PSYCHOLOGICAL AND BEHAVIOURAL CORRELATES OF ACUTE AND CHRONIC CONGRUENT AND INCONGRUENT LOW BACK PAIN

By

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ABSTRACT

The purpose of the study was to examine how the psychological reactions to pain of acute low back pain (LBP) patients would compare to the psychological reactions to pain of chronic LBP patients who displayed signs and symptoms which were either congruent or incongruent with underlying anatomy and physiology. It was also of interest to examine whether negative cognitive and affective variables would mediate the expression of pain in these pain groups, and whether verbal and nonverbal facial measures of pain could be used to discriminate among pain groups.

Subjects were assigned to the acute pain group if they had recurring or persistent pain for less than a three month period, and to the chronic pain group if they had recurring or persistent pain for longer than a three month period. The Pain Drawing (Ransford, Cairns & Mooney, 1976), the Nonorganic Physical Signs Assessment (Waddell, McCulloch, Kummell & Venner, 1980) and the Inappropriate Symptom Inventory (Waddell, Main, Morris, Di Paolo & Gray, 1984) were used to assign chronic pain patients to either the congruent or incongruent chronic LBP group.

A physiotherapy protocol in which patients were asked to genuinely express pain, exaggerate and mask pain in response to a painful range of motion task was used to obtain a wide range of facial behaviour that would likely be relevant to understanding the expression of pain in these patient populations. Verbal reports of pain in response to the painful range of motion task, and in response to the pain that patients experienced on a daily

basis were also examined. In addition, questionnaires concerned with coping strategies, worry and emotionality were used to tap cognitive and affective components of pain. Several demographic and patient pain related variables (e.g., medication use, disability, physical impairment) were also collected.

The results of the study suggested that the acute and chronic incongruent pain patients had a similar psychological reaction to pain that was greater than the psychological reaction to pain of chronic congruent pain patients. In addition, the results suggested that the acute patients and chronic incongruent patients reported the unpleasantness of their pain to be similar, although only chronic incongruent patients differed significantly from chronic congruent patients. Acute and chronic incongruent patients were also similar on several demographic (socioeconomic status, compensation status) and pain related variables (regular use of opiate analgesics, and disability). Both groups differed significantly on the variables from the chronic congruent pain group. One final difference among groups was observed on a measure of physical impairment in which it was found that the chronic incongruent patients had the greatest physical impairment followed by the chronic congruent and acute pain patients. All differences among groups were significant.

The most important variable for optimally discriminating among acute and chronic pain groups was physical impairment. This, however, may have been an artifact since the physical impairment measure was biased toward chronic pain patients obtaining higher scores. The most important variables for discriminating among chronic congruent and incongruent pain groups were related to the patient's negative interpretation of pain, compensation status, and reported regular use of pain killers.

In general, all subjects reported the pain they experienced on a daily basis to be more intense and unpleasant than the pain they experienced in response to the painful leg movements. The facial actions that patients displayed when they were asked to genuinely express pain corresponded to facial expressions that have been found to be associated with pain in previous studies, and included brow lowering, orbit tightening, levator contraction, and mouth opening. Also consistent with previous research were findings suggesting that, although subjects were successful in masking and exaggerating pain, there were still some cues to deception apparent on the face.

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INTRODUCTION

Low back pain (LBP) is among the most frequently occurring and disabling pain conditions in Western society (Waddell, 1982). The cost of the condition in terms of medical and surgical care, financial compensation and lost work time is enormous (Mayer, Gatchel, Kishino, Keeley, Mayer, Capra & Mooney, 1986). Despite the heavy demand that it puts on the health care system and industry, the diagnosis and treatment of LBP remain poor (Kelsey & White, 1980).

One of the most common problems in dealing with LBP is that many LBP sufferers have no diagnosable medical disease or injury, and traditional forms of treatment (e.g., surgery) are often ineffective (Loeser, 1980). The degree to which treatments are ineffective, however, varies between groups of acute and chronic LBP pain patients, as well as within groups of chronic LBP patients.

With acute LBP the LBP problem often resolves itself within a month, frequently without the use of medical treatment (Dilane, Fry & Kalton, 1966). With chronic LBP there is tremendous variation in the effectiveness of treatment among sufferers. In some cases chronic LBP may be alleviated by traditional methods of treatment (e.g., surgery, physiotherapy), whereas in other cases these methods result in expensive medical bills and no resolution of the problem (Loeser, 1980).

Recently a useful distinction has been made between chronic LBP sufferers who have pain that is either congruent or incongruent with underlying anatomy and physiology. The congruent-incongruent pain distinction appears to account for many differences that are observed among chronic LBP sufferers. For instance, chronic LBP patients who have signs and symptoms that are incongruent with underlying anatomy and physiology have been found to utilize more health care resources (Waddell et al., 1984), and to have a poorer outcome and response to surgery, rehabilitation (Doxey, Dzioba, Mitson & Lacroix, 1988; Dzioba & Doxey, 1984; McCulloch, 1977; Taylor, Stern & Kubiszyn, 1984; Uden, Astrom & Bergenudd, 1988), and acupuncture (Lehmann, Russell & Spratt, 1983) than patients with congruent signs and symptoms of pain. Strong correlations among variables such as ineffective coping, maladaptive and dysfunctional cognitions, high levels of anxiety, and reports of high sensory activity have also been found in patients with incongruent signs and symptoms compared to patients with congruent signs and symptoms (Reesor & Craig, 1988).

Of interest in the present study was how the psychological reactions to pain of acute LBP patients would compare to the psychological reactions of patients with congruent and incongruent chronic LBP. It was also of interest to examine whether the patient groups would differ in their verbal report and nonverbal expressions of pain. Both verbal and nonverbal behaviour have been identified as playing an important communicative function in pain assessment procedures, and were predicted to be of use in distinguishing these different groups of patients.

Verbal report is believed to be an essential component of pain assessment, and many objective measures of self reported pain have been developed (Gracely, Dubner & McGrath, 1979; Melzack, 1975). Despite the importance of verbal report in assessment, the information that is obtained through self report measures is limited by many factors which may serve to amplify or attenuate the pain report (Craig & Prkachin, 1983).

Due to limitations of self report, nonverbal expressive behaviour and in particular facial expressive behaviour has been suggested to be a useful source of information that could be used in addition to verbal report in the assessment of pain (Craig & Prkachin, 1983). Nonverbal expressive behaviour has the advantage of being observable, verifiable, and perhaps less subject to distortion than self report (Craig & Prkachin, 1983). To aid in the study of nonverbal expressive behaviour, an objective, systematic, and atheoretical measure of facial activity, the Facial Action Coding System (FACS, Ekman & Friesen, 1978a, 1978b) has been developed.

Recent investigations studying experimentally induced pain (Craig & Patrick, 1985; Patrick, Craig & Prkachin, 1986; Swalm & Craig, 1990) and clinical pain (Craig, Hyde & Patrick, 1991; LeResche & Dworkin, 1988) have shown the applicability of the FACS to the study of pain. These studies have also shown the sensitivity of FACS to variations in: 1) the severity of the painful stimulation; 2) the pain condition studied; 3) the age and sex of the subject; 4) the social context; and 5) subjects' attempts to fake or mask pain. Generally, the results of the studies suggest that nonverbal expressive behaviour adds important and non-redundant information to that provided by self report (Craig, Prkachin & Grunau, In press).

In the present study chronic LBP patients who were identified as displaying congruent or incongruent pain were contrasted with acute LBP patients. The patients were selected from a local physiotherapy clinic which likely represents a more heterogeneous sampling of community pain patients seeking treatment than those referred to tertiary health care settings. A physiotherapy protocol in which patients were asked to genuinely express pain, and exaggerate and mask pain was used to obtain a sample of a wide range of facial behaviour. It was expected that this protocol would elicit important and relevant pain expressions that would aid in the differentiation of pain in these patient populations. The groups were compared on their nonverbal facial expressions of pain, verbal reports of pain, and cognitive and affective reactions to pain. It was expected that information obtained in this study would add to the understanding of the pain experience in acute and chronic pain patients, and would be useful in identifying and assessing pain in congruent and incongruent LBP patients.

LITERATURE REVIEW

Models of Pain

In the past, pain most often has been conceptualized using a sensory-specificity model of pain in which the severity of injury or tissue damage was believed to be directly proportional to the sensation of pain (Craig, 1984; Melzack & Wall, 1988; Wall, 1979). The sensation of pain was understood as a symptom of some underlying pathology (Englebert & Vrancken, 1984), and was believed to play a biologically significant role as a signal or warning to avoid further injury (Englebert & Vrancken, 1984; Wall, 1979).

This model of pain has received considerable criticism because it fails to account for the variability observed in the expression of pain across individuals (Sternbach & Tursky, 1965), and within individuals from one occasion to the next (Lazarus, 1986). There are many dramatic examples that serve to illustrate the lack of correspondence between tissue damage and sensation. The experience of soldiers who express minimal pain to severe wounds from battle and more extreme pain in response to inept injections (Beecher, 1955), and amputees who experience pain in legs that no longer exist (Melzack & Wall, 1988), serve to underscore the fact that sensation is not always directly related to somatic input.

Researchers, who tend to hold a more recent widely accepted model of pain, view the pain experience as multidimensional in nature, produced by the interaction of sensory-discriminative, motivational-affective, and cognitive-evaluative influences

(Melzack & Wall, 1988). Somatic input, previously believed to be the sole determinant of pain, is now considered to be highly salient, but nevertheless modified by cognitive, affective, and behavioural components (Turk, Meichenbaum & Genest, 1983). Under this model of pain, the immediate effects of injury, as well as the acute and chronic pain experiences are differentiated (Englebert & Vrancken, 1984, Melzack & Wall, 1988; Wall, 1979).

In the immediate phase, the sensation of pain may not even be experienced, and activities such as fighting and fleeing may take precedence (Wall, 1979). In the acute phase, the sensation of pain is likely to be closely related to tissue damage, although anxiety, past experience with pain, memory for pain, cultural background, and the meaning of pain to the individual may also contribute to the pain experience (Chapman, 1977; Melzack & Wall, 1988). In both the immediate and acute phases, pain functions to produce actions that prevent further injury, to help individuals learn to avoid similar future situations, and to set limitations on activity which are necessary for proper recovery (Melzack & Wall, 1988; Wall, 1979). In this way, pain functions as a need state promoting healing, rather than as a sensation signaling injury (Wall, 1979).

In comparison to immediate and acute pain, chronic pain under a multidimensional model of pain is not viewed as a symptom related to tissue damage, but rather as a syndrome in and of itself. It is believed to be less related to somatic input than to psychological (cognitive, affective, and behavioural) components of pain (Melzack & Wall, 1988). Further, it is believed to serve no useful function as either a signal of impending injury or as a sensation encouraging rest (Sternbach, 1984). In fact, chronic pain is viewed as being detrimental to the individual's health with dysfunctional pain behaviours (e.g., polypharmacy, polysurgery, frequent use of health care services, limitation of work and social activities, depression and psychological distress) characteristic of the life of the chronic pain patient (Chapman, 1977; Keefe & Gil, 1986; Sternbach, 1984, 1985). In the chronic pain condition, pain persists long after all possible healing has occurred (Chapman, 1977; Melzack & Wall, 1988), and medical interventions for acute pain (e.g., bed rest, withdrawal from job and personal demands, analgesic intake) may not only be ineffective, but may also serve to perpetuate illness and disability (Bonica, 1980; Hrudey, 1991).

The Problem of Low Back Pain

Low back pain (LBP) is among the most frequently occurring pain conditions in Western industrialized society. It is estimated to affect over 80% of the population at some point in their lives (Mayer, Gatchel, Kishino, Keeley, Mayer, Capra & Mooney, 1986), and is believed to be the most frequent cause of morbidity, disability, and perceived threat to health in middle aged men and women (Waddell, 1982). LBP also has been found to be associated with psychological difficulties, with LBP patients reporting more episodes of anxiety (Frymoyer, Pope, Costanza, Rosen, Goggin & Wilder, 1980; Nagi, Riley & Newby, 1973) and depression (Frymoyer et al., 1980) than non-LBP sufferers.

The economic cost of LBP to the health care system in terms of medical and surgical care and to industry in terms of financial compensation and work days lost is enormous (Hrudey, 1991; Mayer et al., 1986). Despite the high prevalence and cost of LBP, the diagnosis and treatment of the condition remain poor (Hrudey, 1991).

Acute Versus Chronic Low Back Pain

Differences among acute and chronic LBP patients in their psychological reactions to pain have long been assumed, but not studied empirically until recently. In general, it has been assumed that as pain persists the patient's psychological reaction to pain increases. The consequence of this has been that cognitive and affective variables have been assumed to play a smaller role in acute LBP conditions, than in chronic LBP conditions (Sternbach, 1988). Recent investigations (Ackerman & Stevens, 1989; Philips & Grant, 1991), however, suggest that the differences among acute and chronic pain sufferers may not be as great as initially assumed, since significant statistical differences among acute and chronic LBP patients on sensory, affective, and evaluative pain scores, depression, state and trait anxiety, negative life change scores, pain behaviour, or pain cognitions have not yet been found.

Although differences among acute and chronic pain patients in their psychological reactions to pain have not been found, differences among acute and chronic LBP in the economic costs to health care and industry are apparent. For instance, in terms of health care utilization it is estimated that a greater percentage (perhaps as high as 80%) of the costs of LBP problems are absorbed by chronic pain patients (Crook, Rideout & Browne, 1984; Hrudey, 1991; Nachemson, 1982). In terms of industry, a distressingly small portion of patients with chronic pain are able to return to work (Beals & Hickman, 1972), and the longer the period of absenteeism the less likely it is that the chronic pain patient will obtain employment (McGill, 1968).

With regard to diagnosis and treatment acute and chronic LBP patients also differ. With chronic LBP patients, it has been estimated that as many as 80% of patients have no specific diagnosis (Bigos & Crites, 1987), and although the condition may be treated successfully with traditional methods of treatment (e.g., drugs, physiotherapy and surgery), more often than not these treatments result in expensive medical bills and no resolution of the problem (Loeser, 1980). In the case of acute LBP patients, the prognosis is significantly better, with the problem often resolving itself within a few months without medical treatment (Chapman, 1977; Dilane, Fry & Kalton, 1966).

Chronic LBP has resulted in higher economic costs and greater demands on the health care system than acute LBP, and, as a result, both clinicians and researchers have focused much of their attention on this condition. Their attention has frequently been directed toward identifying chronic LBP patients who are unlikely to benefit from traditional forms of treatment that may be costly, unnecessary, and potentially harmful.

Organic and Functional Diagnoses

In the past, health care professionals have frequently attempted to identify chronic LBP patients who were likely or unlikely to benefit from traditional modes of treatment using a dichotomous diagnosis (Chapman, 1977; Main & Waddell, 1982). Patients with an obvious underlying cause for their pain have been classified as having an `organic' disorder, and their pain has generally been considered real (Trief, Elliott & Stein, 1987; Turk & Rudy, 1987). In contrast, patients who have complained of persistent pain in the apparent absence of identifiable physical causes have been classified as having a `functional' disorder, and their pain often has been considered unreal (Trief, Elliott & Stein, 1987; Turk & Rudy, 1987). The pain reports of this later group of patients have often been assumed to be a reflection of psychological problems (Biedermann, Monga, Shanks & McGhie, 1986; Chapman, 1977; Joukamaa, 1987).

Support for the dichotomous distinction between organic and functional disorders has been variable. In one study, researchers found chronic LBP patients with nondemonstrable organic signs to have more variable and diffuse pain descriptions than patients with demonstrable organic signs (Leavitt, Garron, D'Angelo & McNeill, 1979). In contrast, in other studies (Fordyce, Brena, Holcomb, De Lateur & Loeser, 1978; Swanson & Maruta, 1980) few and only marginally significant relationships between patient diagnosis and words that are chosen to describe pain have been found.

Few researchers have investigated behavioural activity in patients with varying diagnoses. In the one study where this relation has been investigated, however, behavioural observations of chronic LBP patients revealed that functional patients showed less physical disability, less motivation for treatment, more excessive complaints, and more demands on hospital staff than organic patients (Donham, Mikhail & Meyers, 1984). While the observations in this study are interesting, they are limited since they were not based on objective observational systems, and therefore likely were influenced by the health care professionals own attitudes about how pain should be expressed and tolerated.

In a recent study conducted by Mahon (1991) organic LBP patients were found to have a significantly higher pain threshold than functional patients. The result was attributed more to a response bias to report sensations as painful rather than to an increased sensory sensitivity. That is, functional patients as compared to organic patients had a greater bias to report sensations as painful.

In attempting to find support for the organic functional distinction, another set of investigations have focused on determining whether organic and functional patients differ in psychological disturbance. Many studies have found that the MMPI profiles of functional patients differ significantly from organic patients, often in the pattern of a "Conversion V" (i.e., high scores on scales 1 (hypochondriasis) and 3 (hysteria), and low scores on scale 2 (depression) (Donham, Mikhail & Meyers, 1984; Freeman, Calsyn & Louks, 1976; Gentry, Newman, Goldner & von

Baeyer, 1977; Hanvik, 1951; McCreary, Turner & Dawson, 1979). Many other studies, however, have failed to find such a difference or if they have, the difference has failed to adequately predict diagnosis beyond that which would be expected by chance (Leavitt, 1985; Fordyce, Brena, Holcomb, De Lateur & Loeser, 1978; Oostdam, Duivenvoordern & Pondaag, 1981; Rosen, Frymoyer & Clements, 1980; Sternbach, Wolf, Murphy & Akeson, 1973). That is, while there may be statistically significant differences between the MMPI profiles of organic and functional patients, there is a very large overlap in the profiles (Trief et al., 1987).

In an attempt to explain why organic and functional patients do not differ in the degree of psychological disturbance, Leavitt, Garron, and Bieliauskas (1980) investigated the relation between psychological distress and stressful life events. They found that regardless of the presence or absence of organic pathology, patients who demonstrated psychological disturbance had a higher incidence of stressful life events. The distinction between organic and functional disorders has been criticized on the grounds that judgements of organicity are unreliable (Chapman, 1977; Turk & Rudy, 1987). For judgments of organicity to be reliable current medical knowledge and diagnostic procedures would have to be capable of identifying all sources of pathology (Turk & Rudy, 1987). Only in this way could one ensure that false negatives did not arise when organic pathology was present but undetected (Chapman, 1977). A study conducted by Rosomoff, Fishbain, Goldberg, Santana and Rosomoff

(1989) serves to illustrate this point. All of the chronic LBP patients they studied were judged to have nonorganic physical disorders on the basis of a traditional physical examination. When the patients were studied more thoroughly, however, musculoskeletal disease that could be a source of nociception was present in all of the patients.

The above findings clearly suggest that medical knowledge is limited, and as a result it is not surprising that low reproducibility of clinical findings among experienced physicians assessing backache is common (Nelson, Allen, Clamp & De Dombal, 1979). This low inter-rater reliability can perhaps explain the above contradictory results concerning pain description and psychological disturbance in LBP patients judged to have an organic or functional disorder (Sternbach, 1974).

The lack of reliability of judgements of organicity is not the only criticism of this approach, however. The usefulness and validity of this type of distinction have also been questioned (Sternbach, 1974). The distinction between organic and functional pain assumes that all symptoms are controlled by some underlying pathogenic factor (Reuler, Girard & Nardone, 1980), that symptoms that can not be explained by pathology must have a psychological origin (Chapman, 1977; Craig, 1984; Reesor & Craig, 1988), and that organic disorders and psychological problems can not co-occur (Chapman, 1977; Turk & Rudy, 1987).

This type of approach ignores the multidimensional nature of pain or the interaction between physical, cognitive and affective components of pain to produce the final pain experience (Melzack

& Wall, 1988). Further, it ignores the fact that in studying pain it is rare to find cases where physical variables are not interacting with psychological variables to determine the final pain experience (Bellissimo & Tunks, 1984).

The functional-organic dichotomy has also been criticized on the grounds that it ignores the substantial role that learning plays in the experience of pain. That is, it ignores the fact that the longer a patient has a pain problem (real or imagined) the more his or her behaviour will be governed by the consequences in the environment, and influenced by psychological factors associated with the experience of pain (Chapman, 1977; Reuler, Girard & Nardone, 1980).

<u>Objective Assessment of Incongruent Pain</u>

Recently, there has been an attempt to objectify the assessment of chronic LBP. This attempt has focused on developing inclusionary measures of pain that focus on the degree to which patients display pain that is incongruent with underlying anatomy and physiology. This approach relies on the objective assessment of inappropriate signs and symptoms of pain rather than on intuitive judgements of organicity (Reesor & Craig, 1988). That is, the emphasis is on whether there is evidence that the patient is displaying signs and symptoms of pain that are incongruent with underlying anatomy and physiology, and not on whether the patient does or does not have an objective physical diagnosis (Reesor & Craig, 1988).

The measures that have been developed to assess incongruent pain behaviour involve three different modes of communication:

behavioural, verbal, and pictorial. The behavioural measure focuses on behaviours or signs which deviate from anatomical principles elicited during an orthopedic examination procedure (Waddell, McCulloch, Kummell & Venner, 1980). The verbal report measure of incongruent pain focuses on symptoms that are exaggerated, and do not conform to anatomy and the normal disease course (Main & Waddell, 1982). The pictorial measure, referred to as the `pain drawing', involves scoring exaggerated and non-anatomical features of drawings patients produce to illustrate their pain (Ransford, Cairns & Mooney, 1976). The incongruent pain measures are found to be moderately correlated with one another (Main & Waddell, 1982; Reesor & Craig, 1988), and have the demonstrated advantage of being reliable and easily assessed during routine examinations (Reesor & Craig, 1988).

In recent studies by Reesor and Craig (1988) and Mahon (1991) all three measures were used to differentiate between chronic LBP patients who displayed congruent versus incongruent pain behaviour. Chronic LBP patients were considered to display medically congruent illness behaviour when the behavioural signs, symptom report, and pain drawings were consistent with anatomical principles. Chronic LBP patients were considered to display medically incongruent illness behaviour when <u>multiple</u> nonorganic signs, inappropriate symptoms, or non-anatomical and exaggerated features of the pain drawing were identified.

This classification system focuses on the significance and interpretation of <u>multiple</u> signs as indicators of incongruent pain, and ignores the use of isolated signs or symptoms in differentiating between normal and abnormal illness behaviour (Waddell, Pilowsky & Bond, 1990). It is important to draw the distinction between the use of multiple indicators, rather than isolated indicators since the use of the later has been strongly criticized (Margoles, 1990). It is also important to emphasize that these measures are not indexes of physical pathology as some have come to believe (Rudy, Turk, Brena, Stieg & Brody, 1990). Rather these measures are used as an assessment of the degree to which the patient is displaying incongruent pain behaviour independent of the degree to which they are impaired.

Using these inclusionary measures to assess incongruent chronic LBP, investigators have found chronic LBP patients with incongruent pain to use more health care resources (Waddell, Bircher, Finlayson & Main, 1984) than chronic LBP patients without incongruent pain. More specifically, patients with incongruent pain have been found to receive more specific treatments (i.e., analgesics, local lumbar injections, lumboscaral supports, physiotherapy, spinal manipulation, plaster jackets, and bed rest) upon admission to a back pain clinic than patients with little display of incongruent pain behaviour (Waddell, Bircher, Finlayson & Main, 1984).

Patients who have been identified as having incongruent pain as compared to patients who have been identified as having congruent pain have also been found to have a poorer orthopaedic outcome in response to surgery (Doxey, Dzioba, Mitson & Lacroix, 1988; Dzioba & Doxey, 1984; Taylor, Stern & Kubiszyn, 1984; Uden, Astrom & Bergenudd, 1988). In a study by McCulloch (1977), patients with few or no nonorganic signs had a 74% success rate as a result of chemonucleolysis for prolapsed interverbral disc, while patients with multiple nonorganic signs only had an 11% success rate. Incongruent as compared to congruent patients are also found to have a poorer response to physical pain relief modalities such as acupuncture and transcutaneous electrical nerve stimulation (TENS) (Lehmann, Russell & Spratt, 1983).

Disability or loss of function in activities of daily living (Mahon, 1991; Reesor & Craig, 1988; Waddell, Main, Morris, Di Paola & Gray, 1984; Waddell, Pilowsky & Bond, 1989) and objective physical impairment (Reesor & Craig, 1988; Waddell, Pilowsky & Bond, 1989) have also been found to be related to incongruent pain indicators. Further, rehabilitation, as assessed by whether the patient returns to work, has been found to be related to whether the patient displayed nonorganic signs (Dzioba & Doxey, 1984). More than 45% of patients with few nonorganic signs returned to work, whereas less 25% of patients with multiple nonorganic signs returned to work.

Reesor and Craig (1988) investigated a possible psychological basis for the poor response to treatment and rehabilitation. They found strong correlations among ineffective coping strategies, maladaptive and dysfunctional cognitions, high levels of anxiety and reports of high sensory activity in patients with incongruent pain as compared to patients with congruent pain (Reesor & Craig, 1988). Mahon (1991) also investigated this relation, and while she did not find significant differences between congruent and incongruent patients, she did find a trend that suggested that patients differed on cognitive appraisal and affective distress.

