PAIN PERCEPTION IN CHRONIC PAIN PATIENTS: A SIGNAL DETECTION ANALYSIS

by

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ABSTRACT

The purpose of this investigation was to examine the supposition that chronic pain patients (CPPs) have altered pain perception. Two models were examined that led to opposing predictions as to how CPPs would respond to painful stimuli (i.e., the hypervigilance and adaptation-level models). Both predictions have been supported by past research but because of methodological variation and the type of pain disorder studied, it has remained unclear under what circumstances the predictions of these two models may be met.

The responses of pain patients to painful stimuli have been found to vary for patients with different clinical presentations (i.e., those with and without medically incongruent signs and symptoms). Therefore, the present investigation sought to compare the responses to radiant heat stimuli of sixty CPPs (thirty with and thirty without a medically incongruent pain presentation) to thirty age and sex matched normal control subjects (i.e., pain-free individuals). Signal detection theory methodology was used in order to separately evaluate sensory sensitivity and the response bias to report sensations as painful. In addition, cognitive and affective factors were assessed in order to identify potential psychological correlates of altered pain perception.

The results of this study indicated that the presence of a medically incongruent pain presentation distinguished patients on their subjective report of disability and to a lesser extent cognitive appraisal and affective distress

regarding their pain condition. They did not differ in their responses to painful stimuli. In a post hoc analysis where CPPs were classified into 'organic' and 'functional' diagnostic groups, significant differences in pain threshold and the response bias to report pain were found. Patients classified as 'organic' had significantly higher pain thresholds compared to normal control subjects and patients classified as 'functional'. Differences in pain threshold were primarily represented by the response bias to report sensations as painful rather than sensory sensitivity to the stimuli. The 'functional' group had a slightly lower pain threshold than the normal control group but this difference was not significant. The results are discussed in light of the two models of pain perception. The two methods used to classify pain patients are discussed according to their orthogonal characteristics on sensory, cognitive, and affective components.

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INTRODUCTION

It has been argued that the perception of pain is altered in chronic pain patients and that this is one of the major factors responsible for the development and maintenance of the chronic pain (Chapman, 1978; Sternbach, 1976). Two opposing theoretical perspectives have been proposed to characterize the nature of changes in the response of chronic pain sufferers to painful stimulation. These perspectives have been called the "hypervigilance" and the "adaptation-level" models of pain perception. The hypervigilance model has led to the prediction that chronic pain patients will be more responsive to painful stimuli because they tend to focus most or all of their attention on painful sensations (Chapman, 1978; 1986). In contrast, the adaptation-level model predicts that chronic pain patients will be less responsive to painful stimuli because, relative to the constant pain they have been experiencing, additional stimuli will be judged to be less significant (Rollman, 1979).

Despite the apparent contradiction, various research findings can be found to support both predictions, but with groups of patients suffering from different types of chronic pain conditions. Pain patients presenting with disorders in which physical pathology is unclear and which are associated with higher levels of anxiety have been found to have lower pain threshold and tolerance levels in comparison to people who do not have chronic pain. This finding has been

interpreted as evidence supporting the predictions of the hypervigilance model (Brands & Schmidt, 1987; Malow et al., 1980; Malow & Olson, 1981; Scudds et al., 1987). The opposing position has been supported with chronic pain patients who present with clear organic pathology and for whom anxiety is not a salient feature of their pain condition. These patients have been found to have higher pain threshold and tolerance levels than people without chronic pain and the finding has been interpreted as evidence supporting the adaptation-level model (Naliboff et al., 1981; Cohen et al., 1983; Yang et al., 1983; 1985; Lipman et al., 1987). The different sets of findings attract attention to the roles of pathophysiological and psychological factors as determinants of the perception of pain. In the interest of avoiding a false sense of duality in the experience of pain, it should be noted that both the dominant psychological and physiological factors depend upon biological substrates.

The presence or absence of clear organic pathology has provided the basis for classifying chronic pain patients into two categories: "organic" and "functional". Organic conditions refer to disorders primarily attributable to physical causes, and functional conditions refer to disorders thought to be primarily caused by psychological factors because of an absence of an apparent physical cause (Dorland's Medical Dictionary, 1989). This distinction has been criticized as excessively simplistic with the

acceptance of multidimensional models of pain (Bellissimo & Tunks, 1984; Turk, Meichenbaum, & Genest, 1983; Waddell et al. 1980; 1984; Waddell & Main, 1984). Pain is now considered to be a multidimensional phenomenon always involving cognitive and affective components in addition to physical factors with all components constantly interacting to produce the final pain experience (Melzack & Wall, 1982). In the past, chronic pain conditions were thought to be functional or 'psychologically based' if there were an absence of clear organic pathology. However, because it is now recognized that both physical and psychological factors are present in any chronic pain condition (whether there is physical pathology or not), attempts have been made to differentiate patients who provide positive evidence of psychological dysfunction. These patients are less likely to respond to physical treatments (i.e., surgery, medication, etc.) and may require a more detailed psychological assessment as it relates to their disorder (Ransford, Cairns, & Mooney, 1976; Reesor & Craig, 1988; Waddell et al., 1980; 1984).

