	RSQ Change	B	Beta	df	F	p
AU 6	0.3374	0.1138	031138	3.179	0.337	1,118	15.16	.0002

Variables not in the Equation

AU 4, 7, 10, 25, 43

c. Relationship between "Pain" AUs and the Gracely Painfulness Scale

The following was a stepwise multiple regression analysis examining the relationship between the subjects' scores on the Gracely Painfulness scale and the frequency of the "pain" AUs (i.e., the six AUs which showed the greatest difference in the expected direction between baseline and the genuine pain segment).

Variables in the Equation

						F test for Mult R.		
Variable	Multi R.	RSQ	RSQ Change	B	Beta	df	F	p
AU 6	0.3006	0.0903	0.0903	1.9306	0.301	1,118	11.72	.0000

Variables not in the Equation

AU 4, 7, 10, 25, 43