Other investigators studying LBP also have found psychological variables to be important in distinguishing between those with incongruent and congruent pain related behaviour. For instance, personality traits identified by subscales on the MMPI (Doxey, Dzioba, Mitson & Lacroix, 1988; Lehman, Russell & Spratt, 1983; Waddell, McCulloch, Kummell & Venner, 1980) and depression (Main & Waddell, 1982) have been found to be more strongly related to multiple nonorganic signs than to few nonorganic signs. In studies employing the pain drawing, patients with non-anatomical and exaggerated pain drawings have also been shown to have elevated scores on the MMPI subscales of hypochondriasis and hysteria (Ransford et al., 1976; Dzioba et al., 1984; von Baeyer et al., 1983).

Interestingly, while multiple nonorganic signs related to the MMPI clinical scales they did not relate to the F or K scales on the MMPI (Doxey et al., 1988; Waddell et al., 1980). This suggests that while multiple nonorganic signs may be indicative of patients with significant psychological impairment, they are not indicative of patients who are malingering.

Incongruent pain may also be indicative of patients who place an excessive focus of attention on physical functioning. Recent studies, have found incongruent pain behaviour and symptomatology to be associated with indicators of disease affirmation, and somatic preoccupation (Main & Waddell, 1982;

Waddell, Main, Morris, Di Paola & Gray, 1984; Waddell, Pilowsky & Bond, 1989).

The objective assessment of pain that is incongruent with underlying anatomy and physiology is a dramatic improvement over earlier attempts to assess chronic LBP patients who were unlikely to respond favorably to treatment. The distinction appears to account for many differences that have been observed between varying groups of chronic LBP patients. The major advantage of this type of assessment is that it does not conform to the notion that injury must be directly related to pain intensity, and does not make any assumptions about whether the patient has an organic or functional disorder. Further, it uses various types of information to gain an understanding of the pain experience (pictorial, verbal and nonverbal information is obtained),

Other methods of identifying incongruent and congruent pain presentation may involve the use of the patient's verbal report of pain and nonverbal expressive pain behaviour. Verbal and nonverbal behaviours play an important communicative function in any pain assessment procedure. Since pain is not directly related to tissue damage, health care professionals must rely heavily on the patients willingness and ability to communicate their pain experience through these means (Fordyce, Lansky, Calsyn, Shelton, Stolov & Rock, 1984). In the following sections, the advantages and limitations of the use of verbal and nonverbal expressive behaviour in the assessment of pain will be discussed.

Verbal Report in Pain Assessment

Importance and Use of Verbal Report. Self report has generally been the preferred method of gaining an understanding of an individual's pain experience. Although this may simply be a methodological convenience, there still appear to be a number of other reasons why clinicians and researchers rely heavily on self report. First, the presence or severity of pain is a private and subjective experience, and, as such, it is believed to be best understood through the words of the patient in pain (Wolff, 1978). Second, "there is no physiological measure of pain which is either as discriminating of fine differences in stimulus conditions, as reliable upon repetition or as lawfully related to changed conditions, as the subject's verbal report" (Hilgard, 1969). Third, no other assessment tool allows for the reconstruction of the pain experience after the actual tissue damage or injury has occurred (Craig & Prkachin, 1983). Finally, self report measures of pain, unlike other measures of pain, allow for the separate assessment of the multidimensional components of pain (Gracely, 1983).

Limitations of Verbal Report. Despite the importance of verbal report in pain assessment, its use does suffer from several limitations (Fordyce, 1976). One such limitation in using verbal report is related to the patient's knowledge and ability to describe pain (Fordyce, 1976). In many instances (e.g, with the disabled and very young children) patients are literally incapable of describing how they are feeling (Craig & Prkachin, 1983), and even in instances when patients do have the skills to communicate their pain, they may still find the pain and it's multidimensional qualities difficult to describe (Gracely, 1983).

Pain report is also sensitive to one's educational level (Gaston-Johansson, 1984), and to one's memory for pain (Jamison, Sbrocco & Parris, 1989). More specifically, the detail of the pain report is positively related to patient education (Gaston-Johansson, 1984), and one's memory for pain tends to be inaccurate and subject to overestimation (Jamison, Sbrocco & Parris, 1989). Individual differences in anxiety, depression, attitudes, expectations, coping and response styles, psychological disturbance, and personality characteristics (Beecher, 1955; Gracely, 1983; Jacox, 1980; Kremer & Atkinson, 1981; Kremer, Block & Atkinson, 1983; Teske, Daut & Cleeland, 1983) can also amplify or attenuate the pain report.

The report of pain is also not free from the influence of those who may be asking questions about pain. Factors such as the age, sex, and perceived professional status of the interviewer (Kremer, Block & Atkinson, 1983) have been shown to be related to the disclosure of pain information, and characteristics of the pain condition itself, can influence how pain is reported as well. For example different pain syndromes are perceived to be more acceptable, and therefore are more likely to be complained about (Hardy, 1956).

The social consequences (e.g., direct or indirect reinforcement) of the pain report can also mediate the verbal expression of pain (Fordyce, 1983). Research suggests, for instance, that the verbal report of pain is sensitive to staff attention (Redd, 1980), and attention from significant others (Block, Kremer & Gaylor, 1980; Flor, Kerns & Turk, 1987). In addition, some evidence suggests that the verbal report of pain is influenced by financial incentives (e.g., compensation, disability payments, and litigation awards) (Brena & Chapman, 1981; Finneson, 1976). The relationship between the variables, however, is far too unclear to be conclusive (Kremer, Block & Atkinson, 1983). In some instances, financial or job incentives may actually result in the concealment of pain because of the consequences that would result if the report of pain were to continue (e.g., athletes may minimize the seriousness of an injury) (Craig, Hyde & Patrick, 1991).

Finally, the social context may also influence the report of pain. In a study by Craig and Weiss (1971), subjects who received a series of painful electric shocks in the presence of a tolerant model reported significantly less pain than subjects who received the shocks in the presence of an intolerant model. In a similar study Craig, Best, and Reith (1974) found that low intensity shocks that were usually accepted without expressions of discomfort were rated as progressively more painful in the presence of a confederate who also reported them as painful. In addition, when the shocks were administered by an experimenter rather than through an automated procedure, the tendency to rate the shocks as painful increased further.

<u>Nonverbal Pain Behaviour in Pain Assessment</u>

<u>Importance and Use of Nonverbal Pain Behaviour</u>. Since information obtained from the verbal report of the patient suffers from several limitations, it has been suggested that nonverbal pain behaviours should be used in conjunction with verbal report in order to make a more accurate and complete assessment of pain (Craig & Prkachin, 1983). Nonverbal pain behaviours include behaviours such as paralinguistic vocalizations (e.g., sighs and groans), overt signs of autonomic activity, movements of the limbs (e.g., reflexes) facial expressions, gesticulations, and postural adjustments (Craig & Prkachin, 1983).

One advantage of using overt behaviour in contrast to covert behaviour is that it is observable and publicly verifiable (Craig, 1984; Fordyce, 1978). Further, nonverbal indices may be equally or more sensitive to some aspects of the pain experience (Craig & Prkachin, 1983), and they may also be less subject to purposeful distortion than patients' self reports (Turk & Rudy, 1987). A practical reason for using nonverbal behaviours in assessment is that they likely play a more immediate role in communicating the experience, whereas, verbal report would likely come into play later in the sequence of events (Wall, 1979).

There is much evidence to suggest that people consider and attach importance to nonverbal pain behaviours when making judgements of another's distress. For instance, nurses report preferring and relying more heavily on physiological signs, body movements, and facial expressions than on the patients' verbal complaint of pain (Kahn, 1966). Further, when people make judgements of emotional expression, they attach greater credibility to nonverbal expressions than verbal report especially when the two conflict (De Paulo, Rosenthal, Eisenstat, Rogers & Finkelstein, 1978). The importance of nonverbal behaviours is also highlighted by a study in which judgments of others' attempts at deception were enhanced when observers were provided with nonverbal as well as verbal expressive behaviour (Kraut, 1978).

Further evidence that suggests that nonverbal pain behaviours could be used in the assessment of pain comes from laboratory studies in which naive or untrained observers used nonverbal cues in making judgments about the amount of pain experienced by others (Kleck, Vaughan, Cartwright-Smith, Vaughan, Colby & Lanzetta, 1976; Lanzetta, Cartwright-Smith & Kleck, 1976). In both of these studies it was reported that untrained judges could reliably assess the amount of distress expressed by subjects exposed to painful electric shocks on the basis of observations of nonverbal behaviour. Similarly, Prkachin, Currie and Craig (1983) and Prkachin and Craig (1985) found that naive observers, focusing on facial expressions alone, were able to discriminate among volunteer subjects who received low, medium and high electric shock intensities. In this latter study, they were also successful in determining the amount of self-reported distress experienced by the subjects in response to the varying levels of electric shock.

Limitations of Nonverbal Pain Behaviour. The use of nonverbal behaviour is not without its own difficulties, however. Nonverbal pain behaviours are hypothesized to be shaped by: 1) attitudes toward how one should react to and tolerate pain (Jacox, 1980; Teske, Daut & Cleeland, 1983); 2) personality characteristics (Jacox, 1980) 3) response styles, states of anxiety and depression (Beecher, 1955; Kremer, Block & Atkinson, 1983; Teske, Daut & Cleeland, 1983); 4) social and cultural forces (Jacox, 1980; Teske, Daut & Cleeland, 1983); and 5) environmental contingencies such as attention, financial incentives and avoidance of responsibilities (Block, Kremer & Gaylor, 1980; Brena & Chapman, 1981; Craig, Hyde & Patrick, 1991; Finneson, 1976; Fordyce, 1976, 1978; Redd, 1980). The empirical research to support many of these hypotheses, however, is lacking.

The largest concern with regard to the use of nonverbal pain behaviours is the degree to which they are subject to conscious or unconscious distortion. Darwin (1872) held that "in the case of the chief expressive actions they're not learned but are present from the earliest days and throughout life are quite beyond our control ..." (p. 352). Contrary to Darwin's assertion, however, nonverbal expressions of emotional states do appear to be somewhat under our control. They are believed to come under control through the socialization of display rules that govern when it is, and when it is not acceptable to express various emotions (Ekman & Friesen, 1971). Socially learned and culturally specific display rules may result in expressions that are neutralized, masked or modified in intensity.

Evidence to suggest that there are in fact cultural conventions concerning stereotypic displays of pain comes from the mere recognition that certain persons (e.g., actors and children at play) are able to and do enact them with ease (Craig, Hyde & Patrick, 1991). Experimental evidence for the existence of cultural conventions also exists. In a study conducted by Ekman (1977) subjects who viewed a stressful film in the presence of an observer exhibited initial facial movements, and then rapidly suppressed and replaced these movement with neutral or positive expressions such as smiles. These facial actions indicative of distress were not suppressed when the subjects viewed the film alone. In a similar study conducted by Kleck et al., (1976) subjects undergoing electric shock in the presence of an age peer observer were judged as being less expressive or distressed than when they were alone.

Another study which suggests that facial actions are under the voluntary control of the person expressing them was conducted by Lanzetta, Cartwright-Smith, and Kleck (1976). They found that when subjects were instructed to deceive they were successful in convincing judges that they had received a more or less intense shock than had in fact been delivered. The success one has in achieving control, however, may also be subject to influences of the social context. Subjects smelling pleasant and disgusting odors were less successful at hiding or expressing the experience when aware that someone was in the room with them (Kraut, 1982).

That is, they leaked their evaluations more than when completely alone (Kraut, 1982).

In a study by Craig, Hyde and Patrick (1991), chronic LBP patients were asked both to fake a pain expression in response to a nonpainful leg movement and to suppress a pain expression in response to a painful range of motion leg movement. A genuine pain expression in response to the painful movement was also recorded for the purposes of comparison. These investigators found that subjects were remarkably successful in obtaining voluntary control over their pain expressions. However, using a microanalytic coding system of facial behaviour to study the expressions, they found more brow lowering, and cheek raising and pulling of the lip corner folds in the faked pain expression than in the genuine pain expression. Further, in the masked pain expression condition they found residual cues of the pain expression (e.g., marginal tension around the eyes). These residual cues were interpreted in line with Ekman and Friesen's (1984) notion of micro expressions which may be part of a squelched, neutralized, or masked display of emotion. A decrease in eye blinking was also observed in both instances which was interpreted in line with research that suggests that reduced blinking occurs when persons are engaged in cognitive activity (Holand & Tarlow, 1972; 1975). In summary the findings reported above suggest that subjects do indeed have remarkable control over their facial actions. They also suggest, however, that leakage occurs, and that expert observers viewing facial behaviour on videotape may well be able to detect such leakage.

While expert observers using micro analytic coding systems may be able to make accurate observations regarding pain, there is some concern that general inferences drawn by observers regarding these overt behaviours may be influenced by contextual and individual difference variables, and as a result may not be quite as objective (Craig & Prkachin, 1983). That is, although clinicians attempt to be as objective as possible, the assessment process is influenced by the clinician's own professional and personal experience with pain (e.g., clinicians may search for acute signs of discomfort and distress when these may not be sufficient or applicable to chronic pain), the clinician's endorsement of traditional socio-cultural beliefs about the level of pain to be expected, and a variety of other factors such as the clinician's personality and occupation (Bond, 1979; Dudley & Holm, 1984; Fordyce et al., 1978; Jacox, 1980; Johnson, 1977; Lenburg, Glass & Davitz, 1970; Teske, Daut & Cleeland, 1983).

With regard to personality characteristics, nurturance levels of the raters have been shown to be important in determining observer judgments of pain in an analogue patient/clinical relationship (von Baeyer, Johnson & McMillan, 1982). Further, observer sensitivity to the nonverbal expression of pain has been shown to influence the judgement of pain. Sensitizers are found to assign higher pain ratings than repressors when rating slides portraying low levels of non-verbal pain expression (von Baeyer, 1982).

Variables such as instructional sets and willingness to attribute pain at varying levels of severity may influence the judgment of nonverbal pain behaviours as well (Prkachin, Currie & Craig, 1983; Patrick et al., 1986). For instance, in a study conducted by Prkachin, Currie, and Craig (1983) judges who believed that subjects were hypersensitive provided higher ratings of pain than judges who did not believe that the subjects were hypersensitive. Also, judges had more difficulty discriminating the intensities of the shocks that subjects received when the subjects had been exposed to a tolerant rather than a no influence control condition model (Prkachin, Currie & Craig, 1983).

Characteristics of the patient being observed may also serve to influence judgements of pain. For example, when physicians were asked to rate photographs of patients who varied in attractiveness, patients who were judged to be physically unattractive were rated as experiencing significantly more pain than patients who were judged to be attractive (Hadjistavropoulos, von Baeyer & Ross, 1990).

Objective Measurement of Facial Behaviour. Since erroneous judgments of pain can have detrimental effects on the patient, there has been an increased interest in the development of systematic, objective and sensitive measures of nonverbal behaviour. One approach to the objective assessment of pain has been to develop observational coding systems of a range of bodily and facial behaviours (Chambers & Price, 1967; Johnson, Kirkchoff & Endress, 1975; Keefe & Block, 1982; Kendall, Williams, Pechacek, Shisslak & Herzoff, 1979; Teske, Daut & Cleeland, 1983). One of the most popular measurement systems involves recording discrete motor behaviours such as guarded movements and posture (Keefe & Block, 1982). Through the use of this coding system, homogeneous groups of patients who show similar pain behaviour have been identified (Keefe, Bradley & Crisson, 1990).

Recently, increased attention has also been placed on the use of facial expressive behaviour in the assessment of pain (Craig & Prkachin, 1983; Grunau, Johnston & Craig, 1990; Keefe, Bradley & Crisson, 1990; LeResche & Dworkin, 1988; Prkachin & Mercer, 1989). The amount of information the face can convey in even a short period of time and the types of information conveyed (e.g., emotional and attitudinal) suggest that the face is likely an important area in communication (Harper, Weins & Matarazzo, 1978).

The most sophisticated development to date in the measurement of facial expressive behaviour is the Facial Action Coding System (FACS; Ekman & Friesen, 1978a, 1979b). The major advantage of the FACS is that it is objective, reliable, and atheoretical. The system measures 44 separate facial action units (discrete movements in the forehead, eye, cheek, nose, mouth, chin, and neck regions). The action units or the combination of the action units and the duration and intensity of facial movements can be used to describe any facial expression not just those presumably involved in pain. There is little opportunity for subjective judgements since trained observers are able to use explicit definitions of the specific components of facial expression.

Studies of Painful Facial Behaviour. Many studies in both laboratory (Craig & Patrick, 1985; Patrick, Craig, Prkachin, 1986; Swalm & Craig, 1990) and clinical settings (Craig, Hyde & Patrick, 1991; LeResche, 1982; LeResche & Dworkin, 1988; Prkachin & Mercer, 1989) have shown the applicability of the FACS to the study of pain. Craig and Patrick (1985) used the FACS to characterize female expressive behaviour in response to cold pressor pain, and to study the impact of observing models who were either tolerant or intolerant of the shock on the expression of pain. Narrowing of the eye aperture from below, raising the upper lip, pulling the lip corners, parting the lips or dropping the jaw and eyes closed or blinking were all systematically related to the expression of pain. The facial actions were most salient at the beginning of the cold pressor task and declined in intensity over time. The nonverbal activity was inconsistent with the report of pain that increased with exposure to the cold pressor. Observing an intolerant or tolerant model had no effect on nonverbal expressive behaviour, but did have an effect on verbal report and pain tolerance. These findings suggest that nonverbal expressive behaviour may be less susceptible to social influences and may provide additional and non-redundant information to that provided by verbal report.

The FACS has also been used to study facial expressive behaviour in female subjects experiencing a range of painful and nonpainful shocks (Patrick, Craig & Prkachin, 1986). The effect that observing tolerant or intolerant models had on nonverbal expressive behaviour was also investigated in this study.

Consistent with the previous study, narrowing of the eye aperture from below, raising the upper lips and blinking were all found to be pain related. Unlike the above study, however, brow lowering was also observed. The authors attributed these differences to the different nature of the shock (brief noxious stimulus) and cold pressor (relatively more enduring and aching pain compared to electric shock) experiences.

In this study, social modeling was also found to have an interesting effect on pain expressions. Subjects who were exposed to the tolerant model endured shocks of greater intensity and reported them to be of the same painfulness as subjects who were exposed to intolerant models and experienced shock of a lesser intensity. Although the reports of pain of subjects exposed to the two models were equivalent, the subjects who were exposed to the tolerant model (and thus received higher shocks) were found to have more nonverbal pain related facial actions. These findings suggest that nonverbal pain expressions may provide more relevant and accurate information regarding the pain experience than verbal report.

In another laboratory study (Swalm & Craig, 1990), the FACS was used to describe both male and female expressive behaviour in response to painful and nonpainful shocks. Brow lowering, cheek raising, lip corner pulling, lips parting, and eyes blinking were all found to be indicative of the pain experience. Inner and outer brow raise, cheek dimpler and tight lips, on the other hand were found to contraindicate pain. These results are quite consistent with those already reported. The differences in results that do exist, however, suggest that there are important individual differences in the expression of pain. In this study the FACS was also used to examine the effects of placebos on facial expressive behaviour. The placebo was found to influence pain expressions only in men and not in women. This finding suggests that there may also be some important sex differences in the expression of pain in response to placebo.

In a recent study by Prkachin (1992) the consistency of facial expressions of pain across several modalities of nociceptive stimulation (e.g., electric shock, cold pressor, pressure pain, and ischemia) was examined. The results of the study suggested that the bulk of the information about pain is conveyed through four facial actions or combinations of facial actions which consistently increased in likelihood, intensity, and duration across all modalities compared to a pain-free period. These facial actions or combinations of facial actions were: brow lowering, lid tightening/cheek raising, eye closing, and nose wrinkling/upper lip raising. These actions loaded on one general factor, and could be combined into a sensitive single measure of pain expression. Prkachin, suggests, that the results provide preliminary support for the notion of a universal expression of pain.

The applicability of the FACS to the study of clinical pain has also been demonstrated. LeResche (1982) used the FACS to identify facial actions of slides of patients experiencing pain from acute severe physical trauma. She found that the expression of pain was characterized by a horizontally stretched mouth, sometimes with deepened nasolabial furrow and a lowered brow, with skin drawn tightly around closed eyes. She compared this constellation with the constellations of other negative emotions (e.g., disgust, fear, sadness) and found that although there is some overlap in the individual actions, the constellations remained remarkably different.

In another study of clinical pain, Prkachin and Mercer (1989) used the FACS to investigate facial activity in patients with shoulder pathology who were undergoing active and passive arm movements and experimentally induced pain by pressure. Facial actions related to pain under these circumstances included: brow lowering, narrowing and closing of the eyes, lip pulling, nose wrinkling, and mouth opening. Once again, the results indicate that facial measures of pain yield sensitive information about the pain experience.

LeResche and Dworkin (1988) have extended the use of the FACS to the study of facial expressions in chronic temporomandibular disorder (TMD) patients who were undergoing painful palpations of the muscles of mastication. Facial actions that were observed to be indicative of pain included: tightening the skin around the eye, lowering the brow, closing the eyes, raising the upper lip, wrinkling the nose, and stretching the lips horizontally or opening the mouth. Generally, pain-related activity reached moderate levels of intensity and occurred every four seconds.

Using the FACS, LeResche and Dworkin (1988) found that subjects expressed at least one other negative emotion (e.g., anger, fear, disgust, contempt, sadness) in response to the painful palpitation procedure. Subjects who were found to express more than one negative emotion also were found to be more verbally and nonverbally expressive of the pain. This finding suggests that the expression of intense pain may be associated with the diffuse experience of negative affect.

The FACS has also been used to study facial expressive behaviour in chronic LBP patients undergoing a painful range of motion exercise during a routine physical examination of LBP (Craig, Hyde & Patrick, 1991). Brow lowering, cheek raising, tightening of the eye lids, raising the upper lips, parting the lips and closing the eyes were all found to be associated with the point when the patients were judged to be experiencing the most pain. As mentioned earlier, these investigators also used the FACS to compare genuine, faked, and suppressed pain expressions. By using the FACS, it was possible to identify some cues to deceit.

Other investigators have used the FACS (LeResche, Ehrlich & Dworkin, 1990) to study facial actions (e.g., cheek raising and lip corner pull) that are associated with smiling, but are displayed frequently in response to the painful cold pressor task. The investigators have attempted to determine whether these actions were indicative of a true smile denoting happiness or an insincere smile disguising the experience of negative emotions. In order to study this, the investigators distinguished anatomically between insincere smiles and genuine smiles and videotaped the facial expressive behaviour of female chronic TMD pain patients during a baseline period, a painful examination and a painful cold pressor task. The greatest increase from baseline in insincere smiles occurred in the response to the cold pressor task, but there was also an increase in insincere smiles during the painful palpation examination. No such increase in true smiles was observed.

From these studies it can be concluded that a relatively consistent set of facial actions is associated with the experience of pain in response to both experimentally induced pain (Craig & Patrick, 1985; Patrick, Craig & Prkachin, 1986; Prkachin & Mercer, 1989) and clinical pain (Craig, Hyde & Patrick, 1991; LeResche, 1982; LeResche & Dworkin, 1988; Prkachin & Mercer, 1989). In the majority of these studies (four to seven) brow lowering, tightening of the eyelids, raising of the cheeks, eyes closed or blinking, raising of the upper lip, parting of the lips or dropping of the jaw, have been identified as indicators of painful stimulation (Craig, Hyde & Patrick, 1991). Other facial actions associated with the experience of pain were observed to occur in only a few of the studies. These actions included: horizontal stretching of the mouth, pulling of the lip corners, wrinkling the nose, deepening of the nasolabial furrow, and drooping eyelids (Craig, Hyde & Patrick, 1991).

The variations in pain expressions that have been observed can in part be attributed to the severity and duration of the painful stimulus. It has been proposed that more facial actions occur as pain becomes more severe and enduring (Prkachin & Mercer, 1989). At low levels of pain, facial actions that are consistently related to pain (e.g., brow lowering, and narrowing of the eye aperture) are expected to be observed. At moderate levels of pain, middle facial actions (e.g., upper lip raise, and nose wrinkling) are expected to occur in addition to those already identified. Finally, with the most intense levels of pain, lower facial actions (e.g., mouth opening, horizontal stretch mouth) are expected to come into play.

Further variations in the expression of pain have been attributed to the nature of the pain condition (i.e., low back pain, TMD, and shoulder pathology) the sex, age and individual characteristics of the subject, and the nature of the experimental situation (Craig, Hyde & Patrick, 1991). Despite the variations in pain expressions, it can be concluded that there is a high degree of regularity in facial expressive behaviour associated with pain, and that the use of facial expressive behaviour in the study of pain offers additional and non-redundant information to that provided by self report of pain.