Reesor & Craig (1988) differentiated patients on the basis of whether or not they exhibited symptoms that were "medically incongruent" with known underlying anatomy or physiology using established diagnostic procedures (Ransford et al., 1976; Waddell et al., 1980; 1984). They found evidence of ineffective coping strategies, catastrophic cognitions, high anxiety levels, and higher sensory

intensity ratings of a painful stimulus in patients with medically incongruent symptoms relative to patients who did not exhibit medically incongruent symptoms. This finding is suggestive of the ways in which chronic pain patients may differ in their response to pain. Coping strategies, pain related cognitions, and anxiety levels may be important factors that determine whether the predictions of the hypervigilance or the adaptation-level models are met.

Studies that have examined these two models of pain perception in the past have used Signal Detection Theory (SDT) methodology in order to separately evaluate two components of pain perception, the sensory sensitivity to pain and the response bias to report sensations as painful (Malow et al., 1980; Malow & Olson, 1981; Naliboff et al., 1981; Cohen et al., 1983; Yang et al., 1985). Because of variations in the procedures employed in these studies, however, the effect of chronic pain on pain sensitivity and response bias is still not clear. Investigations which support the prediction of the hypervigilance model and those which support the prediction of the adaptation-level model have generally used different types of pain patients, different types of pain stimuli, different formats of SDT, and wide ranges in the number of stimulus trials.

The purpose of this research was to examine responses to painful stimuli in chronic pain patients with and without medically incongruent symptoms in comparison to a matched normal control group. Signal Detection Theory was used to

separately evaluate both the sensory sensitivity and the response bias components of pain reports among these three groups. In addition, relationships between responses to painful stimuli and cognitive and affective variables were examined. It was intended that this research should help to elucidate some of the conditions under which the predictions of the hypervigilance and adaptation-level models would be satisfied.

The review of the relevant literature will begin with a description of the hypervigilance and adaptation-level models followed by a brief summary of SDT methodology. Research on pain perception in chronic pain patients will then be reviewed with SDT studies presented and critiqued separately from other investigations. Finally, the classification of pain patients with nonorganic signs will be discussed.

LITERATURE REVIEW

The Hypervigilance Model

The hypervigilance model of pain perception in chronic pain patients has developed from Chapman's (1978;1986) discussion of the influence of perceptual vigilance in the development of a chronic pain condition. Chapman proposed that some chronic pain patients develop a perceptual habit of directing most or all of their attention to their pain and signs of somatic distress. As a consequence of this hypervigilance, these patients are predicted to have lower pain threshold and tolerance levels.

Numerous explanations have been proposed to account for this attentional shift. At a basic level, Chapman (1986) reports that pain "often demonstrates a unique ability to captivate attention" (pp. 160-161). Chronic pain patients have been characterized by numerous authors as having restricted movement, decreased attention to their environment, and increased somatic preoccupation (Fordyce, 1976; Sternbach, 1976; Pilowsky, Chapman, & Bonica, 1977; and Melzack & Wall, 1982). It has also been recognized that the physical limitations often associated with painful states render it difficult (or impossible) for the individual to continue with everyday activities. In addition, family and social relationships are often strained and weakened leaving the sufferer alone to focus on his/her affliction (Fordyce, 1976; Melzack & Wall, 1982; and Sternbach, 1976). Anxiety about the significance of the

pain (i.e., whether it indicates a life or life-style threatening event) has also been suggested as attracting attention to the pain (Chapman, 1986).

Other theories regarding the internal focus of attention found in chronic pain patients include the behavioural (Fordyce, 1976) and the cognitive (Pennebaker, 1982) perspectives. Behavioural theory suggests that the internal focus of attention develops as a perceptual habit because of the reinforcement (e.g., sympathy and attention) provided by significant others when the patient reports his/her suffering. Cognitive theory purports that past experiences result in the development of cognitive schemas or sets. These schemas involve the belief that he/she has a malignant condition and lead the individual to search (or be hypervigilant) for confirming somatic cues.