Summary and Purpose

Until recently, acute and chronic LBP patients have been assumed to differ in their psychological reactions to pain. In general, the assumption has been that as pain persists the more negative the psychological reaction to pain would be (Sternbach, 1985). Recent investigations, however, suggest that acute and chronic pain patients may be more similar in their psychological reactions to pain (e.g., they score similarly on measures of depression, anxiety, and pain cognitions) than has often been assumed (Ackerman & Stevens, 1989; Philips & Grant, 1991). These investigations are important in that they represent the first attempts to systematically and objectively compare acute and chronic pain patients. At the same time, however, they suffer from the fact that they failed to make a distinction among chronic congruent and incongruent pain patients. This distinction has proven to be important in that patients with chronic incongruent LBP have been found to utilize more health care resources (Waddell et al., 1984), have a poorer outcome and response to treatment (Doxey et al., 1988), more ineffective coping strategies, and dysfunctional pain cognitions than chronic congruent LBP patients (Reesor & Craig, 1988). Simply comparing acute and chronic pain patients without distinguishing between chronic congruent and incongruent patients may have served to obscure differences that may actually exist between patients.

The purpose of the present study was to compare the psychological reactions to pain of acute pain patients, and chronic pain patients with congruent or incongruent signs. Also of interest in the present study was whether the patient groups would differ in their verbal report and nonverbal expressions of pain (masked, genuine, and exaggerated). Verbal and nonverbal behaviour have been identified as playing an important communicative function in pain assessment procedures, and thus differences between how the patient groups would express their pain both verbally and nonverbally were predicted.

It is of note that the patients in the present study were all selected from a local physiotherapy clinic which likely represents a more heterogeneous sampling of community pain patients seeking treatment than those referred to tertiary health care settings. Other studies of LBP have tended to select patients from this latter setting.

A physiotherapy protocol in which patients were asked to genuinely express pain, and exaggerate and mask pain in response to a painful range of motion task, was used to obtain a wide range of facial behaviour that would likely be relevant or important in understanding the expression of pain in these patient populations. Verbal reports of pain in response to the painful range of motion task, and in response to the pain that patients experienced on a daily basis were also examined. In addition, questionnaires concerned with coping strategies, worry and emotionality were used to tap cognitive and affective components of pain.

In general, the relation among nonverbal expressions of pain, verbal reports of pain, and cognitive and affective measures of pain in the different LBP patient groups were examined. It was hoped that information obtained in this study would add to the understanding of the pain experience in acute and chronic pain patients, and would also be of use in identifying and assessing pain in congruent and incongruent chronic LBP patients.

Hypotheses

Cognitive and Affective Variables. It was predicted that passive coping strategies, dysfunctional cognitions, decreased ability to control and decrease pain, increased levels of emotionality and worry would be more common in chronic incongruent LBP patients than in chronic congruent LBP patients and acute LBP patients. In addition, the negative affective and cognitive pattern was expected to be slightly more pronounced in chronic congruent patients than acute patients, since chronic congruent patients would have experienced their pain for a longer duration than acute pain patients. A significant sex difference was also expected with females predicted to have higher scores on the negative affective and cognitive variables than males.

Verbal report. The cognitive and affective variables were expected to mediate the verbal report of pain, with the patients who were predicted to score higher on negative cognitive and affective variables, also expected to report more pain than patients who were predicted to score lower on these variables. That is, in comparison to acute LBP patients and chronic congruent LBP patients, chronic incongruent LBP patients were expected to have higher scores on sensory intensity and unpleasantness of pain. These higher ratings were expected both in response to: 1) the pain they experienced on a daily basis, and 2) the pain they experienced as a result of a leg movement that produced discomfort during a physical examination. For all patients, the pain experienced on a daily basis was expected to be greater than the pain experienced in response to the painful movement. Chronic congruent LBP patients were expected to obtain higher ratings on both scales than acute LBP patients, although the differences were expected to be minimal in magnitude. Small sex differences were also predicted, with females expected to report more intense and unpleasant pain than males.

Nonverbal Facial Behaviour. A distinctive pattern of facial activity (i.e., brow lowering, cheek raising, tightening of the eyelids, raising of the upper lip, parting of the lips, closing of the eyes) was predicted to be associated with the painful movement for all subjects. The frequency and intensity of these facial actions, however, were expected to be mediated by cognitive and affective variables, with patients predicted to score higher on the negative cognitive and affective variables also predicted to show more frequent and more intense painful facial activity than those who were predicted to score lower on the cognitive and affective measures. That is, in comparison to acute LBP patients and chronic congruent LBP patients, the facial actions of chronic incongruent LBP patients were expected to be more frequent and of greater intensity. Compared to acute LBP patients, the facial actions of chronic congruent LBP patients were also expected to be more frequent and of stronger intensity. Compared to male LBP patients, the facial actions of female LBP patients were also expected to be more frequent and of stronger intensity. Once again, however, the differences between males and females and acute and chronic congruent patients were expected to be minimal.

All subjects were expected to be quite successful in masking their pain expressions. However, chronic incongruent LBP patients were expected to be less successful than acute LBP patients, and chronic congruent LBP patients. Slight differences between the latter two groups were also predicted, with acute LBP patients predicted to be better able to mask their pain than chronic congruent LBP patients. Male LBP patients were also expected to be more successful at masking their pain than female LBP patients. Unsuccessful pain expressions were expected to show more residual cues of facial activity (e.g, marginal tightening around the eyes).

All subjects were also hypothesized to be quite successful in exaggerating an expression of pain. That is, facial actions similar to those hypothesized to occur in response to the painful movement were predicted to occur when subjects were asked to exaggerate a pain expression. When subjects were asked to exaggerate, however, the facial activity was expected to be of stronger intensity than when subjects were actually experiencing pain. Chronic incongruent LBP patients were expected to have more success at exaggerating the pain expression than chronic congruent LBP patients and acute LBP patients, and chronic congruent LBP patients were expected to have more success than acute LBP patients. Female LBP patients were also expected to be more successful at exaggerating than male LBP patients.

METHOD

Subjects

Male and female subjects were selected from among the patients undergoing treatment at the Lansdowne Physiotherapy Clinic in Richmond. Only those patients who were between the ages of 20 and 70 years, who were experiencing pain in the lower back at the time of the assessment, and who demonstrated sufficient command of the English language to complete the questionnaires were used as participants in the study. Litigation/compensation claims and use of prescribed medications were not used as exclusion criteria from the study.

From April to August of 1991 an attempt to recruit all incoming patients who met the above criteria was made. The patients were assigned to one of three groups of back pain patients until each group consisted of 30 subjects with an equal number of male and female subjects in each group. In total 104 patients were approached; of these 8 refused to participate, 2 were omitted from the sample because they did not meet the specified criteria, and 4 were omitted because the group to which they were to be assigned already had the specified number of patients (15 in each group).

The mean age of the sample was 44.11 years (SD=14.95, range=20 to 70 years). Sixty-one percent (n=61) of the sample were married, 12% (n=11) were single, 12% (n=11) were divorced, and 8% (n=7) were widowed. Eighty-four percent (n =76) of the sample were Caucasian anglophone, while 16% (n=14) reported English as their second language, and either East Indian (9%, n=8), German (3%, n=3), Italian (1%, n=1) Hungarian (1%, n=1), or Native Indian (1%, n=1) as their first language.

Socioeconomic status was rated using Blishen, Carroll, and Moore's (1987) index based on the 1981 census. The mean socioeconomic index for the sample was 36.61 (SD=13.18, range=21-72). Of the entire sample 42% (n=38) were employed, 31% (n=28) were off from work because of their injury, 18% (n=16) were homemakers not seeking work outside of the home, and 9% (n=8) were retired. The patients who were employed or temporarily off of work rated their job satisfaction on a 10 cm visual analogue scale, and reported a mean job satisfaction of 7.30 (SD=2.57, range=0-10). The majority (67%; n=60)) of the patients were not receiving any form of compensation, while 33% (n=30) were receiving compensation or disability payments from the Worker's Compensation Board, or the Insurance Corporation of British Columbia.

The mean self-reported duration of the pain condition was 4.36 years (SD=6.73, range=3 days to over 27 years). Nine percent (n=8) of the sample had had one previous surgery, and as few as 6% (n=5) had had as many as two surgeries. The mean percentage physical impairment (objective loss of structural functioning) as assessed by the physical impairment index developed by Waddell and Main (1984) was 7.9% (SD=8.06, range=0-29). This score is slightly below the range (10-20%) of physical impairment that is usually reported for LBP patients. The mean reported disability (subjective loss of functioning) was 31.38% (SD=15.87, range=4-76). According to Fairbank, Couper, Davies and O'Brien (1980) a score between 20-40% suggests that patients are moderately disabled (e.g, likely having greatest difficulties sitting, lifting, and standing, moderate difficulties with travelling, socializing and working, and minimal difficulties with personal care, sexual activity, and sleeping).

Similar to Mahon (1991) and Yang and colleagues (1985) `medication use' was classified into the following categories: anti-inflammatory/analgesics, muscle relaxants/analgesics, and opiate analgesics. Twenty percent (n=18) of the sample reported regularly using anti-inflammatory/analgesics, 30% (n=27) reported regularly using muscle relaxant/analgesics, and 19% (n=17) reported regularly using opiate analgesics. On the day of testing, however, the use of these prescribed medications was substantially lower, with only 11% (n=10) reporting the use of anti-inflammatory/analgesics, 13% (n=12) reporting the use of muscle relaxant/analgesics, and 9% (n=8) reporting the use of opiate analgesics.

Setting

Subjects were informed about the nature of the study, answered questions, and completed their questionnaires while they were in an examination room undergoing their regular physiotherapy treatment. They were lying slightly propped up on their backs and the treatment involved the application of heat or transcutaneous electrical nerve stimulation to their backs. The videotaped portion of the study took place in a separate examination room in the Lansdowne Physiotherapy Clinic. In order to get a full view of the subject's face during the physiotherapy protocol, the camcorder was mounted on a tripod at the end of the examination table.

Videotape Equipment

Subject's facial expressions were recorded on Fuji T-60 video cassettes by using a NEC VHS movie record/playback camcorder system with autofocus. Following the recording of the tapes an RCA video time/date generator, model TC-1440-B was used to provide the videotapes with a digital time display (minutes, seconds, 60ths of a second). This allowed different segments to be selected for the coding of facial activity. For coding purposes the tapes were played back using a Panasonic 1/2 inch, VHS video cassette recorder on a RCA model JD-975 VW 19 inch - television monitor.

Procedure

LBP patients who were receiving treatment at the Lansdowne Physiotherapy Clinic were asked by one of two physiotherapists if they were interested in participating as volunteers in the study. Eighty seven percent (*n*=78) of the patients were approached by one physiotherapist, and the remaining 13% (*n*=22) were approached by the other physiotherapist. If the patient expressed an interest in the study the physiotherapist arranged for the experimenter and the patient to meet during the patient's next scheduled appointment. The author of this study served as the experimenter with 86% (*n*=77) of the patients, while a thoroughly trained research assistant served as the experimenter with 14% (*n*=23) of the patients. When meeting the patient, the experimenter would introduce herself, provide background information, answer questions and have those who were willing read and sign a consent form (see Appendix D).

The study was described as having two purposes: 1) to examine how individuals with LBP cope, and deal with their pain; and 2) to examine how individuals respond nonverbally to a discomforting range of motion exercise. Subjects were told that they would be required to complete a number of questionnaires concerning their coping strategies and pain experience. In addition, subjects were told that they would be asked to follow a number of instructions while carrying out leg movements. They were informed that their responses to the leg movements would be videotaped, coded by qualified coders and perhaps viewed by judges at some later date. Permission to obtain additional information from their charts was also obtained.

Patients were informed in the consent form, and through information given to them prior to the study that the information that was collected from them was for research purposes, and was confidential and anonymous. Further, they were informed that their participation was voluntary, and that they were free to withdraw their consent to participate at any time.

After the signing of the consent form, background information on the patient was collected. This included obtaining information regarding the patients: age, marital status, occupation, first language spoken, duration of pain condition, medication consumption, compensation and litigation claims. Subjects who were employed, or were off from work because of their injury were also asked to rate their job satisfaction on a 10 cm visual analogue scale that was anchored with the phrases "not at all satisfied" and "completely satisfied". All subjects were also asked to rate the intensity and unpleasantness of the pain they were experiencing on a daily basis on two Descriptor Differential Scales (DDS; Gracely et al., 1979).

Following this, information from two measures of incongruent pain were obtained. This involved asking subjects questions from the Inappropriate Symptom Inventory (Waddell et al., 1984), and having subjects complete the pain drawing (Ransford et al., 1976). The subjects were then left alone to complete a number of questionnaires including: 1) The Coping Strategy Questionnaire (Rosentiel & Keefe, 1983); 2) The Pain Experience Scale (Turk & Rudy, 1985); and 3) The Oswestry Disability Questionnaire (Fairbank et al., 1980)

After the subject completed his or her treatment, the physiotherapist who was treating him or her on that day obtained information on measures concerned with the patient's physical impairment (Waddell & Main, 1984) and presence of nonorganic physical signs (Waddell et al., 1980). The physiotherapist then directed the patients to another examination room. The patient was asked to put a blue gown over his or her clothes, and lie down in a supine position; the video camera was adjusted so that only the head and shoulders of the subjects were visible on the video monitor of the camcorder. Once the subject was positioned, the experimenter began video recording, and the physiotherapist who had previously treated the patient began with the experimental protocol (see Appendix E).

The first two sets of instructions involved asking the subject: 1) to keep a neutral expression on his of her face; and 2) to provide a baseline of activity by simply wiggling his or her toes. The next three sets of instructions involved asking subjects to lift both of their legs ten inches off of the examination table. Twenty-two percent ($\underline{n}$=20) of the patients were unable to complete this movement, and were thus asked to attempt to lift one leg ten inches off of the examination table. All patients were able to do this. In response to this movement subjects responded to three instructions which involved having subjects: 1) genuinely respond to the discomforting leg movement, 2) mask their response to the leg movement, and 3) exaggerate their response to the movement (see Appendix E). Figure 1 shows one patient's responses to these instructions.

There was a total of six possible combinations of the instructions, so within each group the first to sixth subject, the seventh to twelfth subject and the thirteenth to fifteenth subject were randomly assigned to one of the six possible combinations. With each instruction the physiotherapists read the instructions aloud, and then give the subjects approximately 10 seconds to respond before asking the subject to finish the movement. It should be noted that on average the actual length of time that subjects were given to respond to each instruction was seven seconds, and not ten. This appears to be a result of the fact that the physiotherapists counted the seconds silently to themselves. There were no differences in the length of time that the subjects took to respond to the instructions, nor were there differences between the physiotherapists in the length of time they gave subjects to respond to the instructions. When the appropriate period of time had elapsed or the subject had finished the movement without instructions to do so, the physiotherapists responded by saying "Okay, now I would like you to ...". In this way it was always possible to tell when the subject had finished the movement despite the fact that this was not visible on videotape.

Following this protocol subjects were asked to rate the intensity and unpleasantness of the straight leg lifting movements on two Descriptor Differential Scales (Gracely et al., 1979). This marked the end of the experiment at which time subjects were given the opportunity to ask questions, and were provided with more information concerning the study and a phone number where they could contact the author should they have any further questions (see Appendix F).

<u>Assignment of Patients to Acute and Chronic Pain Groups</u>

The subjects were assigned to either an acute LBP patient group, or one of two chronic LBP patient groups. The assignment of patients to the acute and chronic pain groups followed the recommendation of the committee for the Classification of Chronic Pain of the International Association for the Study of Pain (IASP). This committee suggests that "3 months [of persistent or recurring pain] is the most convenient point of division between acute and chronic pain [conditions]" (IASP, 1986, p. S5).

Measures Used to Assign Chronic Pain Patients to Congruent and Incongruent Pain Groups

Subjects with chronic pain were assigned to one of two chronic pain groups (an incongruent pain group or a congruent pain group) depending on the degree to which their pain complaint was incongruent with underlying anatomy and physiology. Three different assessment measures of incongruent pain were used to assign the patients to the groups. The measures included the Nonorganic Physical Signs Assessment (Waddell, 1980), the Pain Drawing (Ransford et. al., 1976) and the Inappropriate Symptom Inventory (Waddell et al., 1984). Descriptions of these measures are given below.

The Nonorganic Physical Signs Assessment (Waddell, McCulloch, Kummell and Venner, 1980) (see Appendix A). This measure was used to assess the degree to which patients displayed or reported nonorganic physical signs that did not correspond to anatomical principles. The assessment, carried out by one of two physiotherapists, was relatively rapid since five physical signs were simply scored as present or absent. These signs included: superficial and deep non-anatomically based tenderness, report of pain from axial loadings and simulated spinal rotation during mock examinations, increase in straight leg raising when the patient was distracted, disturbances of muscle strength or sensation in neighboring areas that do not correspond to neurological or anatomical substrates, and overreaction to examination. In order to determine how reliable the ratings were, both of the physiotherapists rated 20% of the LBP patients on the measure. The Pearson correlation coefficient between the physiotherapists' total scores on the measure was $\underline{r}$=.74, indicating that adequate reliability was obtained. Other researchers have also found adequate inter-rater reliability (Mahon, 1991; Reesor & Craig, 1988).

The Pain Drawing (Ransford, Cairns, & Mooney, 1976) (see Appendix B). The pain drawing was used to assess the degree to which patients magnified their pain problem pictorially (Waddell, et al., 1984). Each chronic LBP patient used a variety of symbols to describe the nature and quality of his or her pain on an outline of a human figure. The Ransford et al., (1976) scoring system was used by either the author of this study or a female research assistant to quantify non-anatomical or exaggerated features of this drawing. This system involved scoring the figure for: 1) poor anatomical localization; 2) "expansion" or "magnification" of pain; 3) specific emphases; and 4) a tendency toward full body pain. Inter-rater reliability calculated on 20% of the pain drawings scored by the two raters was high ($\underline{r}$=.83, p < .0001). High Inter-rater reliability using the Ransford et al., (1976) scoring system has also been found previously (Reesor & Craig, 1988; Mahon, 1991).

The Inappropriate Symptom Inventory (Waddell, Main, Morris, Di Paola & Gray, 1984) (see Appendix C). This measure was used as a verbal report measure of symptoms that are vague, poorly localized, and generally inconsistent with known physiological and anatomical principles. Chronic LBP subjects were asked seven questions concerning whether they have experienced symptoms such as pain, numbness or collapsing affecting the whole leg, and whether they have had pain at the tip of their tailbone, lack of pain free spells, intolerance to treatments or emergency admissions to the hospital. Positive responses to the questions were given a score of one; they were summed together to give a total score out of seven.

Criteria for Assigning Chronic Patients to the Congruent and Incongruent Pain Groups

On the basis of the criteria used by Reesor and Craig (1988) and Mahon (1991) chronic LBP patients were assigned to the incongruent pain group if they obtained: 1) a score of two or greater on the nonorganic physical signs measure; 2) a score of five or greater on the pain drawing; or 3) a score of three or greater on the inappropriate symptom inventory. In the absence of these criteria, chronic pain subjects were assigned to the congruent chronic LBP group. The incongruent pain measures were developed for use with chronic pain patients, and as a result they were not used to further subdivide the acute pain patients.

Measures of Physical Impairment and Disability

Measures of physical impairment and disability were obtained on all subjects to determine the severity of the back pain conditions (Waddell & Main, 1984). "Physical impairment is `an anatomical or pathological abnormality leading to loss of normal body ability', whereas disability is `diminished capacity for everyday activities' or `the limitation of a patient's performance compared with a fit person of the same age and sex'" (Waddell & Main, 1984, p. 204).

<u>Physical Impairment</u>. Physical impairment was measured by one of two physiotherapists using the Physical Impairment Index (PII) developed by Waddell and Main (1984) (see Appendix G). It is a standard set of reliable indices of organic impairment and physical limitation. In calculating the PII, consideration is taken of the anatomic pain pattern, time pattern of attacks, previous spinal fractures and lumbar surgery, nerve compression, lumbar flexion and straight leg raising in both legs. The numerical loadings of these physical characteristics are given in Appendix G.

It is of note that this is not an ideal measure of physical impairment in acute LBP patients. This is related to the fact that two of the items on the physical impairment inventory (i.e., time pattern of attacks, and surgery) are such that chronic pain patients will always likely obtain higher scores than acute pain patients. Because there were no other measures that would allow the physiotherapists to assess physical impairment in a short period of time within the physiotherapy setting, it was decided to use this index of physical impairment in the present study despite its short coming. The limitations of the findings with respect to this measure are noted.

The scale yields a percentage in which 0% impairment is indicative of no impairment, 40% is indicative of the worst possible back problem, and 100% is indicative of total body impairment, which would be present only in cases of total paraplegia or the amputation of both legs. Waddell (1987) reports that, in practice, the scale gives a conservative estimate with normal people scoring 2.6% and LBP patients scoring on average 10-20%, and only occasional patients with LBP scoring over 30%. The total PII inter-rater reliability calculated by having two physiotherapists score the same 20% of back patients was found to be very high (r=.88). This is consistent with Waddell (1987) who also has found high inter-rater reliability.

Disability. The Oswestry Low Back Pain Disability Questionnaire (OLDQ; Fairbank, Couper, Davies & O'Brien, 1980) (see Appendix H) was used to measure subjective disability. The questionnaire consists of 10 questions reflecting various degrees of pain related disability in problem areas such as analgesic medication consumption, personal care (e.g., washing and dressing), lifting, walking, sitting, standing, sleeping, sexual and social activity and traveling.

Each question contains 6 statements with each successive statement describing a greater degree or difficulty than the preceding statement. Each question is scored on a 0-5 scale, with 5 representing the greatest disability. The scores for each question are added together, giving a total possible score of 50. The total is then doubled and expressed as a percentage. Disability is easily interpreted: 0-20% indicates minimal disability; 20-40% indicates moderate disability; 40-60% indicates severe disability; 60-80% is indicative of those who are crippled; and 80-100% is indicative of those who are either bed bound or of those who are exaggerating.

The scale's validity has been demonstrated by Fairbank et al., (1980). They found that LBP patients with a strong likelihood of spontaneous recovery showed marked improvement in their disability scores over two and three week intervals. They also found the questionnaire to have high internal consistency and test-retest reliability.

Self Report of Pain

The Descriptor Differential Scales (DDS). This measure, consisting of two 13 item verbal descriptor scales (Gracely, Dubner & McGrath, 1979) (see Appendix I), was used to measure the sensory intensity and unpleasantness of the pain the patients were experiencing on a daily basis, as well the pain the patients were experiencing during painful range of motion tasks. Subjects were asked to pick one set of words from each column. Although the verbal descriptors of pain are not physically measurable, cross modality matching methods have been used to scale and verify the relative magnitude dimensions implied by the descriptors (Gracely, Dubner & McGrath, 1979; Gracely, McGrath & Dubner 1978a). One advantage of using ratio scales produced by cross modality matching techniques is that they are less sensitive to certain response biases that are prominent in categorical rating scales (Gracely, 1979, 1983; Gracely & Dubner, 1981). Further, the ratio scales of verbal descriptors allow for meaningful statements about pain magnitudes (Gracely, 1979).

Reliability coefficients of a group of eight subjects in two sessions one week apart, and reliability coefficients between groups of similar subjects have been reported as 0.96 and 0.89 for sensory intensity and unpleasantness respectively in both instances (Gracely, McGrath & Dubner, 1978a). The scales are seen to be particularly objective because there is substantial agreement between individuals in the values they attach to each adjective (Gracely, 1979, 1983; Gracely & Dubner, 1981). In comparison to visual analogue ratings of sensory intensity and unpleasantness, the DDS is as effective in quantifying sensory intensity and affective aspects of pain, and superior in differentiating or separating the two from each other (Duncan, Bushnell & Lavigne, 1989).

The validity of distinguishing between sensory intensity and unpleasantness has been demonstrated by studies that show the scales are differentially sensitive to placebo, narcotic and tranquilizing drugs (Gracely, Dubner & McGrath, 1979; Gracely, McGrath & Dubner, 1978b). Specifically, fentanyl, a short acting narcotic, reduced the sensory intensity, but not the unpleasantness of electrically induced tooth pulp sensations. In comparison to this, a saline placebo reduced the unpleasantness but not the sensory intensity of the sensations (Gracely, Dubner & McGrath, 1979). In another study, diazepam, a minor tranquilizer, altered the unpleasantness but not the sensory intensity of electrocutaneous stimuli (Gracely, McGrath & Dubner, 1978b). These studies serve to demonstrate that it is not only valid to distinguish between sensory intensity and unpleasantness, but that if the pain experience is to be studied critically, these two dimensions of pain must be examined independently.

In general the scales are still considered to be reliable and advantageous because they: 1) differentiate between varying dimensions of pain: sensory intensity and unpleasantness; 2) anchor subjective responses allowing for within-subject and between-subject comparisons; and 3) can be used in describing both naturally occurring acute and chronic pain and experimentally induced pain (Gracely, 1979, 1983; Gracely & Dubner, 1981).