The hypervigilance model has been associated with somatization disorders and hypochondriasis in recent research (Lipman et al., 1987; Scudds et al., 1987). This implies that the pain reported by these patients is highly overexaggerated and perhaps, unrealistic. Regardless of the reason for the hypervigilance, it has been found that the focussing of attention on a particular sensation results in the reported enhancement of the sensation (Schiff, 1980; Levine et al., 1982). Pain sensations are perceived as more painful when attention is directed toward them and are diminished when subjects are distracted (Leventhal et al., 1979; Miller et al., 1979; Ahles et al., 1983; McCaul &

Malott, 1984). Many of the cognitive pain reduction techniques involve some form of distraction (Turk, Meichenbaum, & Genest, 1983). It is possible, therefore, that hypervigilance enhances sensory sensitivity to pain and not just the tendency to report sensations as painful.

The Adaptation-Level Model

Adaptation-level theory was first proposed by Helson (1964) to account for the observation that perceptions of a particular stimulus vary as the context or background stimuli change. Basically, the theory contends that when an observer makes a judgement about some quality of a stimulus (e.g., size, color, loudness, etc.), he/she establishes a personal (subjective) scale upon which to base the decision. The "adaptation-level" refers to the stimulus intensity that elicits a neutral or medium response. All other stimuli are judged relative to this reference point (i.e., they are 'more' or 'less' of the quality being judged). The adaptation-level is formed by the combination of all internal and external factors that surround the observer. Helson divided these factors into three classes of stimuli: focal, background, and residual. The focal stimulus is that which is currently being evaluated. The background stimuli comprise those that provide the context for the focal stimulus within the experimental situation (e.g., range of stimulus intensities encountered). The residual stimuli include factors that are not under experimental control, for

example, past experience, biological and psychological states. Thus, perceptual judgements are proposed to be relative to some reference point (or adaptation level) which reflects the observer's personal adjustment to the gamut of factors facing him/her.

Adaptation-level theory has been extended to pain perception by Rollman (1979) who found that judgements of pain were based on comparisons with previously experienced pain levels. He proposed that chronic pain patients judge external noxious stimuli relative to a higher adaptation level than pain-free individuals because of their persistent exposure to internal discomfort. This reasoning led to the prediction that chronic pain patients would have higher pain thresholds and would be less likely to report sensations as painful than pain-free individuals. This is the opposite prediction to that proposed by the hypervigilance model.

The hypervigilance and adaptation-level models have referred to 'chronic pain patients' as a general or homogeneous group; however, there is considerable diversity among chronic pain patients as to the origin and nature of their pain problem and their psychological well-being. Both models appear to have received support in past research using Signal Detection Theory (SDT) methodology, but under different circumstances, and with different types of chronic pain populations. Before this research is reviewed, SDT will be briefly presented.

Signal Detection Theory (SDT)

Signal Detection Theory provides a method of measuring perceptual judgements that separately evaluates the influence of sensory sensitivity and the willingness to report sensory events. The theory contends that perceptual judgements are statistical decisions that depend upon both sensory and nonsensory factors. The sensory factors include the intensity of the stimulus that is being judged and the sensitivity of the observer. They are reflected by the observer's accuracy in detecting a stimulus or accurately discriminating between different stimulus intensities and are evaluated by an index of discrimination ability (d'). The nonsensory factors that influence perceptual judgements include attitude, expectancy, learning, and motivation. These affect judgements by altering the tendency for the observer to give a certain response, a tendency that is measured by an index called the response bias or criterion (beta).

Signal Detection Theory was originally derived from a general mathematical theory of statistical decisions (Swets et al., 1961). The theory provides a way of evaluating how decisions are made when people are faced with ambiguous data and was originally adapted for evaluating signal detection in radar operations in 1955 (Swets et al., 1961). It has since become a valuable tool in the psychophysical measurement of perceptual judgements because it provides a way to examine the contribution of sensory sensitivity and

decisional biases (Swets et al., 1961).

The theory is based upon the assumption that the signals to be detected are presented against a fluctuating background of sensory 'noise'. It is assumed that the distribution of the noise is a normal curve and that the addition of a signal on the noise produces a normal curve of greater, but overlapping, overall sensory activity. This is graphically presented in Figure 1.

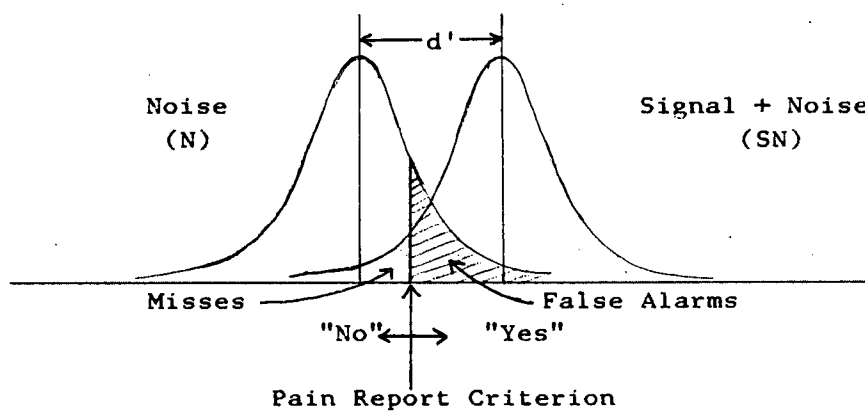

Figure 1. Theoretical distributions of an observer's responses in a signal detection task.