Self Report Measures of Cognition and Affect

The Coping Strategy Questionnaire (CSQ). The CSQ (Rosentiel & Keefe, 1983) (see Appendix J) was used to assess the frequency that patients report using one of seven strategies to cope with pain. These strategies include: diverting attention, reinterpreting the pain sensations, employing coping self-statements, ignoring the pain sensations, praying or hoping, catastrophizing and increasing behavioural activities. Each coping strategy subtype is represented by six items on the questionnaire. Using a seven-point scale (0=never and 6=always), subjects indicated how often they used each item when they experienced pain. In addition, the CSQ includes two measures of overall effectiveness of coping strategies. These measures involved having subjects rate their ability to control pain and their ability to decrease pain on a seven point scale where 0=no control/can not decrease pain, and 6=complete control/can decrease pain completely.

The factor structure of the Coping Strategy Questionnaire has been examined on five different chronic pain populations (Lawson, Reesor, Keefe & Turner, 1990). From this examination a three factor structure has been suggested. The first factor reflects a conscious active use of cognitive strategies or coping processes, and is represented by three scales concerned with ignoring pain sensations, employing coping self statements, and reinterpreting pain sensations. The second factor reflects a self-evaluative component that is represented by two questions concerned with the patient's ability to control pain, and the patient's ability to decrease pain. The third factor reflects passive strategies for dealing with pain, and is represented by the scales concerned with praying and hoping and diverting attention. Two scales that are covered by the CSQ do not consistently relate to any of the three factors. These scales are treated as a separate measures reflecting behavioural coping strategies and tendency to employ catastrophizing cognitions.

In general, the pain-coping strategies are found to be highly predictive of psychological distress and pain report in chronic pain patients (Keefe, Crisson, Urban & Williams, 1990). The catastrophizing scale is a particularly good measure of emotional and behavioural adjustment to pain in chronic pain conditions (Reesor & Craig, 1988; Rosentiel & Keefe, 1983; Turner & Clancy, 1986). Rosentiel and Keefe (1983) and Turner and Clancy (1986) have found a high inter-item correlation (alpha coef. = 0.71 - 0.85), indicating that the test is internally reliable.

The Pain Experience Scale (PES). The PES (Turk & Rudy, 1985) (see Appendix K) was used to assess the subject's cognitive-evaluative reaction to chronic pain. Six items in the questionnaire reflect how worried the subject is, and 13 items reflect how emotional the subject is. For all questions, subjects reported how frequently they felt certain emotions or thought certain thoughts on a seven-point scale, where 0 equaled never and 6 equaled very often. The average of the 6 items reflecting worry, and the average of the 13 items reflecting emotionality was calculated.

Factor analysis has revealed that the two scales are reliable with alpha=0.91, $p < .001$ for the emotionality scale, and alpha=0.74, $p < .001$ for the worry scale. The test-retest reliability after a two week interval is high (r=0.89, p<.001 and r=0.81, p<.001 for each scale respectively). The scales are also sensitive to cognitive behavioural treatment, with significant pre-post changes on both scales being observed following treatment of 30 pain patients.

Videotape Segment Selection

Five 4-second segments from each subject's videotape were selected for coding. The first of these was a "neutral" segment, in which the subject was at rest and his or her face was expressionless. The segment was taken from the beginning of the session when the subject was asked to keep a neutral expression on his or her face. The four seconds prior to the physiotherapist's indication to the patient that they no longer had to keep a neutral expression was used as the segment. This segment served as a reference for the coders when they were coding other segments; it provided information about individual's facial structure, lines, wrinkles, etc. which might otherwise influence the coder's judgments of the presence or absence of particular action units.

The second segment was a "baseline" segment that was taken from the period when subjects were asked to wiggle their toes. Since it was difficult to determine when the subject began wiggling his or her toes, the physiotherapist said "okay" once the subject had finished the movement. In that way the 4 seconds prior to the physiotherapist's verbalization were used as representative of the activity during the baseline segment.

The third segment was taken from the period when subjects were asked to genuinely express their pain. Two seconds preceding and two seconds succeeding the point that the experimenter judged the subject to be expressing the greatest amount of distress were used. If no movement was visible to the experimenter, then four seconds prior to the physiotherapist's request for the patient to complete the movement was taken as the genuine pain segment. In order to calculate the reliability of this judgement, a second coder rated 20% of the patients. The Pearson correlation coefficient between the judgements was very high (r=.99, p < .0001), and the average difference between the segments selected by the experimenter and the research assistant was only 0.48 seconds.

The fourth segment corresponded to the "masked" expression of the subject. Since the subject was masking his or her facial expressions, it was difficult to point out when he or she was experiencing the most pain. Therefore, the physiotherapist was asked to say "okay" once the movement was completed. Once again, the 4 seconds prior to the physiotherapist's verbalization was used as representative of the activity during the masked segment.

The fifth segment corresponded to the period when the subject was "exaggerating" his or her pain. Two seconds preceding and succeeding the moment that the experimenter judged the greatest amount of activity to be occurring was used for this segment. If no observable facial activity was present, the four seconds prior to the physiotherapist's request for the patient to complete the movement were taken as representative of the "exaggerated pain segment". In order to determine the reliability of the judgement, a female research assistant rated 20% of the patients. The Pearson correlation coefficient between the judgements was very high (r=.99, p < .0001), and the average difference between the segments selected by the experimenter and the research assistant was only 0.13 seconds.

Coding and Scoring of Facial Activity

Each segment (i.e., 2-5) of the videotape was scored for all 44 facial action units (AUs) specified by the FACS. However, two sets of actions were combined to make two new variables. AUs 6 (cheek raise) and 7 (lid tighten) were combined into one variable representing orbit tightening. There is a precedent for combining these variables because the forms and muscular bases of the movements are similar (Prkachin, 1991). AUs 9 (Nose Wrinkle) and 10 (Upper Lip Raise) were also combined into one variable representing levator contraction. There is also a precedent for doing this because the movements involve contractions of the same muscle (i.e., the levator labili) and are believed to be different stages of the same expression (Prkachin, 1991; Prakchin & Mercer, 1989). A complete list of the facial AUs is listed in Appendix L.

For each AU scored in a particular segment, the frequency or number of occurrences of each AU was recorded. Further, for the majority of the AUs a standardized five-point rating scale that ranged from A (trace) to E (maximum) (Ekman & Friesen, 1983) was used to code the AUs for intensity. The average intensity of each AU in each segment was then calculated.

There were a few exceptions to the above scoring method. First, AUs 11 (Nasolabial Deepen) and 38 (Nostril Dialation) have not lent themselves to intensity coding (Ekman & Friesen, 1983; Prkachin, 1991) and were thus simply coded as present or absent. Second, anytime AUs involved the opening of the mouth (e.g., AU 25 lips apart, AU 26 jaw drop, and AU 27 mouth stretch) a new variable called "mouth opening" was coded as present. It was then given an intensity score of `1' if the lips were parted (AU 25), an intensity score of `2' if the jaw had dropped (AU 26) and an intensity score of `3' if the mouth was stretched open (AU 27). This is the same procedure that has been used by Prkachin and Mercer (1989).

While the FACS data coders coded segments the volume on the television was turned down so that they were blind to the nature of each segment (other than the neutral segment). The primary coder was also completely blind to the group membership of each subject. The second coder was the author of the study, and as a result was familiar with all of the subjects prior to coding.

However, she did not specifically remember the patient's group membership since the data had been collected anywhere from one to five months prior to her coding. The coders were both thoroughly trained and experienced in the use of the FACS, and had successfully met the reliability criteria for scoring required (Ekman & Friesen, 1978b) for certification as proficient FACS coders.

The primary coder coded 97% ($\underline{n}$=87) of the subjects. The second coder provided primary coding for 3% ($\underline{n}$=3) of the patients, and in addition provided inter-rater reliability coding on an additional 20% ($\underline{n}$=18) of the patients. Percent agreement was calculated according to the formula recommended by Ekman and Friesen (1978a):

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

An agreement was scored if the coders agreed on the occurrence of the AUs within a segment. This form of percent agreement is preferred over one that utilizes both occurrence and nonoccurrence agreement. If the latter is used, the reliability tends to be inflated, since the nonoccurrence of AUs tends to be far more frequent than the occurrence (House, House & Campbell, 1981). This formula yielded a percent agreement of 84%. In order to calculate reliability of judgements of intensity of AUs, the intensity scoring for each agreed upon AU of the two coders were correlated. The Pearson correlation coefficient was moderately high ($\underline{r}$=.80).

<u>Overview of Statistical Analyses</u>

Nine different sets of analyses were carried out. The first of these served to clarify the meaning of acute, chronic congruent and chronic incongruent pain. An ANOVA was used to examine whether the groups differed in chronicity of pain complaint, and a MANOVA was used to examine group and sex differences on the incongruent pain measures. In addition, several Chi Square analyses were carried out to examine how many subjects within the acute and chronic incongruent pain groups met each of the criteria.

A second set of analyses examined whether there were group or sex differences in the implementation of experimental conditions. The third set examined group and sex differences on demographic related variables, and the fourth set examined group and sex differences on pain related background variables. In these analyses categorical variables were analyzed using Chi Square statistics with group and sex as the independent variables. When differences were found Marascuilo's (1980) procedure for carrying out multiple comparisons was used. Continuous variables within each set of the above analyses were analyzed using MANOVA with group and sex as the independent variables. When the multivariate tests were significant, univariate F tests were examined and followed by Tukey's post hoc tests when appropriate.

In a fifth set of analyses a MANOVA examined group and sex differences with respect to the cognitive and affective variables. In a sixth set of analyses a repeated measures MANOVA was used to examine group and sex differences on reported pain intensity and unpleasantness either on an average day or in response to the leg movements. In the above analyses when the multivariate tests were significant, the univariate F tests were examined and followed by Tukey's post hoc tests when appropriate.

A seventh set of analyses was used to examine the facial expressions of pain. This involved carrying out two repeated measures MANOVA's to examine group, sex and repeated measures (e.g., baseline, masked, genuine, and exaggerated) differences in the frequency and intensity of a select group of AUs (i.e., those AUs which occurred more than five percent of the time, or were previously found to be pain related). The frequency scores for those AUs which were found to occur more frequently during the genuine segment compared to the baseline segment were then entered into a principal components analysis to see how the action units inter-related.

In the eigth set of analyses the variables which were found in the above analyses to differ among groups were entered into a discriminant function analysis. This allowed us to determine which of the variables optimally discriminated among the pain groups, and was particularly important since it allowed us to determine the relative importance of demographic, and patient pain related variables compared to the dependent variables of interest. A second discriminant function analysis was carried out, but this time only chronic congruent and incongruent groups were examined. This was useful in that the results could be directly compared to previous research that did not examine acute pain in relation to chronic pain.

A final set of analyses were carried out to examine which of all the variables measured in the study related to the verbal and nonverbal measures of pain. The three criterion variables of interest were: 1) the reported intensity of the painful physiotherapy movement; 2) the reported unpleasantness of the painful physiotherapy movement; and 3) the summed painful facial activity score for the genuine pain segment. Six groups of predictor variables were examined for their relation to each of the criterion variables of interest: 1) group assignment measures; 2) demographic background variables; 3) patient pain related variables; 4) cognitive and affective variables; 5) verbal report variables; 6) and summed painful facial activity scores for each instructional set. For each criterion variable a final stepwise multiple regression analysis was carried out in which those variables which were found to be significantly related to the criterion of interest served as the predictor variables. The above procedure, although somewhat complicated, served to keep the ratio of number of subjects to predictor variables at a minimum.

RESULTS

Clarification of Chronicity of Pain Complaint

An ANOVA with group and sex as the independent variables, and chronicity of pain complaint as the dependent variable was used to examine: 1) whether the separation of patients into distinct acute and chronic pain groups was successful; and 2) whether there were any differences between male and female patients. This analysis revealed a significant main effect for group (F (2, 84)=12.76, p < .0001), but not for sex. No interactions were found. Tukey's post hoc comparisons revealed that the chronic pain groups did not differ significantly from each other on chronicity of pain complaint, but did differ significantly from the acute pain group. On average chronic pain patients had an average pain complaint of 6.5 years, whereas acute pain patients had an average pain complaint of less than one month (29 days). Table 1 presents the mean chronicity of pain complaint in years for the groups.

Clarification of the Meaning of Incongruent Pain

Since patients had to meet only one of the criteria from one of the measures to be assigned to the incongruent pain group it was of interest to examine how many patients within the incongruent pain group met each of the criteria. Table 2 lists the percentage of male and female patients who met each criterion within the incongruent LBP group. Of note when examining Table 2 is the relatively few patients who met the criterion for the pain drawing compared to the number of patients who met the criterion for the nonorganic physical signs assessment, and the

Table 1

<u>Group Means on Chronicity of Pain Complaint</u>

Variable	Acute M	Acute F	Congruent M	Congruent F	Incongruent M	Incongruent F
			Group			
Chronicity (years)	0.10	0.06	4.64	5.70	6.86	8.81

$\underline{n}$=15

Table 2

<u>Percentage of Incongruent Patients (N=30) Meeting Each Criterion</u>

Sex	Nonorganic Signs (>1)	Inappropriate Symptoms (>2)	Pain Drawing Score (>4)
Males	40 (6)	73 (11)	27 (4)
Females	80 (12)	47 (7)	27 (4)

$\underline{n}$=15

inappropriate symptom inventory. Chi square analyses were performed to examine whether there were sex differences in meeting the criteria. There were no differences between the number of males and females who met the criterion on any of the measures.

The congruency among the measures in identifying incongruent pain patients was examined by comparing the number of patients who met one, two or three of the criteria. Table 3 represents the percentage of male and female pain patients in the medically incongruent group who satisfied one, two or three of the criteria. As can be seen in the table only one patient met all three criteria, and about an equal number of men and women met one or two of the criteria. Of those identified as incongruent on the basis of only one of the three criteria, seven were classified as incongruent on the basis of the inappropriate symptom inventory, nine were classified as incongruent on the basis of the nonorganic signs assessment, and only one was classified as incongruent on the basis of the pain drawing.

<u>Comparison of Groups on Incongruent Pain Measures</u>

To clarify the differences that were created by assigning patients to the various pain groups, a MANOVA with group and sex as the independent variables, and the three incongruent pain measures as the dependent variables was carried out. Table 4 presents the mean scores for each of the groups on each of the incongruent pain measures. This analysis revealed a significant main effect for group, $\underline{F}$ (6,166)=9.79, $\underline{p} < .0001$. Univariate F-tests revealed that there was a significant main effect for group

Table 3

Percentage of Incongruent Patients Meeting One, Two or three of the Incongruent Criteria

Sex	Number of Criteria One	Two	Three
Males	60 (9)	40 (6)	0 (0)
Females	53 (8)	40 (6)	6 (1)

n=15

Table 4

Group Means on Measures of Incongruent Pain

Variable	Group Acute M	Acute F	Congruent M	Congruent F	Incongruent M	Incongruent F
Nonorganic Signs	1.13	0.93	0.13	0.20	1.00	2.93
Inappropriate Symptoms	1.13	1.27	0.60	0.93	3.73	2.60
Pain Drawing	1.27	1.40	0.93	0.93	3.20	3.07

n=15

on each of the incongruent pain measures including the nonorganic physical signs assessment (F (2,84)=17.96, $p < .0001$), the inappropriate symptom inventory (F (2,84)=28.68, $p < .0001$), and the pain drawing (F (2,84)=6.34, $p < .01$).

Tukey's multiple comparisons of the pain drawing and the inappropriate symptom inventory revealed that the chronic incongruent patients had significantly higher scores on these measures than chronic congruent patients, and acute pain patients. The latter two groups did not differ significantly from each other on either of the measures. Multiple comparisons of the differences among groups on the nonorganic physical signs assessment revealed that the chronic incongruent patients obtained a significantly higher score on this measure than the other two groups. In addition, the acute pain group obtained a significantly higher score on this measure than the chronic congruent pain group.

The MANOVA of the incongruent pain measures with group and sex as the independent variables also revealed a significant group by sex interaction, F (6,166)=3.62, $p < .002$. Univariate F tests of the interaction revealed that there was only a significant interaction on the nonorganic physical signs assessment measure, F (2,84)=20.27, $p < .001$. Simple effects analysis of the nonorganic physical signs assessment revealed that among males there were significant group differences, F (2,84)=3.28, $p < .05$. Tukey's post hoc comparisons of this difference revealed that the males in the chronic incongruent group and the acute pain group did not differ from each other, but did differ from the chronic congruent group. Simple effects analysis also revealed that there were significant group differences among the females, F (2,84)=22.24, p < .001. Tukey's post hoc comparisons examining the differences among females revealed that the chronic incongruent pain group obtained the highest scores on this measure followed by the acute pain group and then the chronic congruent pain group. All differences among groups were significant.

Simple effects analyses were also used to examine whether males and females differed within each group on the nonorganic signs measure. Here it was found that the males and females differed from each other only within the chronic incongruent pain group, F (1,84)=20.76, p < .001. In this group it was found that females obtained significantly higher scores than males on the nonorganic signs measure. Upon further examination of this measure it was found that females as compared to males were more frequently observed to overreact nonverbally to the physical examination, (X^2 (1)=8.56, p < .01), and to report pain in response to axial loading (X^2 (1)=10.16, p < .002). More specifically, 80% of the incongruent females as compared to 27% of the incongruent males showed exaggerated facial expressions of pain during the examination, and 60% of the incongruent females, compared to 0% of the incongruent males reported pain in response to the axial loading.

Further Examination of Acute Pain Patients

From the above results it appears that the acute pain patients were more similar to chronic congruent patients than incongruent pain patients in the scores they obtained on the incongruent pain measures. However, upon further examination of their scores on these measures it is clear that there is wide variability in the scores. Table 5 shows the percentage of patients within the acute pain group who met the criteria for the incongruent pain measures. Table 6 shows the number of patients who met one, two or three of the criteria. Together these results suggest that it may in the future be useful to examine differences among congruent and incongruent acute pain patients. Unfortunately, the small number of subjects prevented such an analysis in the present study.

Analyses of Experimental Conditions

Chi square analyses were carried out to ensure that there were no differences among groups in the experimental conditions. There were no group or sex differences with regard to which physiotherapist, or experimenter carried out the study or with regard to the order in which the instructions to either genuinely express pain, mask or exaggerate pain were presented. The number of subjects within each group who lifted one leg instead of two off of the examination table did not differ among groups, but did differ between sexes X^2 (1)=7.78, $p < .005$. There were more females (n=16) unable to lift both of their legs off of the examination table than males (n=4). A repeated measures MANOVA (with instructions to genuinely express, mask or exaggerate pain as the repeated measure) with group and sex as the independent variables was used to determine whether there were group, sex or repeated measures differences in the number of seconds the

Table 5

Percentage of Acute Pain Patients Meeting Each of the Incongruent Criterion

Sex	Nonorganic Signs (>1)	Inappropriate Symptoms (>2)	Pain Drawing Score (>4)
Males	33 (5)	20 (3)	13 (2)
Females	33 (5)	20 (3)	6 (1)

n=15

Table 6

Percentage of Acute Patients Meeting One, Two or Three of the Incongruent Criteria

	Number of Criteria		
Sex	One	Two	Three
Males	27 (4)	0 (0)	13 (2)
Females	47 (7)	0 (0)	6 (1)

n=15

subjects held their legs off of the examination table. No significant main effects or interactions were found.

Analyses of Demographic Variables

Using Chi Square analyses categorical demographic variables were analyzed by group and by sex. No differences were found among groups or between sexes with respect to marital status (married as compared to single, separated, divorced, or widowed), first language spoken (English as compared to German, Hungarian, Italian, East Indian, or Native Indian) or work status (working or carrying out regular activities if housewife or if retired as compared to not working). Compensation status was not found to differ between sexes, but did differ among groups, X^2 (2)=19.20, $p < .0001$. Multiple comparisons revealed that there were fewer patients in the chronic congruent group compared to both the acute, and chronic incongruent pain groups who were receiving compensation (i.e., payments from the Workmen's Compensation Board or the Insurance Corporation of British Columbia) or disability payments. The frequency of occurrence of the categorical variables are presented in Table 7.

Group and sex differences on age and socioeconomic status were analyzed using a MANOVA. The means and standard deviations of these variables are presented in Table 8. A main effect for group, but not for sex was found, F (4, 168)=3.38, $p < .05$. No interactions between the variables were present. Univariate analyses revealed that the effect held only for socioeconomic status, F (2, 84)=4.19, $p < .05$. Tukey's multiple comparisons revealed that patients in the chronic congruent group had a

Table 7

Group Means on Categorical Demographic Variables

Variable	Acute M	Acute F	Congruent M	Congruent F	Incongruent M	Incongruent F
Marital Status						
Married	9	10	13	10	9	10
Other	6	5	2	5	6	5
First Language						
English	13	11	12	15	13	12
Other	2	4	3	0	2	3
Work Status						
Reg. Status	7	5	3	2	8	3
Not Working	8	10	12	13	7	12
Compensation						
No	6	6	14	14	9	11
Yes	9	9	1	1	6	4

_n_=15

Table 8

Group Means on Age and Socioeconomic Status

Variable		Acute M	Acute F	Congruent M	Congruent F	Incongruent M	Incongruent F
Age	M	38.5	39.4	48.0	44.3	46.9	47.6
	SD	12.3	15.3	14.1	16.4	15.1	15.8
SES	M	36.6	31.8	45.4	38.7	36.9	30.4
	SD	9.8	12.6	14.4	14.3	12.2	11.6

_n_=15

Table 9

Group Means on Self Reported Job Satisfaction

	Acute M (14)	Acute F (9)	Congruent M (13)	Congruent F (11)	Incongruent M (12)	Incongruent F (7)
M	8.3	5.9	8.1	6.7	7.4	6.4
SD	1.8	2.6	1.8	2.9	2.3	4.0

significantly higher socioeconomic status than patients in either the acute pain group or the chronic incongruent pain group. The differences between the later two groups were not significant.

Finally, an ANOVA was carried out to determine whether there were differences among groups and between sexes in self reported job satisfaction. Patients who were housewives or were retired did not make this rating, and were therefore not included in this analysis. The reduced number of subjects precluded the use of job satisfaction as a variable in the above MANOVA since using this variable in that analysis would have reduced the number of subjects in the analysis of age and socioeconomic status as well. A sex difference, but not a group difference, in reported job satisfaction was found, F (1, 65)=6.42, p < .05. The means (see Table 9) reveal that females reported significantly less job satisfaction than males. It is of note, however, that the mean reported job satisfaction was above average for both sexes.

Analyses of Patient Pain Related Variables

Using Chi Square statistics the patient groups were compared on their reported regular use of medication, and on their reported use of medication taken on the day of the study. No differences among groups or between sexes were found with respect to whether they had taken muscle relaxants or opiate analgesics on the day of the study. A sex, but not a group difference was found in the use of anti-inflammatories on the day of the study. Approximately 20% (n=9) of females compared to 2% (n=1) of males took this type of drug on the day of the study.

With regard to regular medication use, there were no sex or group differences found in the reported regular use of muscle relaxants. A group difference, but not a sex difference, was found in the reported regular use of opiate analgesics, X^2 (2)=7.11, $p < .05$. Multiple comparisons revealed that the acute and chronic incongruent pain groups reported more frequent use of opiate analgesics than chronic congruent patients. Approximately 17% (n=8) of patients in the acute pain group, and 17% (n=8) of patients in the chronic incongruent pain group reported using opiate analgesics on a regular basis compared to only 2% (n=1) of patients in the chronic congruent group making such a claim.

Finally a sex difference, but not a group difference was found in the reported regular use of anti-inflammatories, X^2 (2)=8.40, $p < .005$. Once again more females (33%, n=15) as compared to males (6%, n=3) reported using anti-inflammatories on a regular basis.

Continuous variables relating to the pain condition (i.e., physical impairment and perceived disability) were entered into a MANOVA with group and sex as the independent variables. The means and standard deviations are presented in Table 10. Both a significant main effect for group (F (4, 168)=10.18, $p < .0001$), and for sex (F (2, 83)=4.82, $p < .01$) emerged.

Univariate F tests revealed significant group differences with regard to physical impairment (F (2,84)=15.86, $p < .0001$), and disability (F (2,84)=3.77, $p < .05$). Tukey's multiple comparisons of the differences in physical impairment showed that subjects in the chronic incongruent pain group had greater

Table 10

Group Means on Physical Impairment and Disability

Variable		Acute M	Acute F	Congruent M	Congruent F	Incongruent M	Incongruent F
Impair	M	2.5	2.6	7.2	8.7	12.9	13.1
	SD	4.0	3.0	7.5	5.8	9.5	10.3
Disability	M	29.1	38.8	18.4	32.3	32.5	37.2
	SD	13.2	13.2	13.2	16.2	14.6	17.9

n=15

physical impairment than patients in both the acute and chronic congruent pain group. The differences between the latter two groups were also significant with subjects in the chronic congruent group showing more physical impairment than subjects in the acute pain group. Multiple comparisons of differences among groups in perceived disability revealed that the chronic incongruent pain group and the acute pain group did not differ from each other in perceived disability, but did, however, differ from the chronic congruent pain group, with the former two groups reporting greater disability than the latter group. Univariate F tests also revealed a significant sex difference, with regard to disability (F (1,84)=9.10, p < .003), but not with regard to physical impairment. An examination of the means in Table 10 reveals that the females tended to perceive themselves as more disabled than the males.

Relations Among Incongruent Pain Measures and Severity

The relations between physical impairment and disability and the incongruent pain measures has been previously evaluated (Waddell et al., 1984; Mahon, 1991; Reesor & Craig, 1988). Moderate correlations between disability and the incongruent measures have been found consistently (Mahon, 1991; Reesor & Craig, 1988). The relations between physical impairment and the measures of incongruent pain have been somewhat less consistent. Reesor and Craig (1988) found physical impairment to be moderately correlated with the pain drawing and the inappropriate symptom inventory, but not with the nonorganic physical signs assessment. Mahon (1991) found physical impairment to correlate with the inappropriate symptom inventory and not with the pain drawing and nonorganic signs assessment. In the present study, disability and physical impairment were moderately correlated with all of the measures. The correlations are presented in Table 11.

Choice of Covariates

In the above analyses examining group differences on demographic and pain related variables, it was found that the groups differed on socioeconomic status, compensation status, reported regular use of pain killers, perceived disability and physical impairment. These variables were all considered for their potential use as covariates. It was decided that two of the variables (reported regular use of pain killers, and perceived disability) were unsuitable as covariates since they were subjective and had a large degree of measurement error. A third variable (compensation status) was also unsuitable as a covariate since it was a categorical variable and the adjustment of group means would render the results incomprehensible (e.g., the means would be adjusted such that the patients were neither on or off compensation status). A fourth variable (physical impairment) was also considered unsuitable since it was biased toward the acute pain patients obtaining lower scores on this measure than the chronic pain patients.

The variable that was left to consider as a potential covariate was socioeconomic status which was objectively scored and had low measurement error. In the analyses which follow, the covariate was correlated with the dependent variables of

Table 11

Correlations Among Measures of Incongruent Pain and Severity

Variable	Nonorganic Signs	Inappropriate Symptoms	Pain Drawing Score
Physical Impairment	.32 **	.41 *	.25 *
Subjective Disability	.27 *	.28 *	.28 *

n=90

*p < .01

**p < .001

interest, but no significant relations between the dependent variables and covariate were found. Consequently, no covariance analyses were performed since to do so would only reduce the degrees of freedom and result in a loss of power.

Analyses of Cognitive and Affective Measures

A MANOVA with group and sex as independent variables was used to examine group and sex differences on the cognitive and affective variables (see Method section for description of each variable). Means and standard deviations of these variables can be found in Table 12. While no main effects for sex, or interactions emerged, a significant main effect for group was found, F (14,158)=1.76, p <.05. Univariate F tests examining differences among the groups on the seven cognitive and affective variables revealed differences among groups on: 1) the tendency to employ passive coping strategies, F (2,84)=3.59, p < .03; 2) the tendency to report catastrophizing cognitions (F (2,84)=4.91, p < .01); and 3) the tendency to respond emotionally to the pain, F (2,84)=6.35, p < .003. Tukey's multiple comparisons revealed that acute and chronic incongruent patients did not differ in their scores, but did differ from chronic congruent patients. That is, they scored significantly higher than chronic congruent patients on all three measures.

Analyses of Verbal Report of Pain

Since some subjects were only able to lift one leg up off of the examination table instead of two it was first of interest to examine whether these subjects differed in the reported intensity and unpleasantness of the pain they experienced in response to

Table 12

Group Means and Standard Deviations on the Cognitive and Affective Variables

Variable		Acute M	Acute F	Group Congruent M	Group Congruent F	Incongruent M	Incongruent F
Cognitive							
	M	2.22	2.42	2.48	2.47	2.37	2.34
	SD	1.04	0.91	1.08	0.87	1.08	1.09
Evaluative							
	M	3.03	3.37	2.87	3.47	2.87	2.83
	SD	1.24	1.17	1.09	1.03	1.20	1.05
Passive							
	M	2.08	2.95	1.57	1.93	2.41	2.33
	SD	1.07	1.30	1.18	0.99	1.14	1.31
Catastrophic							
	M	1.12	1.91	0.63	1.08	1.46	2.02
	SD	0.82	1.48	0.74	0.95	1.32	1.31
Behavioural							
	M	2.66	3.00	2.51	3.07	2.90	2.87
	SD	1.0	1.16	1.55	1.16	1.26	1.57
Worry							
	M	2.99	3.26	2.61	2.89	2.91	4.02
	SD	0.91	1.47	1.68	1.13	1.58	1.45
Emotionality							
	M	2.43	3.12	1.72	2.03	2.34	3.14
	SD	1.01	1.05	0.92	1.05	1.28	1.27

n=15

the physiotherapy examination. No differences were observed, and we were therefore reasonably confident that this slight deviation from the experimental procedure would not confound the results.

A repeated measures MANOVA was carried out to determine whether there were group or sex differences in the intensity and unpleasantness of the pain experienced either on a daily basis or in response to the painful range of motion exercises. The means and standard deviations of the variables are presented in Table 13. The MANOVA revealed that there was an overall effect of group (F (4,168)=2.57, p < .05), and time (daily versus movement), (F (2,83)=12.92, p < .001). No main effects involving sex were found, and in addition, no interactions among the variables were present.

Univariate F tests revealed that there was a significant difference among the groups in the reported unpleasantness of pain, (F (2,84)=5.12, p < .008), but not in the reported intensity of pain. Tukey's post hoc tests revealed that the chronic incongruent patients reported their pain to be significantly more unpleasant than the chronic congruent patients but not the acute pain patients. No differences between the acute and chronic congruent pain patients were observed.

Univariate F tests also revealed that the pain reported on a daily basis was significantly greater than the pain that was reported in response to the movement both in terms of intensity (F (1,84)=14.99, p < .0001) and unpleasantness (F (1,84)=25.42, p< .0001). An examination of the means revealed that the pain

Table 13

Group Means and Standard Deviations on Pain Intensity and Unpleasantness

Variable		Acute M	Acute F	Congruent M	Congruent F	Incongruent M	Incongruent F
Daily Pain							
Inten.	M	21.54	27.21	22.82	23.35	28.20	32.91
	SD	11.78	17.93	10.29	12.53	15.33	15.73
Unpl.	M	14.65	18.69	10.75	14.77	18.65	19.30
	SD	10.50	12.39	6.77	11.21	13.31	10.88
Movement							
Inten.	M	13.67	20.69	14.17	20.07	17.23	30.78
	SD	15.67	17.14	12.08	15.68	16.80	16.33
Unpl.	M	8.49	5.81	6.61	7.03	10.32	19.29
	SD	11.83	3.70	5.95	6.18	14.51	14.84

n=15

experienced on a daily basis was reported to be significantly more intense and unpleasant than the pain experienced in response to the leg movement.

<u>Analyses of Facial Activity</u>

Because of the large number of AUs available to study (e.g., 40) it was decided to only include in the analyses those AUs which either: 1) were found to be related to pain in previous studies of pain (Craig, Hyde & Patrick, 1991); or 2) were observed to occur more than 5% (14/270) of the time across all pain segments (i.e., genuine, masked, and exaggerated) and across all subjects. The AUs retained for the analyses were AUs: 1, 2, 4, 6 and 7 combination, 9 and 10 combination, 12, 17, 20, 24, 25,26 and 27 combination, 43, and 45 (see Appendix L for a brief description of the AUs or AU combinations.

To begin, a repeated measures MANOVA was carried out with the frequency of the facial variables as the dependent variables, group and sex as the independent variables, and instructional set (i.e, baseline, masked, genuine, and exaggerated) as the repeated measure. There were no main effects or interactions involving either group or sex. There was, however, an overall main effect for instructional set, $\underline{F}(36, 729)=4.19$, $\underline{p} < .0001$. Univariate F-tests (see Table 14) revealed that there were significant differences among the instructional sets for all variables except AUs 2 (outer brow raise), 24 (lip press), and 45 (blink). The means of the variables are presented in Table 15, and a summary of Tukey's post hoc tests are presented in Table 16.

Table 14

Univariate F-tests on Frequency of AUs Across Instructional Sets.

Variable	F	p≤
01-Inner Brow Raise	2.94	.03
04-Brow Lowerer	15.77	.0001
06/07-Cheek Raise/Lids Tight	21.88	.0001
09/10-Nose Wrinkle/Upper Lip Raise	5.84	.001
12-Lip Corner Pull	5.06	.002
17-Chin Raise	3.12	.03
20-Lip Stretch	7.24	.0001
43-Eyes Closed	15.63	.0001
25/26/27-Mouth Opening	7.44	.0001

Table 15

Mean Frequency of Occurrence of the Variables Across Instructional Sets.

Variable	Baseline	Masked	Genuine	Exag.
01-Inner Brow Raise	.06	.08	.10	.20
04-Brow Lowerer	.02	.09	.14	.33
06/07-Orbit Tightening	.03	.19	.32	.64
09/10-Levator Contract	.00	.02	.12	.17
12-Lip Corner Pull	.07	.04	.13	.22
17-Chin Raise	.02	.10	.11	.17
20-Lip Stretch	.03	.13	.06	.26
25/26/27-Mouth Opening	.20	.24	.56	.62
43-Eyes Closed	.01	.07	.08	.19

Table 16

Results of Tukey's Post Hoc Tests on Differences in the Frequency of AUs Across Instructional Sets.

Instructional Set	Differences In Frequency of AUs
Baseline versus:	
Masked	No differences.
Genuine	AUs 4, 6+7, 9+10, 25+26+27 occurred more frequently during the genuine segment.
Exaggerated	AUs 1, 4, 6+7, 9+10, 12, 17, 25+26+27, 43 occurred more frequently during the exaggerated segment.
Masked versus:	
Genuine	AU combination 25, 26, 27 occurred more frequently during the genuine segment.
Exaggerated	AUs 4, 6+7, 9+10, 12, 25+26+27, 43 occurred more frequently during the exaggerated segment.
Genuine versus:	
Exaggerated	AUs 4, 6+7, 20, and 43 occurred more frequently in the exaggerated pain segment.

A second repeated measures MANOVA was carried out to examine if there were group, sex, or instructional set differences in the mean intensity of the AUs. There were no main effects or interactions involving either group or sex. Once again, an overall main effect for instructional set, $\underline{F}(36, 729)=4.67$, $\underline{p} < .0001$, was found. Univariate F-tests (see Table 17) revealed that there were significant differences among the instructional sets for all AUs except 45 (blinking). The means of the variables are presented in Table 18, and a summary of Tukey's post hoc analyses are presented in Table 19.

The frequency scores of those variables which were found to occur more frequently during the genuine pain segment as compared to the baseline segment (i.e., AU 4, 6+7, 9+10, and 25+26+27) were entered into a principal components analysis (PCA) to determine how the separate pain related variables interrelated empirically. This resulted in the emergence of one factor which accounted for approximately 44 percent of the variance in facial activity. The factor loadings are presented in Table 20.

<u>Prediction of Pain Group</u>

Those variables which were found in the above analyses to differ with respect to group were entered into a discriminant function analysis to determine which variables optimally discriminated among the pain groups. The predictor variables included all of those variables from the above analyses which were found to be reliably related to group status: compensation status, socioeconomic status, use of opiate analgesics, perceived disability, physical impairment, use of passive coping

Table 17

Results of Univariate F-tests Examining Mean Intensity of AUs Across Instructional Sets.

Variable	F	$p\leq$
01-Inner Brow Raise	7.00	.0001
02-Outer Brow Raise	4.38	.005
04-Brow Lowerer	18.30	.0001
06/07-Cheek Raise/Lids Tight	34.10	.0001
09/10-Nose Wrinkle/Upper Lip Raise	8.49	.0001
12-Lip Corner Pull	5.65	.001
17-Chin Raise	4.01	.008
20-Lip Stretch	12.69	.0001
24-Lip Press	3.61	.014
43-Eyes Closed	12.99	.0001
25/26/27-Mouth Opening	8.15	.0001

Table 18

Mean Intensity of AUs Across Instructional Sets.

Variable	Baseline	Masked	Genuine	Exag.
01-Inner Brow Raise	.09	.09	.19	.49
02-Outer Brow Raise	.07	.04	.07	.30
04-Brow Lowerer	.03	.13	.32	.87
06/07-Orbit Tightening	.10	.36	.53	1.5
09/10-Levator Contract	.00	.04	.18	.39
12-Lip Corner Pull	.17	.09	.26	.54
17-Chin Raise	.06	.13	.20	.34
20-Lip Stretch	.03	.19	.09	.59
24-Lip Press	.01	.06	.18	.16
25/26/27-Mouth Opening	.29	.40	.71	.82
43-Eyes Closed	.01	.12	.13	.43

Table 19

Results of Tukey's Post Hoc Tests Examining Differences in the Mean Intensity of AUs Across Instructional Sets.

Instructional Set	Differences In Frequency of AUs
Baseline versus:	
Masked	No differences.
Genuine	AUs 6+7, 24, and 25+26+27 were greater in intensity during the genuine segment.
Exaggerated	The mean intensity of all Aus was greater during the exaggerated segment.
Masked versus:	
Genuine	AU combination 25, 26, 27 was more intense during the genuine segment. No other differences were found.
Exaggerated	All of the AUs were of greater intensity during the exaggerated segment.
Genuine versus:	
Exaggerated	AUs 1, 2, 4, 6+7, 9+10, 20, and 43 were of greater intensity during the exaggerated segment.

Table 20

Factor Loadings of Pain Related AUs.

Variable	Loading	Total Variance
04-Brow Lowerer	.75	44%
06/07-Orbit Tightening	.71	
09/10-Levator Contraction	.68	
25/26/27-Mouth Opening	.50	

strategies, presence of catastrophizing cognitions, tendency to respond emotionally to the pain, unpleasantness of the pain on a daily basis, and in response to the physiotherapy movement.

Two significant discriminant functions emerged: 1) X^2 (20)=77.09 p < .00001; 2) X^2 (9)=22.09, p < .009). The two discriminant functions accounted for 49% and 23%, respectively, of the between group variability. By examining the group means on the functions (see Table 21) it is clear that the first discriminant function maximally separated acute pain patients from the chronic pain groups, while the second discriminant function maximally separated chronic incongruent pain patients from chronic congruent pain patients, with acute pain patients in between.

The loading matrix of correlations between predictors and discriminant functions (see Table 22) suggests the best predictor for distinguishing between acute and chronic pain groups is physical impairment (in line with Tabachinick and Fidell (1989) only loadings greater than .50 were interpreted). This is not surprising since the physical impairment of the patient is in part determined by the duration of the pain complaint, and the number of surgeries both of which are greater for chronic as compared to acute pain patients.

Further examination of Table 22 suggests that the best predictors for distinguishing between chronic incongruent and chronic congruent with acute pain patients in between are: 1) emotional responses to pain; 2) presence of catastrophizing cognitions; 3) reported unpleasantness of the leg movement;

Table 21

<u>Group Means on the Discriminant Functions</u>

Group	Function 1	Function 2
Acute	-1.35	0.02
Chronic Congruent	0.65	-0.68
Chronic Incongruent	0.70	0.66

Table 22

<u>Results of the Discriminant Function Analysis Predicting Group Status</u>.

Predictor Variables	1	2	Univariate F (2,87)	
Impairment	0.56	0.51	16.36	***
Emotionality	-0.20	0.58	6.05	**
Catastrophizing	-0.09	0.57	4.72	**
Movement Unpleasantness	0.18	0.55	5.40	**
Socioeconomic Status	0.13	-0.50	4.08	*
Compensation Status	-0.46	0.49	11.80	***
Disability	-0.12	0.47	3.47	*
Regular Pain Killers	-0.14	0.46	3.73	*
Day Unpleasantness	-0.03	0.43	2.46	*
Passive Coping	-0.18	0.40	3.52	*
Canonical R	0.70	0.48		
Eigenvalue	0.95	0.31		

*** $p < .0001$; ** $p < .01$; * $p < .05$

Table 23

<u>Classification Results Based on the Two Discriminant Functions.</u>

Group	1	2	3
Acute	25 (83.3%)	5 (16.7%)	0 (0.0%)
Chronic Congruent	4 (10.0%)	20 (66.7%)	6 (23.3%)
Chronic Incongruent	3 (13.3%)	8 (23.3%)	19 (63.3%)

4) physical impairment; and 5) socioeconomic status. Consideration of both discriminant functions resulted in correct classification of the groups 71% of the time. More specific classification results are presented in Table 23.

Prediction of Membership in Chronic Pain Groups

The distinction between acute and chronic pain groups has traditionally been made on the basis of the duration of the pain complaint, and is relatively straightforward. The distinction between chronic congruent and incongruent pain patients, however, is much more complicated since health care professionals must often rely on multiple sources of information in making such a distinction. Since this distinction is more complex it was decided to carry out another discriminant function analysis disregarding information on the acute pain patients and using only information on the chronic pain groups. This analysis also allowed for a more direct comparison with other research in the field (e.g., Reesor & Craig, 1988). Once again those variables which were found in the above analyses to differ with respect to group were entered into a discriminant function analysis to determine which variables optimally discriminated among the chronic congruent and incongruent pain groups.

One significant discriminant function emerged (X^2 (10)=20.92 p < .05), and accounted for 32% of the between group variability. The mean on the function for chronic congruent patients was .68, whereas the mean on the function for chronic incongruent patients was -.68. The loading matrix of correlations between the predictors and the discriminant function (see Table 24) suggested

Table 24

<u>Results of Discriminant Function Analysis Predicting Congruent and Incongruent Pain Groups</u>.

Predictor Variables	Function 1	Univariate F (2,87)	
Catastrophizing	0.58	9.35	**
Emotionality	0.54	8.27	**
Movement Unpleasantness	0.51	7.23	**
Compensation Status	0.51	7.25	**
Regular Pain Killers	0.50	6.93	**
Socioeconomic Status	-0.46	5.93	*
Physical Impairment	0.44	5.55	*
Disability	0.43	5.21	*
Day Unpleasantness	0.42	5.05	*
Passive Coping	0.39	4.33	*
Canonical R	0.57		
Eigenvalue	0.48		

** $p < .01$
* $p < .05$

Table 25

<u>Classification Results of Congruent and Incongruent Patients.</u>

Group	1	2
Chronic Congruent	24 (80.0%)	6 (20.0%)
Chronic Incongruent	11 (36.7%)	19 (63.3%)

that the best predictors of group status were: 1) variables related to the negative interpretation of pain (i.e., emotionality, catastrophizing, movement unpleasantness); 2) compensation status; and 3) reported regular use of pain killers. That is, chronic incongruent patients could be discriminated from chronic congruent patients in terms of their increased likelihood to negatively interpret their pain, be on compensation, and use pain killers on a regular basis. Consideration of the discriminant function resulted in correct classification of the groups 72% of the time. More specific classification results are presented in Table 25.

Predictors of Verbal and Nonverbal Measures of Pain.

Because in general the verbal and nonverbal measures of pain were of limited use in discriminating among groups, it was of interest to examine which variables collected in the study were in fact related to the verbal and nonverbal measures of pain. The criterion variables in three separate sets of stepwise regression analyses were: 1) the intensity of pain reported by the subjects in response to the painful movements; 2) the unpleasantness of pain reported by the subjects also in response to the movement; and 3) a composite genuine painful facial activity score created by summing the frequency of action units 4, 6 and 7, 9 and 10, and 25,26 and 27 that resulted when subjects were asked to genuinely express their pain.

For each criterion seven different stepwise multiple regression analyses were carried out. One analysis was carried out for each of six sets of predictors. In addition, one final analysis was carried out which used as predictors those variables which from the previous analyses were found to be significantly related to the criterion. This procedure, although somewhat complicated, served to reduce the ratio between number of subjects and predictors for each regression analysis. The six groups of predictor variables were as follows:

1) **group assignment measures** - the duration of pain complaint, the pain drawing, the inappropriate symptoms inventory, and the nonorganic signs score.

2) **demographic variables** - marital status, English as first or second language, work status, compensation status, age, socioeconomic status.

3) **pain related variables** - medication taken on a regular basis or the day of testing, physical impairment, and disability.

4) **cognitive and affective variables** - use of cognitive, evaluative, passive, and behavioural coping strategies, presence of dysfunctional cognitions, worry, and emotionality.

5) **verbal report of pain** - the intensity and unpleasantness of daily pain and movement pain.

6) **nonverbal expression of pain** - the sum of the pain related activity that occurred during baseline, masked, genuine, and exaggerated pain segments.

Predictors of Movement Pain Intensity. Of the group assignment measures, the pain drawing (B=.38, p < .001) and the nonorganic signs assessment (B=.31, p < .002) were found to be significant predictors of the reported intensity of the pain provoked by the movement. Together they accounted for 24% of the variance in the reported pain intensity. Of the demographic variables first language spoken, ($\underline{B}$=.26, $\underline{p}$ < .03), and socioeconomic status ($\underline{B}$=-.21, $\underline{p}$ < .04) both significantly predicted pain intensity. Together the variables accounted for 11% of the variance in reported pain intensity. Regular use of opiate analgesics ($\underline{B}$=.27, $\underline{p}$ < .009) also related to the intensity of the painful movement accounting for 17% of the variance in reported pain intensity.

From the cognitive and affective variables, tendency to catastrophize ($\underline{B}$=.29, $\underline{p}$ < .009) and to use behavioural coping strategies ($\underline{B}$=.26, $\underline{p}$ < .009) predicted pain intensity and accounted for 14% of the variance. The intensity of the movement was also significantly related to the reported unpleasantness of the movement ($\underline{B}$=.77, $\underline{p}$ < .00001) and the reported intensity of pain experienced on a daily basis ($\underline{B}$=.22, $\underline{p}$ < .002). The variables together accounted for 64% of the variance in pain intensity. Of the nonverbal expressive measures, only the sum of pain related variables during the genuine pain segment ($\underline{B}$=.42, $\underline{p}$ < .0001) significantly related to the reported pain intensity accounting for approximately 18% of the variance in pain intensity scores.

Variables which in the above analyses were significantly related to reported pain intensity were entered into a further stepwise regression analysis. The results of this analysis are reported in Table 26. The best predictors of pain intensity were

Table 26

<u>Significant Predictors of Movement Intensity</u>.

Step	Variable	Beta	$p<$	Total R^2
1	Unpleasantness of Movement	.77	.00001	.66
2	Intensity of Daily Pain	.22	.03	
3	Behavioural Coping Strategies	.15	.01	
4	Pain Drawing Measure	.17	.007	
5	Genuine Pain Expression	.13	.04	

other verbal report measures of pain, the use of behavioural strategies, the pain drawing, and the amount of genuine facial activity.

Predictors of Movement Unpleasantness. Of the group assignment measures, the nonorganic signs assessment (B=.36, p < .002) and the pain drawing (B =.20, p < .05) accounted for 17% of the variance in the reported unpleasantness of the movement. Compensation status (B=.27, p < .009) proved to be a significant predictor of pain unpleasantness accounting for approximately 8% of the variance. The use of anti-inflammatories on a regular basis (B=.25, p < .02) and physical impairment (B=.23, p < .03) also together accounted for 11% of the variance in the reported unpleasantness of the movement.

Of the cognitive and affective variables, worry (B=.21, p < .05) was the only variable which accounted for a significant proportion of the variance (R^2=.05) in pain unpleasantness. The intensity of the movement (B=.77, p < .00001) was also significantly related to pain unpleasantness, accounting for approximately 59% of the variance. Finally, among the pain expression measures facial activity during the genuine pain segment (B=.41, p < .0001) accounted for a significant proportion of the variance in reported pain unpleasantness (R^2=.16).

Variables which related to pain unpleasantness in the above analyses were entered into a further regression analysis as predictor variables. Only reported pain intensity entered into the equation to significantly predict pain unpleasantness (see Table 27).

Table 27

Significant Predictors of Movement Unpleasantness.

Step	Variable	B	p<	Total R^2
1	Movement Intensity	.77	.00001	.59

__Predictors of Genuine Painful Facial Activity__. Of the group assignment measures only the pain drawing (_B_ =.32, _p_ < .002) significantly predicted (R^2=.10) the painful facial activity observed during the genuine pain segment. Of the demographic background variables, marital status (_B_=.23, _p_ < .03) was found to be significantly related to the genuine expression of pain accounting for approximately 5% of the variance. The expression of genuine pain was also positively associated with the reported sensory intensity of the movement (_B_ = .42, _p_ < .00001) which accounted for 18% of the variance in the facial activity score. Finally, the genuine expression of pain was significantly related to the exaggerated expression of pain (_B_ = .43, _p_ < .00001), and the amount of painful facial activity observed during the baseline segment (_B_=.30, _p_ < .002). Together these variables accounted for 28% of the variance in the genuine pain expression.

Once again, those variables which were significantly related to the genuine expression of pain score in the above analyses were entered together as predictors into a stepwise multiple regression analysis. The results of this analysis (see Table 28) suggest that the degree to which subjects expressed pain in the genuine pain segment was largely a function of how much they were willing to exaggerate their pain, and how much facial activity they showed during baseline. In addition, however, the degree of genuine painful facial activity was also related to how intense subjects found the painful leg movement.