The observer's task is to decide whether the level of sensory activity experienced is due to the signal superimposed on a background level of sensory activity or to simply, the background noise itself. The overlap in the two distributions is an ambiguous zone which results in the observer having to adopt a decision criterion (i.e., a specified level of sensation) whereby sensory activity above and below that level is judged to indicate the presence or absence of a signal, respectively.

Because the two distributions overlap, there are four possible outcomes of the decision: a hit, miss, false alarm, or a correct rejection. These are presented in the grid below (see Table 1).

	Response: "Yes" Signal Present	Response: "No" Signal Absent
Signal + Noise	HIT	MISS
Noise Alone	FALSE ALARM	CORRECT REJECTION

Table 1. Decisional Matrix for Binary SDT Task

The proportion of hits to false alarms will depend upon the degree of overlap of the two distributions and the criterion level adopted by the observer. The degree of overlap of the two distributions will be affected by the strength of the signal and the sensitivity of the observer. When the signal strength is specified and held constant, it is possible to evaluate the observer's sensory sensitivity to detect the signal. A sensitive observer will have a larger proportion of hits to false alarms. Sensory sensitivity is graphically represented by the distance between the means of the two distributions and is quantified in the parameter, d' (Swets et al., 1961).

The criterion level adopted by the observer will also affect the proportion of hits to false alarms. If a very conservative level is employed, the observer tries to

minimize the false alarms but by doing so, will also reduce the number of hits. In contrast, a liberal criterion would be adopted to maximize the proportion of hits but, in turn, this will also increase the number of false alarms. The criterion level can change with, for example, different expectations about the likelihood of a signal being presented, the motivation of the observer in giving a certain response, and the cost of giving a false alarm versus the benefit of obtaining a hit. The criterion (or response bias) is represented quantitatively by the parameter, beta.

This theory can also be applied to the assessment of discriminability of two stimuli or signals, both presented against the normally distributed background noise ($N + S_1$, $N + S_2$). The observer's task is to indicate which signal was presented. The same principles are valid for this type of task as for the simple detection task. The sensitivity index (d'), however, is a measure of the observer's ability to discriminate between the two stimuli which will reflect his/her sensory sensitivity if the stimuli intensities are held constant. In addition, instead of a binary decision made by the subject (i.e., presence or absence of a signal; stimulus A or stimulus B), subjects can also judge the stimuli on a rating scale as to the certainty of their decision. Swets et al. (1961) pointed out that the use of rating scales can produce reliable data with fewer trials. However, McNicol (1972) cautions that the number of

categories used in the rating scale should be limited to 10 and the subject should be given considerable practice in their use prior to the experiment. This is because subjects have been found to have difficulty in using several categories simultaneously and, consequently, this method is less sensitive to changes in d' than SDT methods involving binary judgements (Clark & Dillon, 1973; McNicol, 1972).

Signal Detection Theory was first used in psychophysics to investigate exteroceptive senses, such as vision and audition (Swets et al., 1961). Clark (1974) subsequently has provided a thorough explanation of how SDT can be applied to the assessment of experimental pain. Traditional pain measures (e.g., threshold and tolerance) confound pain report with sensitivity to pain and, therefore, the ability to separately evaluate these two components was viewed as highly valuable in studying the effects of analgesics and in assessing clinical pain (Clark, 1974; Chapman, 1977; 1985).

One of the main difficulties in the application of SDT to pain research, however, has been the definition of a 'signal'. It assumes prior knowledge which allows the researcher to specify when a signal (a stimulus expected to cause pain) and a blank trial (a signal which does not cause pain) have been presented. Pain sensations are usually preceded by other sensations such as warmth, heat, or pressure which does not allow for the clear identification of a nonsignal trial (McBurney, 1976; Rollman, 1977). Pain researchers have circumvented the problem by having subjects

rate the stimulus levels on a pain rating scale (Clark, 1969; 1974). Some researchers have used a different set of stimulus levels for each subject on the basis of their individual pain thresholds, thus confounding the stimulus set with individual subjects factors (Clark, 1969; Clark & Dillon, 1973; Cohen et al., 1983; Nalibotf et al., 1981). This 'tailoring' of the stimulus set results in a 'floating' baseline, however, which eliminates the ability to examine baseline differences in sensitivity. The consequence is greater ambiguity in the interpretation of group differences in d' or changes in d' as a result of an intervention.

The interpretation of d' and beta as separate measures of physiologically based pain sensitivity and psychologically or emotionally based response bias (Clark, 1974) has been one of the major criticisms of SDT in its application to pain research (Chapman, 1985; Coppola & Gracely, 1983; Gracely, 1989; Rollman, 1977). Chapman (1978) noted that, although d' and beta are statistically independent, it is not accurate to say they are not functionally related. It has been pointed out that these measures tend to change together in pain modulation studies (i.e., as d' decreases, response criterion increases) which results in interpretive problems (Chapman, 1985; Rollman, 1977). However, Gracely (1989) has noted that although changes in these measures are difficult to interpret, situations in which they remain the same is confirmation of

similar sensory abilities.

Rollman (1976; 1977; 1979b; 1980) has expressed additional concerns with the application of SDT to pain research. Briefly, Rollman (1977) has indicated that variation in the methodologies (e.g., number of practice and experimental trials, number of different stimulus intensities judged, number of categories used for judgements, type of pain stimulus judged, etc.) employed in SDT pain research has contributed to inconsistent results across labs. Rollman (1977) further pointed out that methodological variations may affect the SDT parameters, thus limiting the external validity to the conditions present in the study. Rollman (1977) suggested that many of the methodological requirements for an ideal SDT study were not met in the pain studies he reviewed. These requirements include: a large number of stimulus trials (e.g., 250), a large number of practice trials (several hundred), particularly if several categories are used in a rating scale (e.g., 10), and a limited number of stimulus intensities to be judged (i.e., two). Rollman purports that these parameters are necessary to produce reliable, accurate data in SDT experiments.

These requirements for a SDT study are somewhat impractical for pain research, however. The time involved would result in poor subject compliance and high attrition rates, especially in studies involving chronic pain patients. Chapman (1977) asserts that Rollman is describing

determining psychophysical functions. He considers that SDT can be useful in pain research even if it is not applied in the rigorous psychophysical way that Rollman suggests because it provides some insight into the process of pain judgements. Finally, Chapman noted that although more precise data are produced if only two stimuli are judged, multiple stimuli may be used provided control groups are also tested with the same number of stimuli.

In summary, Chapman (1977) noted that "there is no more reason to assume that SDT data must precisely fit the assumptions of the earliest SDT model than there is to demand that other data exactly fit all the requirements of a t-test or any other parametric statistical test before it is used." (p. 299). Chapman (1977; 1985) and Clark (1974; 1987) maintain that SDT is currently a useful method of providing separate measures of the sensory and response bias components of pain. They do not suggest that it is the 'final solution' to pain measurement, but only that it provides useful information that will help us gain additional insight in how various factors affect the experience of pain.

Research on Pain Perception in Chronic Pain Patients

In general, there are two groups of investigations: one which reports that chronic pain patients are overresponsive to pain, and the other indicating the chronic pain patients are underresponsive to pain. Studies using SDT methodology will be reported and critiqued separately from other investigations after which an analysis of this area of research will be presented.

SDT studies on pain perception in chronic pain patients. Research on myofascial pain dysfunction (MPD) has revealed that chronic pain patients with this disorder have lower pain thresholds than normal control subjects (Malow et al., 1980). Signal detection theory investigations of MPD have shown that although this chronic pain group is less able to discriminate between different intensities of focal pressure pain (suggesting decreased sensitivity), their criterion to report sensations as painful was lower than normal control subjects (Malow et al., 1980; Malow & Olson, 1981). After successful treatment, MPD patients' pain thresholds were higher, their ability to discriminate between stimulus intensities was improved and their pain report criterion was higher. These post-treatment responses of the MPD patients were similar to the responses of the normal control group (Malow & Olson, 1981). Thus, these chronic pain patients were found to be more likely to report sensations as painful than people without chronic pain

despite apparently lowered sensitivity to the stimuli.

In contrast to the above investigations that found chronic pain patients to be more responsive to painful stimulation than pain-free individuals, there are several studies that indicate chronic pain patients are less responsive to pain. Naliboff et al., (1981) and Cohen et al., (1983) examined the responses of chronic low back pain patients, chronic respiratory patients, and nonpatient control subjects to painful thermal stimulation. They found that both the back pain and chronic respiratory patients had higher pain thresholds than the nonpatient control subjects. Signal detection theory analysis indicated that back pain patients showed poorer discriminability of painful radiant heat stimuli than the respiratory patients and nonpatient control subjects, again suggesting lowered sensitivity to pain stimuli as was found with the MPD patients. However, they did not find any reliable group differences for beta (i.e., pain report criterion).

Other SDT investigations have also revealed that chronic back pain patients have higher pain thresholds. They also reported decreased discriminability for radiant heat; however, they found that chronic pain patients had a higher criterion to report pain relative to normal control subjects (Yang et al., 1983; 1985). That is, they were less inclined than the normal control group to call the sensations 'painful'. Yang et al.(1985) attributed the additional finding of differences in the pain report

criterion to methodological differences.