Table 28

Significant Predictors of the Pain Expression During the Genuine Pain Segment.

Step	Variable	Beta	$p<$	Total R^2
1	Pain Expression During the Exaggerated Segment	.43	.0003	.34
2	Movement Intensity	.32	.004	
3	Pain Expression During the Baseline Segment	.30	.005	

DISCUSSION

Overview of Discussion

The results of the present study suggested that acute and chronic incongruent pain patients had a similar psychological reaction to pain that was greater than the psychological reaction to pain of chronic congruent patients. In addition, the results suggested that acute patients and chronic incongruent patients reported their pain to be similar in unpleasantness, although only the chronic incongruent patients had significantly higher scores on this measure than the chronic congruent patients. Acute patients and chronic incongruent patients were also more similar to each other than they were to the chronic congruent pain groups on several demographic variables (socioeconomic status, compensation status) and several pain related variables (regular use of opiate analgesics, and disability). One final difference among groups was observed on a measure of physical impairment in which it was found that the chronic incongruent group had greater physical impairment than the chronic congruent and acute pain groups. Differences between the latter two groups were also significant with the chronic congruent patients showing more physical impairment than the acute pain group.

Of all the variables noted above the most important variable for optimally discriminating among acute and chronic pain groups was physical impairment. This, however, may have been an artifact since the physical impairment measure was biased toward chronic pain patients obtaining higher scores. The most important variables for discriminating among chronic congruent and incongruent pain groups were related to the patient's negative interpretation of pain, compensation status, and reported regular use of pain killers.

No differences among groups were observed in their nonverbal expressions of pain. This, however, may have been an artifact of the procedures used to study facial expressions of pain. That is, having subjects not only genuinely express pain, but also mask and exaggerate their pain expressions may have served to attenuate the facial actions observed, and as a result differences among groups may have been obscured.

In general, the facial actions that patients displayed when they were asked to genuinely express pain in response to the leg movements corresponded to facial actions that in previous studies have been found to be associated with pain, and included brow lowering, orbit tightening, levator contraction, and mouth opening. Also consistent with previous research were findings suggesting that, although subjects were remarkably successful in both masking and exaggerating pain, there were still some cues to deception apparent on the face.

Clarification of Group Status

It should be recalled that patients were assigned to the acute and chronic pain groups on the basis of whether they had experienced LBP for a period less than or greater than three months. This distinction was effective in separating the groups, and resulted in the formation of an acute pain group who had on average experienced their pain for a period less than one month, and the formation of the two chronic pain groups who had on average experienced their pain for a period of six and a half years.

It should also be recalled that chronic pain patients were further subdivided into congruent and incongruent pain groups. Patients were assigned to the incongruent pain group if they had: 1) a score of two or greater on the nonorganic signs assessment; or 2) a score of three or greater on the inappropriate symptom inventory, or 3) a score of five or greater on the pain drawing. When patients did not meet these criteria they were assigned to the chronic congruent pain group.

Using these criteria it was found that only one of the chronic incongruent patients actually met all three of the criteria, about half of the incongruent patients met two of the criteria, and about half only met one of the criteria. These findings are similar to those of Reesor and Craig (1988) and Mahon (1991) who also used this classification system.

Also of interest in the present study is the fact that the pain drawing was of limited use in classifying patients as incongruent. When patients met two of the criteria, they were more likely to have met the criteria for the nonorganic signs assessment, and the inappropriate symptom inventory, and when patients had met only of the criteria, it was more likely to have been the criteria for these measures as well, and not the pain drawing. Reesor and Craig (1988), and Mahon (1991) did not find this. That is, they found all three measures to be equally effective in identifying the incongruent pain patients. The differences between the studies may be a result of the different patient populations. In the studies conducted by Reesor and Craig (1988) and Mahon (1991) the patients were drawn from a comprehensive back pain assessment center providing tertiary care which for many patients was the last resort for help. In contrast, the patients in the present study were drawn from a primary care physiotherapy clinic, which was likely to be one of the patients' first resorts for help.

Despite the fact that the pain drawing was not used frequently to classify patients as incongruent, patients in the incongruent pain group still scored higher on average than patients in the chronic congruent group on this measure as well as on the other measures. This may suggest that to properly identify patients as chronic incongruent on the basis of the pain drawing (at least within a physiotherapy clinic setting) the criterion score should be lowered perhaps to the mean of 3.

While the acute pain patients were not further subdivided into groups on the basis of the incongruent pain measures, it was still of interest to determine how they scored on these measures relative to the chronic pain groups. When this comparison was made it was found that the acute pain patients were more similar to the chronic congruent patients than to the chronic incongruent patients on the pain drawing, and on the inappropriate symptom inventory. On the nonorganic signs assessment, however, the scores of the acute pain patients fell between the scores of the chronic congruent and incongruent subjects.

Overall with respect to the classification criteria, it would appear that the acute pain patients were more similar to the chronic congruent pain patients than to the chronic incongruent patients. However, when we examined how many of the patients in the acute pain group actually met the criteria for identifying incongruent pain we found that six males and eight females met the criteria for incongruent pain presentation. Because of the small number of subjects involved it was not possible to determine whether there were significant differences between the acute pain groups on any of the dependent variables collected in the study.

Future research perhaps could be directed toward an examination of difference among groups who show congruent and incongruent signs in the acute pain stage. It may be that patients who show incongruent signs in the acute pain stage as compared to patients who show congruent signs in the acute pain stage are more likely to have their pain develop into a chronic pain condition. In general, it would seem important to determine whether patients who show incongruent signs in the acute pain stage are the same patients who show incongruent signs in the chronic pain stage. If the signs persist it may suggest that one can identify patients with incongruent pain much earlier in the pain cycle than was previously thought possible, and this may in turn have implications for treatment. That is, since patients with incongruent pain have poorer coping strategies and more dysfunctional cognitions than congruent pain patients (Reesor & Craig, 1991) the treatment package for acute pain patients with incongruent signs may be more effective if, in addition to the routine focus on physical treatment modalities, more emphasis were also placed on psychological treatment strategies.

In general, few sex differences on the incongruent pain measures were found. Unlike the studies conducted by Reesor and Craig (1988) and Mahon (1991), females as compared to males were not found to be more likely to have met two or more the incongruent criteria. In addition, the mean scores on the pain drawing, and the inappropriate symptom inventory were not found to differ between males and females.

The exception to finding no sex differences was on the nonorganic signs assessment measure where it was found that females in the chronic incongruent pain group obtained higher scores than males in that same group. In addition, it was found that females in the chronic incongruent group had higher scores than both acute and chronic congruent patients, whereas males in the chronic incongruent only had higher scores than the chronic congruent pain group and not the acute pain group.

Upon further examination of the nonorganic signs inventory it was found that the females obtained higher scores on this instrument because they more frequently exaggerated their expressions of pain in response to examination, and reported pain in response to axial loading of the spine. The scoring of exaggerated expressions of pain in this instrument is likely very sensitive to observer biases, and as a result the finding that women score higher on this instrument needs to be treated cautiously.

<u>Group Differences</u>

<u>Demographic Variables</u>. In the present study the pain groups were found to differ with respect to two demographic variables, namely compensation status and socioeconomic status. In both cases, chronic incongruent patients and acute pain patients were found to be more likely on compensation and to be of a lower socioeconomic status compared to chronic congruent patients. Research comparing acute and chronic pain patients is particularly sparse (Ackerman & Stevens, 1989), and as a result it is difficult to determine whether within this sample the acute pain patients are unusual or usual with respect to their similarity to chronic incongruent patients and dissimilarity to chronic congruent patients.

Research concerning chronic congruent and incongruent patients is more abundant. At the same time, however, comparison of the present findings to other findings is made difficult by the fact that the chronic patients in other studies tend to be sampled from tertiary health care settings rather than a more heterogeneous community sample. These differences in sampling may account for the fact that differences between chronic congruent and incongruent patients on socioeconomic status and compensation status were found in this study, but not in studies conducted by Reesor and Craig (1988), Mahon (1991) and Waddell and colleagues (1980).

There appear to be two alternative explanations for finding that patients who have incongruent pain are more likely to come from a lower socioeconomic stratum, and be on compensation as compared to patients with chronic congruent pain. One explanation may be that patients begin to display incongruent signs of pain when they are not coping well with their pain, and are under stress. The incongruent signs under this model may be viewed as either a result of the patient's emotional vulnerability or hypersensitivity to pain and or the patient's way of obtaining the attention of his or her health care provider in order that his or her pain condition be taken seriously. In the present context, negative life circumstances, such as being on compensation or coming from a lower socioeconomic stratum, may result in increased stress and difficulties with coping, and as a consequence the presence of multiple incongruent signs and symptoms may become more likely. Recent research does support the notion that being on compensation is a major source of stress that adds to the deterioration of the pain condition (Guest & Drummond, 1992).

An alternative explanation for these findings is that patients, perhaps as a result of different learning histories, are predisposed to display their pain in certain ways. In the present context, this would suggest that patients who come from a lower socioeconomic stratum and are likely to seek compensation may have different learning histories from patients with higher socioeconomic status, and as a result display their pain in a way that is incongruent with underlying anatomy and physiology.

Unfortunately, the present results do not shed light on whether congruent and incongruent symptoms occur as a result of some predisposition to express pain in this way, or as a result of stress. It rests with future research to develop a longitudinal design to address this question.

Pain Related Characteristics. The patient groups were also found to differ with respect to several pain related variables, namely physical impairment, perceived disability and reported regular use of opiate analgesics. With regard to physical impairment, it was found that the acute pain patients (2.6%) showed the lowest degree of physical impairment, followed by chronic congruent patients (8%), and chronic incongruent patients (13%). All differences were significant.

The mean score on the physical impairment index obtained by the acute pain group is particularly notable, since it corresponds to the scores that patients with no physical pathology typically obtain. This suggests that the validity of the physical impairment inventory with acute pain patients is questionable. The mean score of the chronic congruent patient group is also below what is expected in a LBP patient population, whereas the mean score of the chronic incongruent group just falls within the expected range which Waddell (1987) reports to be 10-20%. The scores on the physical impairment index in this study are substantially lower than the scores obtained in a study by Reesor and Craig (1988). Their chronic congruent subjects had a mean score of 13, while their chronic incongruent subjects had a mean score of 20 on physical impairment. Once again, the discrepancy in scores may well be a result of sampling.

It was not particularly striking to find that acute pain patients obtained significantly lower scores the chronic pain patients on this measure. This follows from the fact that scores on the physical impairment inventory are in part a function of chronicity of pain complaint and number of previous surgeries both of which are higher for chronic pain patients than acute pain patients.

What was striking in this study and in other studies (Reesor & Craig, 1988) was that chronic incongruent pain patients had a higher level of physical impairment than chronic congruent pain patients. One explanation for this finding is that measures of incongruent pain are actually measures of physical impairment. Although this may be the case, it seems implausible for a number of reasons. First, patients with acute pain had the lowest levels of physical impairment, yet their scores on the incongruent pain measures were higher than the congruent pain patients who had higher levels of physical impairment, and significantly so on at least one measure (i.e., nonorganic physical signs measure). Second, it is unlikely that a difference in physical impairment of only 5% could produce such significantly different incongruent pain scores. Third, it seems highly improbable that by measuring nonorganic signs (e.g., the report of pain in response to axial loading), inappropriate symptoms (e.g., the presence of pain in the tip of the tailbone), or pain drawings (e.g., the nonanatomical presentation of pain in highly exaggerated pain drawings) one is actually measuring physical impairment.

What then can account for the finding that patients who show multiple incongruent signs also have higher levels of physical impairment than patients who show few incongruent signs? One explanation is that any variable (whether it be physical impairment, recent onset of the pain condition, poor coping strategies, or negative life circumstances) which increases the patient's uncertainty about his or her pain condition (e.g., in terms of diagnosis, or effectiveness of treatment) and difficulties in coping will result in an increase in the number of incongruent signs and symptoms. The increase in incongruent signs and symptoms can then be viewed as a result of either the patient's excessive focus of attention on somatic functioning, and or the patient's way of getting a health care professional to take their pain condition seriously. Uncertainty and concern for one's health will not only likely result in an increased number of incongruent signs, but may also result in decreased physical activity. The decreased physical activity over time may in turn result in higher levels of physical impairment.

An alternative explanation for the finding is that patients are perhaps predisposed to respond to their pain in a manner that is either congruent or incongruent with underlying anatomy and physiology. If they respond incongruently this also suggests that they will have a greater psychological reaction to their pain. The greater psychological reaction to pain could in turn result in less activity, and as a result increased scores on measures of physical impairment. Both of the above explanations appear plausible, and as a result future research which follows the development of LBP longitudinally is needed to determine whether 1) increased physical impairment causes increased stress and as a result chronic incongruent pain presentation, decreased physical activity and further physical impairment; or 2) chronic incongruent pain which involves an increased psychological reaction to pain and decreased activity result in increased levels of physical impairment.

Further differences among groups were also found on reported disability and use of opiate analgesics. Here it was found that acute pain patients and chronic incongruent patients had a greater likelihood of using opiate analgesics on a regular basis and showed more functional disability than chronic congruent pain patients. More specifically, with respect to medication use, 17% of the acute pain patients, and 17% of the chronic incongruent patients were using opiate analgesics on a regular basis compared to only 2% of the chronic congruent patients. With respect to disability, while there were group differences, all of the patient groups had scores between 20-40% which according to Fairbank and colleagues (1980) suggests that patients were moderately disabled (e.g, likely having greatest difficulties sitting, lifting, and standing, moderate difficulties with travelling, socializing and working, and minimal difficulties with personal care, sexual activity, and sleeping). The level of disability in the patients in this sample was comparable to the level of disability found in LBP patients in other studies (Mahon, 1991; Reesor & Craig, 1988).

What is of particular interest here is not that acute pain patients show this level of disability and medication use, but that chronic incongruent patient's do. That is, with acute pain health care professionals often suggest that patients reduce their activity, and use opiate analgesics to reduce pain. With chronic pain, however, it is widely recognized that such actions are often contraindicated in the reduction of pain (Bonica, 1980), and thus what is surprising about these results is that chronic incongruent patients are showing the same amount of inactivity and medication use as the acute pain patient. Why this is so can only be speculated upon. It can only be assumed that the health care professionals who are treating these patients, not knowing what else to do for their patients, continue to prescribe medication, and suggest decreased physical activity.

<u>Cognitive and Affective Measures</u>. Interesting group differences, but not sex differences, on the cognitive and affective variables also emerged. These differences suggested that acute and chronic incongruent pain patients responded more emotionally to their pain, were more likely to use passive coping strategies, and more frequently reported dysfunctional, catastrophizing cognitions than chronic congruent pain patients.

Findings showing that congruent and incongruent pain patients differed were expected since other researchers have found cognitive and affective variables to be important in discriminating among these pain groups. For instance, Reesor and Craig (1988) found strong correlations among ineffective coping strategies, maladaptive and dysfunctional cognitions, and high levels of anxiety in patients with incongruent pain as compared to patients with congruent pain (Reesor & Craig, 1988). Mahon

(1991) also investigated this relation, and while she did not find significant differences between congruent and incongruent patients, she did find a trend that suggested that patients differed on cognitive appraisal and affective distress. Other investigators have found dysfunctional personality traits identified by subscales on the MMPI (Doxey et al., 1988; Lehmann et al., 1983; Waddell et al., 1980), and depression (Main & Waddell, 1982) to be more strongly related to multiple nonorganic signs than to few nonorganic signs.

Findings showing that acute pain patients had similar tendencies to chronic incongruent patients in their emotional reactions to pain, use of passive coping strategies and tendency to employ dysfunctional catastrophizing cognitions were not expected. Rather, it was expected that patients whose pain had persisted into the chronic pain stage would have higher elevations on the negative cognitive and affective variables than patients whose pain was within the acute pain stage. In addition, it was expected that chronic congruent patients who tend to cope better with their pain than chronic incongruent pain patients, would only have slightly higher scores on the cognitive and affective variables than acute pain patients. The acute pain patient's psychological reaction was still expected to be somewhat negative, however, since acute pain is assumed to be associated with elevated levels of anxiety (Sternbach, 1985) and the psychological reactions of acute and chronic pain patients (with no differentiation made between chronic congruent and incongruent patients) have been found to be remarkably similar (Ackerman & Stevens, 1989; Philips & Grant, 1991 a).

When the present findings concerning group differences on cognitive and affective variables are considered in the context of other group differences on demographic and patient pain related variables two alternative interpretations of the results are plausible. One interpretation suggests that in the acute pain stage, patients develop a negative psychological reaction to their pain (e.g., respond emotionally, catastrophize), and tend to use passive strategies to cope (e.g., praying and hoping, use of opiate analgesics, decreased physical activity). In addition, since acute pain is common among laborers it is likely that patients are likely to be from a lower socioeconomic status, and to be on compensation since it is difficult for them to return to more demanding work. The onset of pain is likely to result in greater stress and uncertainty for some patients than others, and as a result some patients may begin to show incongruent signs and symptoms because of their excessive focus of attention on their pain or in attempt to gain the attention of their health care providers and have their pain condition taken seriously. This interpretation of pain also suggests that as pain persists, as it does for 15-40% of acute pain patients (Philips & Grant, 1991 b) some patients will adapt, while others may persist in their acute pain reaction. Those patients who adapt are likely to be under less stress (e.g., from a higher socioeconomic status and not on compensation), and will show a lessened psychological reaction, and fewer attempts to cope passively with the pain. Because they are not under as much stress and are coping more effectively with their pain these patients are not likely to show incongruent symptoms and signs. Patients who do not adapt, on the other hand, will persist in the acute pain reaction (e.g., negative psychological reaction, and passive attempts to cope), and incongruent symptoms will become more frequent as the patient's become excessively focused on their pain and attempt to gain the attention of their health care providers. The continual use of passive coping strategies (e.g., inactivity) may in turn result in increased physical impairment in those who do not adapt as compared to those who do. In general, this interpretation of incongruent signs would suggest that incongruent signs and symptoms covary with stress, and that patients who show incongruent signs and symptoms in the acute pain stage are not necessarily the same patients who show incongruent signs in the chronic pain stage.

An alternative interpretation of the results is that patients are predisposed through learning, environmental, and or biological factors to display pain that is either incongruent or congruent. Incongruent pain is used loosely here to refer to patients who are predisposed to have a negative psychological reaction, cope passively, focus excessively on their somatic symptoms, and display and report signs and symptoms that are incongruent with underlying anatomy and physiology. Congruent pain on the other hand involves a lesser psychological reaction to the pain, fewer attempts to cope passively, less somatic focusing, and few or no incongruent signs and symptoms of pain.

One factor which may be related to the predisposition of patients to have incongruent pain may be socioeconomic status with patients from a lower socioeconomic status more likely to display incongruent pain than patients from a higher socioeconomic status. This overall interpretation of pain suggests that the congruent and incongruent pain patterns will be present in the acute pain stage, and will remain relatively stable if pain persists into the chronic pain stage. It may also suggest that more patients with incongruent pain will develop acute LBP to begin with, and be more likely to have their pain persist into the chronic pain stage.

Once again future research is needed to address whether patients are predisposed (perhaps because of biological differences or because of differences in learning histories) to display incongruent pain, or if these symptoms occur as a result of stress. For instance, if a longitudinal study of LBP showed that incongruent signs varied as a function of stress, support for a stress model of incongruent pain would be provided. If on the other hand, a longitudinal study of LBP showed that patients who have incongruent signs and symptoms in the acute pain stage continue to have incongruent signs and symptoms in the chronic pain stage, and the same was found of congruent pain patients support for a dispositional model of incongruent pain would be provided.

If support for a stress model of incongruent pain were found future research would need to address the factors which are most important in creating this reaction (e.g., physical impairment, off from work, from a lower socioeconomic status, inadequate social support). On the other hand if support for a dispositional model of incongruent pain were found, one would need to examine what types of variables are important in creating the incongruent and congruent pain patterns. In general, future research needs to examine how effective the current methods of identifying incongruent pain are with acute pain patients (e.g., how many incongruent signs should be present before one identifies an acute pain patient as having incongruent pain). Future research needs to also address whether incongruent pain patterns are amenable to psychological treatment, and whether treatment is more effective if patients with incongruent pain patterns are identified earlier in the pain cycle. It may be that the incongruent patients require a more psychological based treatment package with graded and gradual rehabilitation back to normal functioning, whereas congruent patients may be able to be treated effectively with a more traditional approach (e.g., rest, physiotherapy, medication) with only minimal psychological counselling.

If nothing else the above results concerning group differences on the cognitive and affective have important implications for the treatment of acute pain patients in general. Traditionally, several assumptions about acute pain have been made which have affected treatment. First, it has been assumed that acute pain although related to cognitive and affective variables (e.g., anxiety) is more related to tissue pathology (Sternbach, 1985). The results of the present study, and those of others (Ackerman & Stevens, 1989; Philips & Grant, 1991 a) suggest that cognitive and affective variables play a much larger role in acute pain, and in fact parallel the role played in the most distressed chronic pain patients. Second, it has been assumed that the distress of acute pain patients is transient and for only a small minority (10-15%) of patients will the distress continue into the chronic pain stage (Nachemson, 1982). A recent study by Philips and Grant (1991 b), however, suggests that the distress of the acute pain patient continues over a period of at least one and half months, and that for a large proportion of patients (40%) the pain persists into the chronic pain stage (6 months). The consequence of these assumptions, which to this point have received no support has been that psychological interventions for the treatment of acute LBP have largely been ignored, and the use of physical and pharmaceutical interventions to relieve pain have been focused upon (Philips & Grant, 1991 c). If future research continues to find that ineffective coping strategies, emotional reactions to pain, and dysfunctional cognitions are characteristic of the acute pain patient (whether they are showing signs of incongruent pain or not) psychological interventions at early stages will most certainly be implicated.

Verbal Report of Pain. In the present study, cognitive and affective features of the pain condition were expected to mediate the verbal report of pain. Therefore, it was hypothesized that acute pain patients, and to a lesser extent chronic congruent pain patients, who were predicted to have somewhat lower scores on the cognitive and affective variables, would report less intense and unpleasant pain than chronic incongruent patients. Because of the longer duration of the pain condition, chronic congruent patients were expected to report more intense and unpleasant pain than acute pain patients, although these differences were expected to be minimal. No support for these hypotheses were found.

Instead we found no group differences in the intensity of pain in response to the leg movement or in response to the pain experienced on a typical day. On average all groups reported more intense pain on a daily basis than they did in response to the leg movements. The average pain experienced on a daily basis roughly corresponded to the verbal descriptor strong, while the pain in response to the leg movements roughly corresponded to the verbal descriptor slightly intense.

While no group differences were found in the intensity of pain, group differences were found on the unpleasantness of pain both in response to the leg movement and in response to the pain experienced on a typical day. Acute and chronic incongruent patients were found to report their pain to be similar in its unpleasantness, but only chronic incongruent pain patients differed significantly from chronic congruent patients in reported pain unpleasantness scores.

In general, all groups were found to report the pain they experienced on a daily basis to be more unpleasant than the pain they experienced in response to the leg movements. The mean unpleasantness of pain experienced on a typical day roughly corresponded to the verbal descriptor "very distressing", whereas the unpleasantness of the pain in response to the leg movements roughly corresponded to the verbal descriptor "very unpleasant".

Facial Expressions of Pain. Cognitive and affective variables were also expected to mediate the expression of pain. Therefore, it was hypothesized that acute and to a lesser extent chronic congruent patients, who were also predicted to have lower scores on the negative cognitive and affective variables, would be less nonverbally expressive of their pain than chronic incongruent patients. Chronic congruent patients, because of the duration of their pain complaint, were expected to show more pain related facial activity than acute pain patients. No support for the hypotheses were found.

No group differences were found in either the frequency or intensity of action units that occurred when subjects were asked to mask, genuinely express or exaggerate pain. Finding no differences between chronic congruent and chronic incongruent patients was particularly surprising since chronic incongruent patients are often assumed to be exaggerating or overreacting to their pain. This assumption is so prevalent that one sign of incongruent pain is the overreaction to pain upon examination (Waddell et al., 1980).

The lack of findings may be in part be attributed to the procedures used to study facial expressions. First, using these procedures the subjects may not have been motivated to exaggerate or overreact to their pain. Second, since subjects were very aware of the fact that their facial actions were being videotaped and studied, they may have responded differently than if they had not been aware. Third, having subjects mask, genuinely express and exaggerate facial expressions of pain may have resulted in different expressions of pain than if subjects had not been asked to carry out these instructions. To adequately test the hypothesis set out in this study future research should perhaps utilize a between subjects design.

Discrimination Among Pain Groups. It should be recalled that the groups were found to differ with respect to a number of important demographic and patient pain related variables. Ideally all of these variables would have been used as covariates in the analyses of the dependent variables. However, two variables were unsuitable as covariates (i.e., reported use of pain killers, and disability) because of their large degree of measurement error and subjectivity, one variable (i.e., compensation status) was unsuitable as a covariate because of its dichotomous nature, one variable (i.e., physical impairment) was unsuitable because it was biased toward acute pain patients obtaining lower scores than chronic pain patients, and one variable (i.e., socioeconomic status) although suitable as a covariate, did not relate to the dependent variables of interest.