It is difficult to draw conclusions about how chronic pain patients respond to laboratory pain in these SDT investigations because of the variation in the methodologies employed. Many of the studies required subjects to make category judgements of intensity in their SDT task (Naliboff et al., 1981; Cohen et al., 1983; Yang et al., 1985). The use of category judgements in SDT has been found to be less sensitive to changes in d' than binary judgements because subjects were found to have difficulty using all the categories simultaneously and consistently (Clark & Dillon, 1973), particularly if only a small number of practice trials were given (McNicol, 1972). It is not clear how many practice trials were given in these studies or even if any were given at all.

There is wide variation among the above SDT studies with respect to the number of trials given per stimulus intensity, ranging from 3 trials per intensity (Malow et al., 1980; Malow & Olson, 1981) to 26 trials per stimulus intensity (Naliboff et al., 1981; Cohen et al., 1983). More reliable estimates of the SDT indices are gained with a greater number of trials. Therefore, the findings obtained with these greatly varying numbers of experimental trials may not be comparable. In addition, some of the studies have selected different stimulus intensities to be used in the SDT task for each subject based on each person's recorded pain threshold (Cohen et al., 1983; Naliboff et

al., 1981). Yang and his colleagues, however, used the same set of stimuli for all subjects. Clark (1974) has indicated that d' values obtained with different stimulus intensities for each subject are not directly comparable.

Finally, two types of pain stimuli were used in these studies: focal pressure (Malow et al., 1980; Malow & Olson, 1981) and radiant heat (Cohen et al., 1983; Naliboff et al., 1981; Yang et al., 1985). Rollman (1983) has suggested caution in comparing results of studies using different pain stimuli. Thus, while there is some consistency across different methodologies in that it appears that all chronic pain patients exhibit a reduced ability to discriminate between painful stimuli, one cannot be sure because of the above methodological variations.

Other investigations of pain perception in chronic pain patients. Recent studies have been undertaken to ascertain whether chronic pain states affect pain tolerance levels (Brands & Schmidt, 1987; Lipman et al., 1987; Scudds et al., 1987). Brands and Schmidt (1987) found that chronic low back pain patients with no apparent pathological basis for their condition had lower tolerance to cold pressor pain than normal controls. Scudds et al. (1987) examined pain thresholds, tolerance levels, and personality correlates of fibrositis patients, rheumatoid arthritis patients, and normal control subjects. Fibrositis is a chronic pain condition in which there is an "absence of laboratory, radiographic, and examination evidence of inflammatory

disease" (Scudds et al., 1987, p. 563). The fibrositis group was reported to score significantly higher than normal controls on hypochondriasis, depression, anxiety, and social introversion. In addition, they showed significantly lower pain thresholds and tolerance levels than normal control subjects and rheumatoid patients. The authors suggest that these results are consistent with the hypervigilance model of pain perception.

In contrast, Lipman et al. (1987) compared the tolerance levels to radiant heat stimuli of chronic pain patients and normal volunteers. The chronic pain group consisted of patients experiencing severe pain resulting from a variety of disorders. In general, however, the conditions were all considered to have organic etiologies and to be treatable by neurosurgical intervention. They found that the chronic pain patients exhibited higher tolerance levels of painful thermal stimuli than normal volunteers. Furthermore, they found that the pain tolerance levels decreased in the chronic pain group following surgical interventions and were similar to the responses of the normal volunteers.

Analysis of Research on Pain Perception in chronic pain patients

It is difficult to reach a conclusion regarding altered pain perception in chronic pain patients because of the method variation used in the above studies. There are some consistent differences, however, between studies indicating overresponsiveness or underresponsiveness to pain in chronic pain patients such as, the type of pain stimuli used and the type of pain disorder studied.

Type of pain stimulus used. A consistent methodological difference between studies finding overresponsiveness and these reporting underresponsiveness to pain in chronic pain patients concerns the general type of pain induction technique used. Investigations that have reported pain patients to have low pain thresholds used focal pressure and cold pressor pain induction methods (Brands & Schmidt, 1987; Malow et al., 1980; Malow & Olson, 1981; Scudds et al., 1987). These pain induction methods have been termed 'tonic stimuli' because they produce deep, prolonged painful sensations. In contrast, investigations that found pain patients to have high thresholds to pain used radiant heat stimuli (Cohen et al., 1983; Lipman et al., 1987; Naliboff et al., 1981; and Yang et al., 1985) and one study simply used a questionnaire format (i.e., no pain was induced) (Yang et al., 1983). Radiant heat and others producing short-term or transient pain (e.g., electric shock) have been termed 'phasic stimuli'.

Tonic and phasic stimuli are believed to act on the nervous system in different ways. Cold pressor and pressure pain are believed to primarily stimulate the large unmyelinated 'C' fibres of nociception and produce slow, diffuse, and aching sensations (Chapman, 1986). These methods of pain induction are favored by some investigators because of the similarity with clinical pain conditions (Malow et al., 1980; 1987). However, this type of stimulus may not be appropriate for SDT investigations. Signal Detection Theory requires many repeated presentations of brief stimuli (Chapman, 1985). The nature of tonic pain induction techniques is such that it takes some time for each stimulus to be administered (e.g., 60 seconds or more) which necessarily limits the number of trials given per stimulus intensity (e.g., only 3 trials per intensity were administered in Malow's investigations).

Radiant heat pain involves brief (3 to 4 seconds), discrete stimuli and, although it is not considered to be as similar to the experience of chronic pain, it is a widely used form of pain induction technique (Rollman & Harris, 1987). This is because it is a very reliable and easily controlled source of pain stimuli. Phasic pain has been found to stimulate the A-delta fibres. In addition, radiant heat (in contrast to electrical and mechanical pain induction techniques) was found to conform to the assumption that the variances of the two underlying distribution in SDT are equal (Clark, 1969; Rollman, 1976). This assumption is

important for the parametric calculations of d' (Rollman, 1976). Finally, the relatively brief administration time for stimulus presentation makes radiant heat a suitable pain induction technique for SDT because more trials may be administered in a given time.

Differences in the type of pain population studied. An important distinction between the studies that found overresponsiveness in pain patients and those that found underresponsiveness was the type of pain patient studied. A general difference appears to be whether the pain condition had an obvious organic cause or not. One of the distinct diagnostic criteria for MPD, established by Laskin, has been that there is no evidence of organic pathology in the affected area (in Scott, 1981). The International Association for the Study of Pain: Subcommittee on Taxonomy (1986) also indicated that the physical pathology of MPD was unknown. This is also true for fibrositis and, in addition, Scudds et al. (1987) reported a strong association between fibrositis and hypochondriasis. Low pain tolerance levels were reported in chronic pain patients for whom no organic cause was apparent (Brands & Schmidt, 1987).

In contrast, Naliboff et al. (1981) and Cohen et al. (1983) both used patients "typical of an organically based disorder without major psychiatric problems." (Cohen et al., 1983, p. 247). Lipman et al. (1987) also conducted their study using pain patients with obvious organic causes and who were likely to obtain relief from upcoming surgical

interventions. Yang et al. (1983) were less clear as to the nature of the conditions of their pain patients, however Yang et al. (1985) indicated that their pain patients were diagnosed with herniated lumbar disks, myofascial syndrome, and osteoarthritis.

Malow and Olson (1980) have commented on the possibility that people with 'organically caused' pain syndromes may differ in their response to pain in comparison with people who do not exhibit obvious organic signs. They suggested that "the absence of organic causes for chronic pain may result in people who are temporarily more sensitive to painful stimulation than normal individuals." (p. 71). Other investigations have found that pain patients with unclear or no apparent organic cause for their discomfort report greater intensity of pain than patients with clear physical etiologies (Leavitt et al., 1979; Perry et al. 1988).

Cohen et al. (1983), however, have suggested that the difference in results may instead "reflect the different psychological components of the disorders." (p. 251). Leavitt & Garron (1979) found that psychological factors were related to increased pain report in either 'organic' or 'non-organic' patients. It is interesting to note that both MPD and fibrositis have been strongly associated with stress and anxiety and in both conditions, the physical cause is unclear (Schwartz et al., 1979; Malow et al., 1980; Scott, 1981; Scudds et al., 1987). Characteristic symptoms of

anxiety include worry and anticipation of possible calamity to self or others and hypervigilance for possible misfortune (American Psychiatric Association, Diagnostic and Statistical Manual of Mental Disorders III - Revised, 1987). Research on the relationship between pain and anxiety has generally supported the observation that anxiety is associated with increased pain report, decreased pain threshold and tolerance levels (Lepanto et al., 1965; Halsam, 1966; Mendler & Watson, 1966; Klusman, 1975; Weisenberg et al., 1977; Kent, 1984; Sternbach, 1986; Wharton & Clark, 1987). Techniques to reduce anxiety resulted in increased pain threshold and tolerance (Bobey & Davidson, 1970; Elton & Stanley, 1976).

Feared stimuli, whether external or internal (e.g., somatic sensations), have been found to capture attention (Williams et al., 1988; Chapman, 1986). Bushnell et al. (1985) found that the selective attention to painful heat stimuli improved subjects' ability to detect temperature changes. They attributed this finding to changes in the sensory neural pathways and not to changes in the subjects' decision criterion. It is plausible that the hypervigilance model is applicable to a subgroup of chronic pain patients who are particularly anxious about their condition and are attentive to signs of somatic distress. A review of the significance of the organic/functional classification system will follow in conjunction with a review of the role of

cognitive and affective factors in the experience of chronic pain.