Because of the difficulties in carrying out covariance analysis, the discriminant function analysis was of particular interest. It allowed us to determine which variables, among those noted above which were significantly related to group status, were the most important in discriminating among the groups. When this analysis was carried out it was found that two significant discriminant functions emerged.

The first discriminant function accounted for 49% of the variability among groups, and appeared to maximally separate acute pain patients from the two chronic pain groups. The loading matrix of correlations between predictors and the first discriminant function suggested the best predictor for distinguishing between the acute and the two chronic pain groups was physical impairment. This was not surprising since the measure of physical impairment used in this study was in part determined by the duration of the pain complaint, and the number of surgeries, both of which are known to be greater for chronic as compared to acute pain patients.

The second discriminant function was also significant and accounted for 23% of the between group variability. This function maximally separated chronic incongruent pain patients from chronic congruent pain patients, with acute pain patients in between the two. This function was correlated with an array of characteristics the most important of which included: 1) emotional responses to pain; 2) presence of catastrophizing cognitions; 3) reported unpleasantness of the leg movement; 4) physical impairment; and 5) socioeconomic status. The results, suggested that chronic incongruent patients can be characterized by their greater negative subjective interpretation of their pain (e.g., emotional responses to pain, catastrophizing cognitions, perceived unpleasantness of pain) greater physical impairment, and lower socioeconomic status compared to chronic congruent pain patients.

In general, consideration of both discriminant functions resulted in the correct classification of the groups 71% of the time. More specifically, acute pain patients were correctly classified as acute 83% of the time, and incorrectly classified as chronic congruent 17% of the time. Chronic congruent patients on the other hand were correctly classified as congruent 67% of the time, and incorrectly classified as acute 13% of the time, and incongruent 20% of the time. Finally, chronic incongruent subjects were correctly classified as incongruent 63% of the time, and incorrectly classified as acute 10% of the time, and congruent 27% of the time. While these results are encouraging there is definitely much room for improvement. Future research can perhaps be directed toward finding other important variables which may help in the classification of the pain groups.

Discrimination Among Chronic Pain Groups. Since previous research has primarily focused on differences among chronic congruent and incongruent pain patients it was decided to carry out a further discriminant function analysis using the variables to discriminate only between the congruent and incongruent pain groups. This analysis also seemed in order since in practice it is easy to distinguish between acute and chronic pain patients on the basis of duration of pain complaint, and difficult to distinguish between chronic pain groups with varying degrees of incongruent pain presentation.

In doing this it was found that the discriminant function accounted for 32% of the between group variability suggesting that much variability between groups was left unexplained. The loading matrix of correlations between the predictors and the discriminant function suggested that the best predictors of group status were: 1) variables related to the negative interpretation of pain (i.e., emotionality, catastrophizing, movement unpleasantness); 2) compensation status; and 3) reported regular use of pain killers. That is, chronic incongruent patients could be discriminated from chronic congruent patients in terms of their increased likelihood of negatively interpreting their pain, being on compensation, and using pain killers on a regular basis. Consideration of the discriminant function resulted in correct classification of the groups 72% of the time. More specifically, it was found that congruent pain patients were correctly classified 80% of the time, while incongruent patients were correctly classified 63% of the time.

The results of the discriminant function analysis are somewhat different from the results of the discriminant function analysis reported in the study of chronic congruent and incongruent LBP carried out by Reesor and Craig (1988). In their study they similarly found catastrophizing to be an important variable in discriminating among groups. In addition, however, they also found physical impairment, sense of control and affective pain ratings to be important as well. Their classification results were also somewhat better which may be in part a result of a larger sample (40 congruent and 40 incongruent) patients. More specifically, they found that 81% of their patients were correctly classified.

Differences in the importance of physical impairment in discriminating among groups is somewhat troubling, and it rests with future studies to determine whether the differences are an effect of sampling from different patient populations (e.g., Reesor and Craig's patients were sampled from a tertiary care center, whereas ours were sampled from a primary care, more heterogeneous community based sample). Regardless of differences in patient populations, however, the importance of catastrophizing in discriminating among congruent and incongruent pain groups is clear, and strongly suggests that chronic incongruent patients are having difficulty coping.

Facial Expressions of Pain

Genuine, Masked and Exaggerated Expressions. It should be recalled that on the basis of previous research it was hypothesized that subjects, regardless of group status, would show a consistent set of facial actions associated with pain, and, in addition, would be remarkably successful in both masking and exaggerating their pain. These hypotheses were largely supported. With regard to AU frequency, brow lowering (AU 4), orbit tightening (AUs 6 and 7), levator contraction (AUs 9 and 10), and mouth opening (AUs 25, 26 and 27) were all found to occur more frequently during the genuine pain segment than during the baseline segment when subjects were simply instructed to carry out the non-painful task of wiggling their toes. Examining the intensity of AUs was a less useful way of discriminating among the genuine and baseline segments. It was found, for instance, that only orbit tightening (AUs 6 and 7), lip press (AU

24), and mouth opening (AUs 25, 26 and 27) were more intense during the genuine pain segment than during the baseline segment.

The above results are comparable to those that have been found in studies of facial expressions of clinical and experimental pain. That is the AUs which were found in the present study to occur more frequently during the genuine pain segment rather than the baseline segment have also been found to be consistently related to pain in other studies (Craig, Hyde & Patrick, 1991). The most relevant study to compare the findings to is the study carried out by Craig, Hyde & Patrick (1991) in which facial expressions of LBP patents in response to physiotherapy leg movements were studied. Although they used a slightly different method for coding the facial actions they also found brow lowering (AU 4), cheek raising (AU 6), tightening of the eye lids (AU 7), raising of the upper lip (AU 10), and parting of the lips (AU 25) to occur more frequently in response to the painful leg movements, than in response to baseline. In addition, however, they found eye closing (AU 43) to be more frequently associated with pain; this was not found in the present study.

With regard to the subject's ability to mask pain, comparisons between baseline, masked, and genuine segments are most relevant. That is, subjects would be viewed as having been successful in masking their pain if their facial expressions during the masked pain segment were similar to those found during baseline periods, and dissimilar from those found during genuine pain segments. Partial support for the subject's ability to mask pain was found in that the frequency and intensity of AUs found during baseline and masked pain segments were not significantly different. However, the frequency and intensity of AUs found during the genuine pain segment and the masked pain segment were also not significantly different except with respect to mouth opening which was found to be slightly more frequent and intense during the genuine pain segment, as compared to the masked pain segment. Therefore, while subjects were successful in reducing their facial activity during the masked pain segment to a point where the activity was not significantly different from baseline, it was not reduced enough to result in significant differences between genuine and masked pain segments. This suggests that while residual cues of pain may be present on the face it is likely extremely difficult to determine whether the patient is in pain.

The above results are somewhat comparable to the results found by Craig, Hyde, and Patrick (1991) who also found few differences between masked and baseline segments. The exception was: 1) AU 7 (lid tightening) which was found to be marginally more frequent during the masked segment as compared to the baseline segment; and 2) AU 45 (blinking) which was found to be significantly less frequent during the masked segment compared to the baseline segment. With regard to differences between masked and genuine segments, outer brow raise (AU 2), cheek raise (AU 6), parted lips (AU 25), closed eyes (AU 43) and blinking (AU 45) were found to be less frequent during the masked pain segment as compared to the genuine pain segment. Similar to the present study they found no differences between the genuine and masked pain segments with respect to several important pain AUs, namely brow lowering (AU 4), lid tightening (AU 7), levator contraction (AUs 9 and 10), jaw dropping or mouth stretch (AUs 26 and 27). Together the results suggest that, while subjects instructed to mask expressions of pain in both studies decreased their facial activity to baseline levels for the most part, many facial actions continued to occur at levels which were comparable to those expected when subjects were genuinely expressing pain.

With regard to the exaggerated expressions of pain the comparison that was of primary interest was that between genuine and exaggerated pain segments. This comparison showed that several AUs which were associated with pain in the present study, namely brow lowering (AU 4), and orbit tightening (AUs 6 and 7), were more frequent during the exaggerated pain segment than during the genuine pain segment. In addition, two AUs which were not associated with pain in the present study, but have been associated with pain in previous studies (e.g., lip stretch (AU 20) and eyes closed (AU 43) were also more frequent. With regard to AU intensity several pain associated AUs (brow lowering (AU 4), orbit tightening (AU 6 and 7), and levator contraction (AUs 9 and 10)) increased in intensity, while several other non-pain related AUs (i.e., inner and outer brow raise (AUs 1 and 2), lip stretch (AU 20) and eye closing (AU 43) also increased in intensity as well. These results suggest that when subjects were exaggerating their pain they were able to keep much of the same facial expression that would be expected when subjects were genuinely expressing pain. In addition, however, they added considerably to the expression

It is difficult to compare the above results to those found by Craig, Hyde and Patrick (1991) since the instructions in their study were significantly different from the instructions given to the subjects in the present study. That is, in the present study subjects were asked to exaggerate their expressions of pain in response to a painful movement, whereas in the study carried out by Craig, Hyde and Patrick (1991) subjects were asked to fake an expression of pain in response to a non-painful movement. Our choice to have subjects exaggerate rather than fake was made because we felt that incongruent pain was likely to be more related to exaggerated expressions of pain, rather than faked expressions of pain. Nevertheless, some comparison can be made between the exaggerated expressions of pain in the present study, and the faked expressions of pain in the study by Craig and colleagues (1991). Craig and colleagues, for instance, also found that brow lowering (Au 4) and cheek raising (AU 6) increased during the faked as compared to the genuine pain segment. In addition, however, they also found that pulling at the corner of the lips (AU 12) increased and blinking (AU 45) decreased. The similarities in results may suggest that there is a relationship between exaggerated and faked expressions of pain.

<u>Relations Among Genuine Facial Actions of Pain</u>. From the above comparison it was clear that there were a number of AUs which were related to pain, but it was not clear how the AUs related to each other. It was decided, therefore, to carry out a

principal components analysis of the AUs to determine how they interrelated empirically. When this was done it was found that the AUs were all highly correlated, and loaded on one single pain factor which accounted for approximately 44 percent of the variance in facial activity in the genuine pain segment. The large amount of variance which was left unexplained suggests that there is wide variation in the individual expression of pain. Despite this, it appears that brow lowering (AU 4), orbit tightening (AUs 6 and 7), levator contraction (AUs 9 and 10), and mouth opening (AUs 25, 26 and 27) carry the bulk of the information about pain. These results compare to those reported by Prkachin (1992) who studied facial actions which were consistently related to four experimental modalities of pain (e.g., cold pressor, ischemia, electric shock, and mechanical pressure). He found brow lowering (AU 4), orbit tightening (AUs 6 and 7), levator contraction (AUs 9 and 10) and eyes closing (AU 43) to carry the bulk of the pain information. The only differences between the two studies rests with the importance of mouth opening in the present study, and the importance of eye closing in Prkachin's study. These could be a result of differences in the intensity and nature of pain experienced between the two studies.

It has been proposed, for instance, that more facial actions occur as pain becomes more severe and enduring (Prkachin & Mercer, 1989). At low levels of pain, facial actions that are consistently related to pain (e.g., brow lowering, and orbit tightening) are expected to be observed. At moderate levels of pain, middle facial actions (e.g., levator contraction) are expected to occur in addition to those already identified. Finally, with the most intense levels of pain, lower facial actions (e.g., mouth opening, horizontal stretch mouth) are expected to come into play.

If we interpret the results of the present study, and the results of Prkachin's study in line with this conceptualization, it is likely that the pain experienced in response to the leg movements was of a more intense nature than the pain experienced in response to the experimental pain in Prkachin's study. That is, in the present study mouth opening was found to be importantly related to pain, whereas in the study conducted by Prkachin it was not. Despite differences in results, what is important to emphasize about these results is that in both studies the experience of pain was found to be consistently related to a number of facial actions which suggests that the presence of genuine pain in patients should be easy to identify.

<u>Predictors of Verbal and Nonverbal Measures of Pain</u>

Since the verbal and nonverbal measures of pain were generally of limited use in discriminating among groups it was of interest to examine which of all of the variables measured in the study could be used to predict the verbal and nonverbal measures of pain. The variables in the study were divided into six distinct groups (see Results). Variables from each group were used to predict pain intensity, pain unpleasantness, and genuine painful facial activity, and then those variables which were significant within their groups were entered together into a final stepwise regression analysis.

Predictors of Movement Intensity. With regard to pain intensity, several variables (e.g., the pain drawing, the nonorganic signs assessment, first language spoken, socioeconomic status, regular use of opiate analgesics, tendency to catastrophize, and to use behavioural coping strategies, unpleasantness of the movement, intensity of pain experienced on a daily basis, and the genuine painful facial activity score) were found to predict the intensity of the pain when they were entered into a regression analysis that only included other similar variables as predictors. When all of these significant predictors were entered together into a regression analysis, however, variables which appeared to be importantly related to intensity of pain were found to share variance with more important variables, and thus failed to make a unique contribution. The results of this analysis suggested that the verbal report measures of pain were all highly related since the most important variables in predicting pain intensity were found to be other verbal report measures of pain (e.g., movement unpleasantness, and daily pain intensity).

The results also suggested that the use of behavioural strategies to cope with pain. The unique contribution of the behavioural strategies to the prediction of pain intensity was at first somewhat surprising since one current and apparently effective approach to treating pain is to encourage normal activity as much as possible irrespective of pain (Philips &

Grant, 1991 c). These results at first would seem to suggest that such an approach is not effective in reducing pain intensity since patients who cope with their pain more actively (e.g., going to movies, shopping, doing projects, household chores) also reported more intense pain. However, the approach that is described above also typically involves graded exposure such that patients begin their return to activity at low levels and build up. Although it is difficult to determine, it may have been that the patients in this sample did not grade their exposure, but rather immediately returned to normal activity. In general, the results suggest the relation between activity (e.g., normal versus graded exposure) and pain intensity needs to be further explored.

Predictors of Pain Unpleasantness. With respect to the unpleasantness of pain, several variables (e.g., the nonorganic signs assessment, the pain drawing, compensation status, the use of anti-inflammatories on a regular basis, degree of worry, the intensity of the movement, and the facial activity found during the genuine pain segment) were found to predict the rating when they were entered into the regression analyses with other similar predictor variables. When they were all entered together, however, the most important variable in predicting the unpleasantness of the pain was the reported intensity of the pain. Together, the above results suggest that our hypotheses that cognitive and affective features of pain would mediate the verbal report of pain were not supported.

Predictors of Genuine Painful Facial Activity. Several variables (e.g., the pain drawing, the subject's marital status, the reported intensity of the movement, and the overall facial activity of subjects during the exaggerated segment and the baseline segment) were found to predict painful facial activity when entered into a regression analysis that included variables only from that group. When these significant predictors were entered together, however, the degree to which subjects expressed pain in the genuine pain segment was largely a function of how much they were willing to exaggerate their pain, and how much facial activity they showed during a baseline segment. In addition, the genuine facial expression of pain was also related to how unpleasant subjects found the painful leg movement. These results suggest first, that there is a small, but nevertheless positive correlation between the nonverbal and verbal expressions of pain. Second, they suggest that the degree to which subjects express pain is largely a function of how expressive they are in the first place (baseline facial activity) or how willing they are to actively exaggerate pain. The implication is that if one wishes to get an accurate assessment of the patient's nonverbal expression of pain, one must take into account how expressive that person is to begin with.

Summary and Directions for Future Research

The purpose of the present study was to examine how the psychological reactions to pain of acute LBP patients would compare to the psychological reactions to pain of chronic LBP patients who displayed signs and symptoms which were congruent or incongruent with underlying anatomy and physiology. It was also of interest to examine whether verbal and nonverbal measures of pain could be used to discriminate among pain groups.

In the literature describing acute and chronic pain conditions it is often assumed that as pain persists the psychological distress of the patient will increase (Sternbach, 1985). This led us to hypothesize that acute pain patients would obtain lower scores on cognitive and affective measures of pain than chronic pain patients. Research also suggests, however, that there is wide variability in the psychological reactions of chronic pain patients, with some chronic pain patients (e.g., chronic congruent patients) coping better with their pain than others (e.g., chronic incongruent patients). This led us to further hypothesize that the differences between acute pain patients and chronic congruent pain patients on the cognitive and affective variables would be much smaller than the differences between acute and chronic incongruent pain patients. We further hypothesized that cognitive and affective variables would mediate the verbal report of pain and the nonverbal expression of pain, such that acute pain patients and chronic congruent pain patients, who were predicted to have lower scores on the negative cognitive and affective measures, would also be less verbally and nonverbally expressive of their pain than chronic incongruent pain patients.

Contrary to our hypotheses quite a different pattern of results emerged. To begin we found that acute and chronic incongruent pain patients responded more emotionally to their pain, were more likely to use passive coping strategies, and more frequently reported dysfunctional, catastrophizing cognitions than chronic congruent pain patients. In addition to having a similar negative psychological reaction to pain, acute and chronic incongruent patients reported their pain to be similar in its unpleasantness, although only the chronic incongruent patients differed significantly from the chronic congruent patients. Acute and chronic incongruent patients were also more likely to be from a lower socioeconomic status, on compensation, using opiate analgesics on a regular basis and reporting greater disability as a result of the pain than chronic congruent patients. Groups were also found to differ with respect to physical impairment with chronic incongruent patients scoring highest on the measure followed by chronic congruent and acute pain patients. All differences were significant.

In carrying out several discriminant function analyses it was found that acute pain patients could be maximally separated from the two chronic pain groups on the physical impairment measure. This analysis was largely biased, however, since the measure of physical impairment was biased toward acute pain patients obtaining lower scores on the measure than chronic pain patients. A further discriminant function analysis suggested that the chronic incongruent patients could be discriminated from chronic congruent patients in terms of their increased likelihood of negatively interpreting their pain, being on compensation, and using pain killers on a regular basis.

The pattern of results that were found in the present study are subject to two alternative interpretations. One interpretation of the results is that whether patients display incongruent signs and symptoms is largely a function of how much stress patients are under, how uncertain they are about their pain condition, and how difficult it is for them to cope with their pain. This interpretation further suggests that in the acute pain stage all patients will have a negative psychological reaction to pain, and those who are having the most difficulties coping with their pain will show incongruent signs and symptoms. Further as pain persists some patients will adapt, while others may persist in their acute pain reaction. Those patients who adapt are likely to be under less stress (e.g., from a higher socioeconomic status and not on compensation), and as a result will show a lessened psychological reaction, fewer attempts to cope passively with the pain, and as a result few incongruent symptoms and signs. Patients who do not adapt, on the other hand, will persist in the acute pain reaction (e.g., negative psychological reaction, and passive attempts to cope), and incongruent symptoms will become more frequent as the patient's become excessively focused on their pain and attempt to gain the attention of their health care providers in order that their pain condition be taken seriously. The continual use of passive coping strategies (e.g., inactivity) may in turn result in increased physical impairment in those who do not adapt as compared to those who do. This model predicts that inocngurent signs will covary with stress, and that patients who show incongruent signs and symptoms at one stage need not show incongruent signs and symptoms at another.

An alternative interpretation of the results is that patients are predisposed through learning, environmental, and or biological factors to display pain that is either incongruent or congruent. Incongruent pain is used loosely here to refer to patients who are predisposed to have a negative psychological reaction, cope passively, focus excessively on their somatic symptoms, and display and report signs and symptoms that are incongruent with underlying anatomy and physiology. Congruent pain on the other hand involves a lesser psychological reaction to the pain, fewer attempts to cope passively, less somatic focusing, and few or no incongruent signs and symptoms of pain. One factor which may be related to the predisposition of patients to have incongruent pain may be coming from a lower socioeconomic strata. This overall interpretation of pain suggests that the congruent and incongruent pain patterns will be present in the acute pain stage, and will remain relatively stable if pain persists into the chronic pain stage. It may also suggest that more patients with incongruent pain will develop acute LBP to begin with, and be more likely to have their pain persist into the chronic pain stage.

Future research is needed to address whether patients are predisposed (perhaps because of biological differences or because of differences in learning histories) to display incongruent pain or if incongruent symptoms occur as a result of stress. Future research should also examine whether different types of treatment would be more effective with congruent as compared to incongruent patients.

In general, the results showing that acute pain patients do indeed have a strong psychological reaction to pain have important implications for the treatment of acute pain patients in general. That is, if future research continues to find that ineffective coping strategies, emotional reactions to pain, and dysfunctional cognitions are characteristic of the acute pain patient (whether they are showing signs of incongruent pain or not) psychological interventions at early stages will most certainly be implicated, and in need of evaluation.

One of the most surprising conclusions from the study was the fact that no differences in nonverbal expressions of pain among groups of chronic congruent and incongruent patients were found. While this may indeed be the case, the lack of findings may in part be an artifact of the design. That is, different results may have been found if subjects were not aware that they were being observed, and if subjects had not been asked to mask and exaggerate their pain. This procedure may have resulted in the amplification or attenuation of the genuine pain expressions that would not normally have resulted if patients had not been asked to follow these instructions. Future research which either only asks patients to genuinely express their pain, or uses a between groups design to study masked, exaggerated and genuine expressions of pain would better be able to test hypotheses concerning facial expressions of pain.

While no group or sex differences were found with respect to expressions of pain, differences in facial activity did emerge as a result of the instructional sets. The facial actions which were associated with pain in the present study were highly inter-related, and were consistent with facial expressions which were found to be associated with pain in past research. The facial actions associated with pain included: brow lowering, orbit tightening, levator contraction, and mouth opening. When subjects were asked to mask their facial expressions of pain they were successful in the sense that they reduced their facial actions to a level expected only to be found during baseline. They were unsuccessful in the sense that their facial activity during the masked pain segment, although reduced, still did not differ significantly from the genuine pain segment. The exception to this was the degree of mouth opening which was found to be significantly less during both baseline, and masked pain segments compared to the genuine pain segment. It is interesting to note that mouth opening is expected to occur with only the most intense levels of pain (Prkachin & Mercer, 1989), and that subjects in effect unknowingly reduced this action when masking pain.

With regard to exaggerated expressions of pain, once again subjects were remarkably successful in following the instructions. That is, they tended to increase the frequency and intensity of all facial actions that were associated with pain. In addition, however, subjects also added and increased the intensity of several non-pain related actions. Using these non-pain related actions as cues it may be possible to detect patients who are indeed exaggerating pain.

The final point that needs to be made, is that in the present study assumed differences between acute and chronic LBP patients, led us to make certain hypotheses about how these patient groups would cope with and express their pain. The question that this raises is whether health care professionals also make these assumptions in their assessment of pain. Future research needs to be directed toward understanding the assumptions that health care professionals make, how these assumptions in turn effect diagnosis and treatment of patients, and how in general health care professionals use the vast array of data (e.g., physiological, psychological, verbal and nonverbal expressions) that is available to them when they are making judgements about another's pain.

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APPENDIX A

Nonorganic Physical Signs
(Waddell et al., 1980)

A) Overreaction to examination

Facial expression	________
Muscle tension	________
Collapsing	________
Sweating	________

B) Tenderness

Superficial	________
Nonanatomic	________

C) Simulation

Axial loading	________
Simulated rotation	________

D) Distraction

Straight leg raising	________

E) Regional Disturbances

Weakness	________
Sensory	________

Total Score	________

Scoring

Any individual sign counts as a positive sign for that type; a finding of two or more of the five types is clinically significant. Isolated positive signs are ignored.

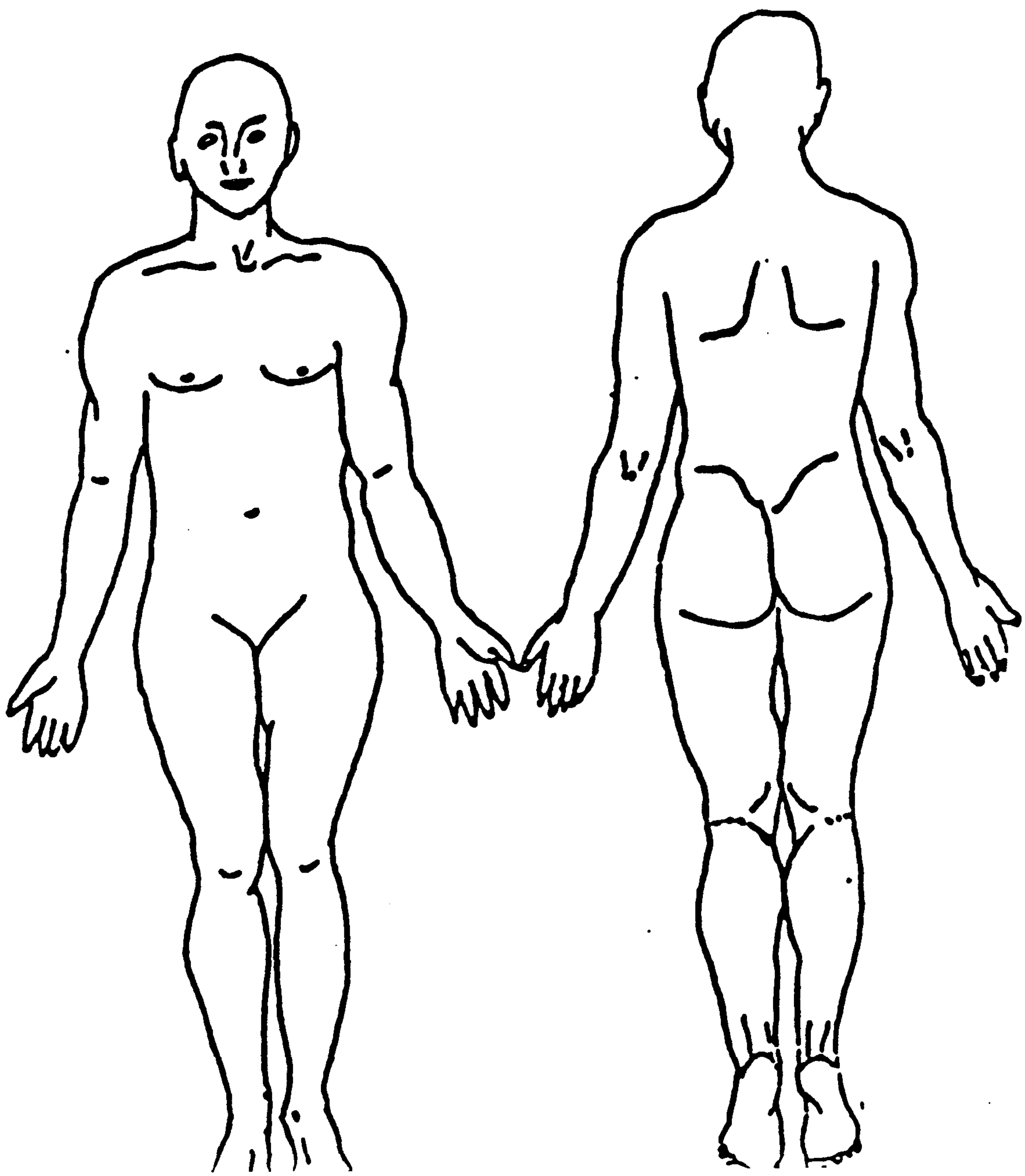
APPENDIX B

Pain Drawing
(Ransford et al., 1976)

On the human form below, mark where your numbness or pain is, using the kind of marks that correspond to what you feel in each area.

Numbness ---- Pins & Needles oooo Aching ^^^^

Burning xxxx Stabbing ////



Scoring: Pain Drawing

(From Ransford et al., 1976)

Points are assigned on the following basis:

1. Unreal drawings:

Poor anatomical localization, scores 2 unless indicated; bilateral pain not weighted unless indicated.

a) total leg pain
b) lateral whole leg pain (trochanter area and lateral thigh allowed)
c) circumferential thigh pain
d) bilateral anterior tibial area pain (unilateral allowed)
e) circumferential foot pain (scores 1)
f) bilateral foot pain (scores 1)
g) use of four or five modalities suggested in instruction (patient is unlikely to have burning areas, stabbing areas, pins and needles, numbness and aching all together; scores 1)

2. Drawings showing "expansion" or magnification" of pain:

This may also represent unrelated symptomatology; bilateral pain not weighted.

a) back pain radiating to illiac crest, groin, or anterior perineum (each scores 1; coccygeal pain allowed)
b) anterior knee pain (scores 1)
c) anterior ankle pain (scores 1)
d) pain drawing outside the outline; this is a particularly good indication of magnification (scores 1 or 2 depending on extent)

3. "Particularly Hurt Here" indicators:

Each category scores 1; multiple use of a category is not weighted.

a) add explanatory notes
b) circle painful areas
c) draw lines to demarcate painful areas
d) use arrows
e) go to excessive trouble and detail in demonstrating the pain areas using the symbols suggested

4. "Look How Bad I Am" indicators:

Additional painful areas in the trunk, head, neck or upper extremities drawn in. Tendency toward total body pain (scores 1 if limited to small areas, otherwise 2).

APPENDIX C

Inappropriate Symptom Inventory
(Waddell et al., 1984)

Note: Must rule out spinal pathology (e.g., tumor or infections in spinal column) before the symptoms listed below are considered to be inappropriate.

Unless otherwise indicated score 1 if the patient responds yes to the questions.

Interview Questions:

1). Do you get pain at the tip of your tailbone ? ______

2). Does your whole leg ever become painful ? ______

3). Does your whole leg ever go numb ? ______

4). Does your whole leg ever give way ? ______

5). In the past year have you had any spells with very little pain ? (no is scored as 1) ______

6). Do you think that the treatments you have had so far for your pain problem have helped you ? (no is scored as 1) ______

7). Have you ever had to go to the emergency department in a hospital for your back pain ? ______

Total ______

APPENDIX D

Consent Form: Nonverbal Expression Study

We are interested in studying how patients respond to the various assessment procedures that are carried out by physiotherapists. For our study we are requesting your permission to videotape a short segment of the physiotherapy session you are about to undergo. During this segment of the physiotherapy session we will be asking you to carry out certain movements under different instructions. In order to assess your reactions to the procedures, the videotapes will be coded and viewed by independent observers. You will also be requested to fill out several brief questionnaires related to the discomfort you may experience during those movements and more generally on a day-to-day basis.

We are also interested in understanding how back pain affects your life, and how you have come to cope with the discomfort you may be feeling. Therefore, we will also be asking you to fill out a number of questionnaires concerning your pain experience and your coping strategies.

The short segment of the physiotherapy session that I am interested will take about five minutes. The questionnaires can be completed during your treatment session, and will take about 15 minutes. All of the 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 treatment at the Lansdowne Physiotherapy Clinic. Thank you.

Heather Hadjistavropoulos, M.A. Student
Department of Psychology
UBC Ph. 822-5280

Kenneth D. Craig, Ph.D
Department of Psychology
UBC Ph. 822-3948

I agree to participate in this study and give permission to the Lansdowne Physiotherapy Clinic to release medical information solely for the purposes of this investigation, and subject to the condition that this information is kept in strict confidence. I am aware that I can stop participation at any time without penalty.

Signature ______________________________

Date ______________________________

APPENDIX E

Physiotherapy Protocol

NEUTRAL: I would like you to keep a neutral expression on your face for about 10 seconds.

SAY OKAY AFTER 10 SECONDS

BASELINE: I would like you to wiggle your toes for about 10 seconds.

SAY OKAY AFTER 10 SECONDS

THE NEXT THREE SETS OF INSTRUCTIONS ARE TO BE PRESENTED IN RANDOM ORDER

GENUINE: I would like you to lift both of your legs up to about here (10-12 inches off of the examination table), and hold it for about 10 seconds. When you are doing this please genuinely express the pain or discomfort you are feeling.

SAY OKAY AFTER 10 SECONDS

MASKED: I would like you to lift both of your legs to about here (10-12 inches off of the examination table), and hold it for about 10 seconds. When you are doing this try and mask or cover up any pain you may be feeling.

SAY OKAY AFTER 10 SECONDS

EXAGGERATED: I would like you to lift both of your legs to about here (10-12 inches off of the examination table), and hold it for about 10 seconds. When you are doing this exaggerate the discomfort or pain you are feeling.

SAY OKAY AFTER 10 SECONDS

APPENDIX F

Debriefing Script

Thank you for your participation in this study. The purpose of this study is twofold. First, we are interested in examining nonverbal expressions of pain in response to the procedures carried out by physiotherapists. As you may well know, when assessing pain in others, health care professionals often must rely heavily on nonverbal information. By nonverbal information we mean expressions on your face. It is important that we study nonverbal expressions in order to ensure that an accurate assessment of the discomfort and pain one feels will be made.

Also of interest in this study is how ongoing pain influences how you feel and how you learn to cope with the pain. Since in many instances it is difficult to treat back pain, learning to cope with pain appears to be one of the best possible solutions for dealing with pain. We are hoping that the information that we obtained from you will help us learn more about the various ways of dealing with acute and chronic pain, and will also help us determine if there is a relationship between the way one copes with pain and the way one expresses pain nonverbally.

If you are interested in further information we would be happy to answer your questions. Once again thank you for your cooperation.

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UBC Ph. 822-5280

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APPENDIX G

Clinical Chart for Routine Calculation of Impairment
(Waddell, G., & Main, C. J., 1984)

Mathematical Constant			28
Pain Problem	Back pain	0	
	Back and referred pain	8	____
	Root pain	-2	
	Neurogenic claudication	8	
Time pattern	Recurring	4	____
	Chronic	8	
Previous fracture	Transverse process	1	
	Compression	2	____
	Fracture/dislocation	6	
Previous back surgery	None	0	
	One	3	____
	More than one	6	
Root Compression	None	0	
	Doubtful	1	____
	Definite	2	
Subtotal A			+____

Lumbar flexion	______cm x 2	-____
Straight leg raising (left)	______/10	-____
Straight leg raising (right)	______/10	-____
Subtotal B		-____

Subtotal A	+____
Subtotal B	-____
Impairment	____

APPENDIX H

The Oswestry Low Back Pain Disability Questionnaire (OLDQ)
(Fairbank, Couper, Davies, & O'Brien, 1980)

Please read:

This questionnaire has been designed to provide information as to how your back pain has affected your ability to manage in everyday life. Please answer every section, and mark in each section only the one statement which applies to you. We realize you may consider that two statements in any one section relate to you, but please just mark the statement which most clearly describes your problem.

<u>Pain Intensity</u>
I can tolerate the pain I have without using pain killers.
The pain is bad but I manage without taking pain killers.
Pain killers give complete relief from pain.
Pain killers give moderate relief from pain.
Pain killers give very little relief from pain.
Pain killers have no effect on the pain; I do not use them.

<u>Personal Care (Washing, Dressing, etc.)</u>
I can look after myself normally without causing extra pain.
I can look after myself but it causes extra pain.
It is painful to look after myself; I am slow and careful.
I need some help but manage most of my personal care.
I need help every day in most aspects of self care.
I do not get dressed, wash with difficulty and stay in bed.

<u>Lifting</u>
I can lift heavy weights without causing extra pain.
I can lift heavy weights but it gives extra pain.
Pain prevents me from lifting heavy weights off the floor, but I can manage if they are conveniently positioned.
Pain prevents me from lifting heavy weights but I can manage light to medium weights if they are conveniently positioned.
I can lift only very light weights.
I cannot lift or carry anything at all.

<u>Walking</u>
Pain does not prevent me from walking any distance.
Pain prevents me from walking more than 1 mile.
Pain prevents me from walking more than 1/2 mile.
Pain prevents me from walking more than 1/4 mile.
I can only walk using a stick or crutches.
I am in bed most of the time, and have to crawl to the toilet.

Sitting
I can sit in any chair as long as I like.
I can only sit in my favorite chair as long as I like.
Pain prevents me from sitting more than 1 hour.
Pain prevents me from sitting more than 1/2 hour.
Pain prevents me from sitting more than 10 minutes.
Pain prevents me from sitting at all.

Standing
I can stand as long as I want without extra pain.
I can stand as long as I want but it gives extra pain.
Pain prevents me from standing for more than 1 hour.
Pain prevents me from standing for more than 30 minutes.
Pain prevents me from standing for more than 10 minutes.
Pain prevents me from standing at all.

Sleeping
Pain does not prevent me from sleeping well.
I can sleep well only by using tablets.
Even when I take tablets I have less than six hours sleep.
Even when I take tablets I have less than four hours sleep.
Even when I take tablets I have less than two hours sleep.
Pain prevents me from sleeping at all.

Sex Life
My sex life is normal and causes no extra pain.
My sex life is normal but increases the degree of pain.
My sex life is nearly normal but is very painful.
My sex life is severely restricted by pain.
My sex life is nearly absent because of pain.
Pain prevents any sex life at all.

Social Life
My social life is normal and gives me no extra pain.
My social life is normal but increases the degree of pain.
Pain has no significant effect on my social life apart from limiting more energetic interests (e.g., dancing, etc).
Pain has restricted my social life and I do not go out as often.
Pain has restricted my social life to my home.
I have no social life because of pain.

Travelling
I can travel anywhere without extra pain.
I can travel anywhere but it gives me extra pain.
Pain is bad but I manage journeys over two hours.
Pain restricts me to journeys of less than one hour.
Pain restricts me to short necessary journeys under 30 minutes.
Pain prevents me from travelling except to the doctor or hospital.

Scoring of the OLDQ

(Fairbank, Couper, Davies & O'Brien, 1980)

Each section is scored on a 0-5 scale, 5 representing the greatest disability. The scores for all sections are added together, giving a possible score of 50. The total is doubled and expressed as a percentage. If a patient marks two statements, the highest scoring statement is recorded as a true indication of his disability. If a section is not complete because it is inapplicable (e.g., sex life), the final score is adjusted to obtain a percentage.

APPENDIX I

Descriptor Differential Scales (Gracely, 1980)

Please circle one word or word-pair on each of the scales below to describe:

1) the pain you experience on an average day.

2) the most severe pain you experienced in response to the movements.

Sensory	Unpleasantness
A. Extremely Intense	A. Very Intolerable
B. Very Intense	B. Intolerable
C. Intense	C. Very Distressing
D. Strong	D. Slightly Intolerable
E. Slightly Intense	E. Very Annoying
F. Barely Strong	F. Distressing
G. Moderate	G. Very Unpleasant
H. Mild	H. Slightly Distressing
I. Very Mild	I. Annoying
J. Weak	J. Unpleasant
K. Very Weak	K. Slightly Annoying
L. Faint	L. Slightly Unpleasant
M. No Sensation of Pain	M. No Discomfort

Scoring of the Descriptor Differential Scales
(Gracely, Dubner & McGrath, 1979)

Sensory		Unpleasantness	
A. Extremely Intense	59.5	A. Very Intolerable	44.8
B. Very Intense	43.5	B. Intolerable	32.8
C. Intense	34.6	C. Very Distressing	18.3
D. Strong	22.9	D. Slightly Intolerable	13.6
E. Slightly Intense	21.3	E. Very Annoying	12.1
F. Barely Strong	12.6	F. Distressing	11.4
G. Moderate	12.4	G. Very Unpleasant	10.7
H. Mild	05.5	H. Slightly Distressing	06.2
I. Very Mild	03.9	I. Annoying	05.7
J. Weak	02.8	J. Unpleasant	05.6
K. Very Weak	02.3	K. Slightly Annoying	03.5
L. Faint	01.1	L. Slightly Unpleasant	02.8
M. No Sensation	00.0	M. No Discomfort	00.0

APPENDIX J

Coping Strategy Questionnaire

Individuals who experience pain have developed a number of ways to cope, or deal with, their pain. These include saying things to themselves when they experience pain, or engaging in different activities. Below are a list of things that patients have reported doing when they feel pain. For each activity, please indicate, using the scale below, how much you engage in that activity when you feel pain, where a 0 indicates you never do that when you experience pain, a 3 indicates that you sometimes do that when you experience pain, and a 6 indicates that you always do that when you experience pain. Remember you can use any point along the scale.

0	1	2	3	4	5	6
Never do that			Sometimes do that			Always do that

WHEN I FEEL PAIN ....

1. I try to feel distant from the pain, almost as if the pain was in somebody else's body.
2. I leave the house and do something, such as going to the movies or shopping.
3. I try to think of something pleasant.
4. I don't think of it as pain but rather as a dull or warm feeling.
5. It is terrible and I feel it is never going to get any better.
6. I tell myself to be brave and carry on despite the pain.
7. I read.
8. I tell myself that I can overcome the pain.
9. I count numbers in my head or run a song through my mind.
10. I just think of it as some other sensation such as numbness.
11. It is awful and I feel it overwhelms me.
12. I play mental games with myself to keep my mind off the pain.
13. I feel my life isn't worth living.
14. I know someday someone will be here to help me and it will go away.
15. I pray to God it won't last long.
16. I try not to think of it as my body, but rather as something separate from me.
17. I don't think about the pain.
18. I try to think years ahead, what everything will be like after I've gotten rid of the pain.
19. I tell myself it doesn't hurt.
20. I tell myself I can't let the pain stand in the way of what I have to do.
21. I don't pay any attention to it.
22. I have faith in doctors that someday there will be a cure for my pain.

23. No matter how bad it gets I know I can handle it.
24. I pretend it is not there.
25. I worry all the time about whether it will end.
26. I replay in my mind pleasant experiences in the past.
27. I think of the people I enjoy doing things with.
28. I pray for the pain to stop.
29. I imagine that the pain is outside of my body.
30. I just go on as if nothing has happened.
31. I see it as a challenge and don't let it bother me.
32. Although it hurts I just keep going.
33. I feel I can't stand it any more.
34. I try to be around other people
35. I ignore it.
36. I rely on my faith in God.
37. I feel like I can't go on.
38. I think of things I enjoy doing.
39. I do anything to get my mind off the pain.
40. I do something I enjoy, such as watching TV or listening to music.
41. I pretend it is not a part of me.
42. I do something active, like household chores or projects.

Based on all of the things you do to cope, or deal with, your pain, on an average day, how much control do you feel you have over it? Please circle the appropriate number. Remember, you can circle any number along the scale.

0	1	2	3	4	5	6
No Control			Some Control			Complete Control

Based on all of the things you do to cope, or deal with your pain, on an average day, how much are you able to decrease it? Please circle the appropriate number. Remember, you can circle any number along this scale.

0	1	2	3	4	5	6
Can't decrease it at all			Can decrease it somewhat			Can decrease it completely

Key to Coping Strategy Questionnaire

<u>Cognitive Coping Strategies:</u>

1. Diverting Attention: 3, 9, 12, 26, 27, 38
2. Reinterpretation: 1, 4, 10, 16, 29, 41
3. Catastrophizing: 5, 11, 13, 25, 33, 37
4. Ignoring Sensations: 17, 19, 21, 24, 30, 35
5. Praying or Hoping: 14, 15, 18, 22, 28, 36
6. Coping Self-Statements: 6, 8, 20, 23, 31, 32

<u>Behavioural Coping Strategies</u>:

1. Increased Behavioural Activities: 2, 7, 34, 39, 40, 42

<u>Effectiveness Ratings</u>:

1. Control Over Pain
2. Ability to Decrease Pain

APPENDIX K

Pain Eexperience Scale

Many people report having the following kinds of thoughts and feelings when their pain is very severe. We would like to know how frequently you experience each of the thoughts and feelings listed below when your pain is very severe. Read each item and then circle a number on the scale under the statement to indicate how often you have that thought or feeling.

1. I feel frustrated.

    0 1 2 3 4 5 6
    Never Very Often

2. I think about my pain getting worse.

    0 1 2 3 4 5 6
    Never Very Often

3. I feel irritable.

    0 1 2 3 4 5 6
    Never Very Often

4. I am depressed because of my pain.

    0 1 2 3 4 5 6
    Never Very Often

5. I wonder what it would be like to never have any pain.

    0 1 2 3 4 5 6
    Never Very Often

6. I feel angry.

    0 1 2 3 4 5 6
    Never Very Often

7. I feel overwhelmed.

    0 1 2 3 4 5 6
    Never Very Often

8. I feel afraid that my pain will get worse.

    0 1 2 3 4 5 6
    Never Very Often

9. I think, " This pain is driving my crazy"

0 1 2 3 4 5 6
Never Very Often

10. I feel impatient with everybody.

0 1 2 3 4 5 6
Never Very Often

11. I worry about my family.

0 1 2 3 4 5 6
Never Very Often

12. I think about whether life is worth living.

0 1 2 3 4 5 6
Never Very Often

13. I feel anxious.

0 1 2 3 4 5 6
Never Very Often

14. I feel disappointed with myself for giving into the pain.

0 1 2 3 4 5 6
Never Very Often

15. I feel everyone is getting on my nerves.

0 1 2 3 4 5 6
Never Very Often

16. I think, "It is so hard to do anything when I have pain."

0 1 2 3 4 5 6
Never Very Often

17. I wonder how long this will last.

0 1 2 3 4 5 6
Never Very Often

18. I think of nothing other than my pain.

0 1 2 3 4 5 6
Never Very Often

19. I feel sorry for myself.

0	1	2	3	4	5	6
Never						Very Often

Scoring of the Pain Experience Scale

Scale 1: **Emotionality** = (1, 3, 4, 6, 7, 9, 10, 12, 13, 15, 16, 18, 19) /13

Scale 2: Worry = (2, 5, 8, 11, 14, 17) /6

APPENDIX L

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

<u>Upper Face</u>

AU	Description
1	Inner Brow Raise
2	Outer Brow Raise
4	Brow Lower
5	Upper Lid Raise
6/7	Orbit Tightening
41	Lids Droop
42	Eye Slit
43	Eyes Closed
44	Squint
45	Blink
46	Wink

<u>Lower Face</u>

AU	Description
9/10	Levator Contraction
* 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	Lips Tight
24	Lip Press
25/26/27	Mouth Opening
28	Lip Suck

<u>Miscellaneous Actions</u>

AU	Description	AU	Description
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 Side	37	Lip Wipe
31	Jaw Clench	* 38	Nostril Dilate
32	Bite	39	Nostril Compress

Note. Those AUs marked with an asterisk were not coded for intensity.

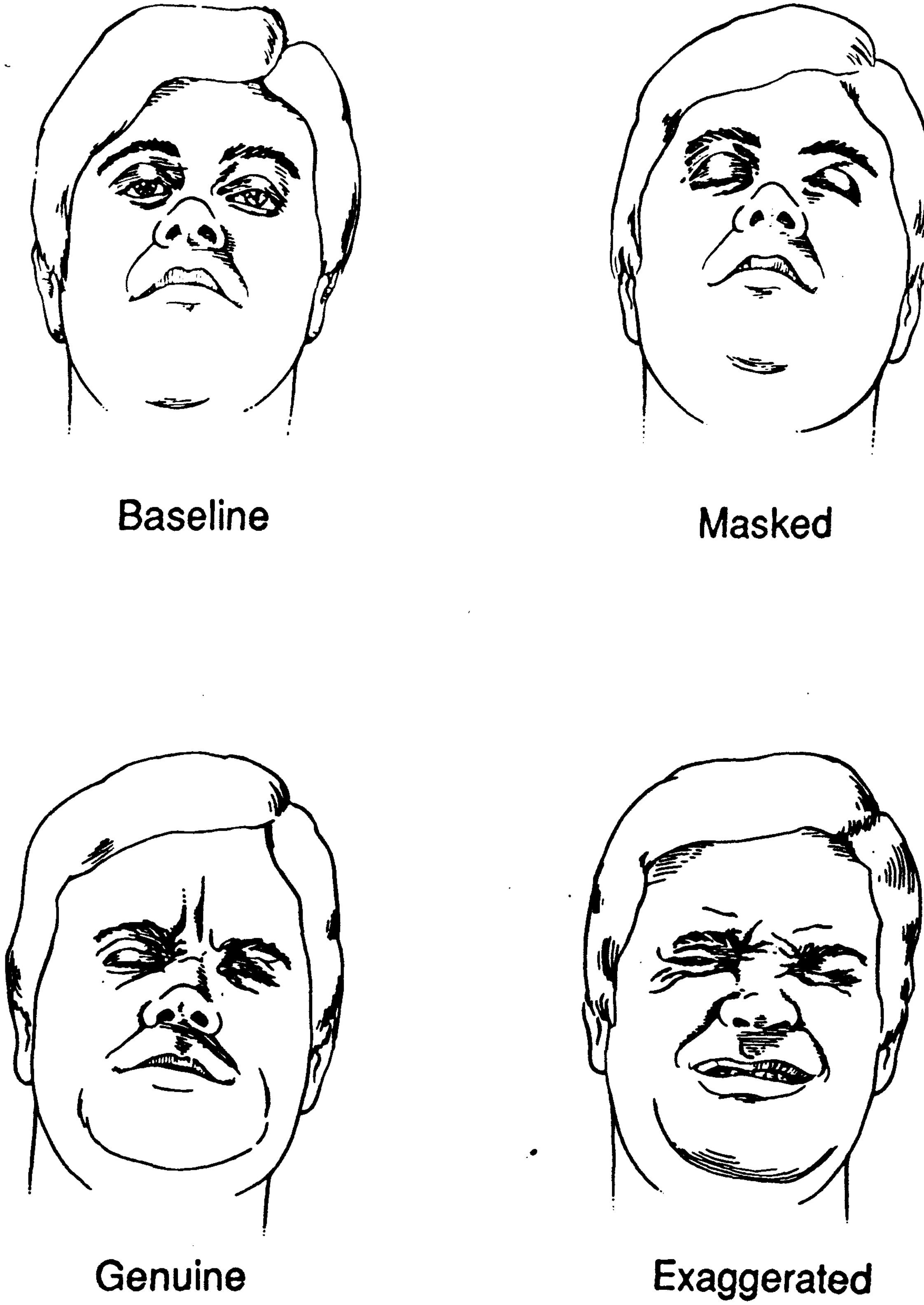

Figure 1. Artist's drawing of one patient's facial activity during baseline, masked, genuine, and exaggerated pain segments.