Classification of pain patients

One of the major ways that pain patients have been classified in the past has been on the basis of the presence or absence of identifiable organic causes. This diagnostic process has yielded two categories of pain patients. Those patients with obvious underlying physical causes for their pain have been classified as having 'organic' or 'somatogenic' disorders and have been considered to display 'real pain' (Turk & Rudy, 1987). However, those patients complaining of persistent pain in the absence of identifiable physical causes or whose pain reports were disproportionate to the tissue damage have been classified as having 'functional' or 'psychogenic' disorders, and have been considered to display 'unreal pain' (i.e., pain that is emotionally based) (Turk & Rudy, 1987).

This type of mind-body dualism has been criticized in the wake of current formulations of pain which consider pain to involve sensory-discriminative, motivational-affective, and cognitive-evaluative components which are constantly interacting in the experience of pain (Melzack & Wall, 1982). There has been substantial support for the role of cognition and affect as mediating factors in the perception of pain (Craig, 1989; Elton, 1987; Thompson, 1981; Turk, Meichenbaum, & Genest, 1983). In addition, the

organic/functional distinction has encountered problems. It is rare to find an organically caused pain condition that does not also involve psychological variables (Bellisimo & Tunks, 1984; Turk et al., 1983; Waddell & Main, 1984). Orthopaedic treatments often have been ineffective with apparently organically caused disorders because of the tendency to ignore the psychological factors (Leavitt & Garron, 1979; Leavitt, 1987; Derebery & Tullis, 1986; Waddell et al., 1980). Finally, an alternative explanation for "functional" disorders is apparent in the tendency to attribute inappropriate pain report to malingering or 'secondary gain' (e.g., financial incentives through compensation or litigation). Several studies, however, have failed to find a relationship between nonorganic signs and compensation or litigation claims (Leavitt et al., 1982; Melzack et al., 1985; Reesor & Craig, 1988; Waddell et al., 1980).

It is becoming apparent in recent research that the degree of detectable physical pathology contributes less to the variance in pain perception and disability in chronic pain patients than does the cognitive appraisal and emotional reaction to the condition (Barnes et al., 1989; Flor & Turk, 1987; Lacroix et al., 1990; Lee et al., 1989; Main & Waddell, 1984; Polatin et al., 1989; Turk & Rudy, 1987; and Waddell, 1987). Pain patients who reported catastrophic cognitions regarding their pain and a sense of helplessness in controlling the pain also reported higher

intensities of pain and increased disability. This was true for patients with limited organic findings and for patients with clear organic causes (Flor & Turk, 1987; Keefe et al., 1989; and Spinhoven et al., 1989).

Bandura et al. (1987) found that self-efficacy to withstand cold pressor pain was correlated with increased pain tolerance and activation of opioid analgesic systems. Self-efficacy is defined by the authors as a person's belief of him/herself as being capable to achieve certain levels of performance and to maintain control over events. Thus, it appears that a sense of control over pain is associated with the release of endogenous opioid substances which act as analgesics (i.e., decrease sensitivity to pain). Cognitions of control have been associated with decreased pain report and increased pain tolerance in past research (Bowers, 1968; Hill et al., 1952; Lepanto et al., 1965; Mendler & Watson, 1966; Halsam, 1966; Szpiler & Epstein, 1976; Flor & Turk, 1987; Spinhoven et al., 1989). Chronic pain patients who exhibit self-efficacy to control or cope with pain may represent the subgroup of patients who have been reported to be less responsive to painful stimuli and who appear to conform to the predictions of the Adaptation-level model.

Emotional response to stress has been linked to biochemical factors that affect pain sensitivity. Animal research conducted to investigate altered pain perception under stressful conditions revealed that analgesia and hyperalgesia could be produced by the same situation in rats

(Jorum, 1988a). The critical factor leading to each of these outcomes appeared to be the animal's emotional behaviour exhibited during the nonnoxious stressful situation. Rats that lay quietly were found to be less sensitive to pain whereas rats that were agitated and "hyperemotional" exhibited hypersensitivity to pain. Hyperemotionality refers to motor agitation, defecation, and vocalization and is considered to be an index of anxiety in animals (Jorum, 1988b; Tanaka et al., 1983). Jorum (1988b) further investigated the biochemical bases for these responses in addition to seeing whether the hyperalgesic response could be conditioned. He found that noradrenergic mechanisms mediated the hyperalgesic response and that the hyperalgesic response could be conditioned such that the "mere anticipation of an event which has earlier produced hyperemotionality with a subsequent decrease in nociceptive threshold results in hyperalgesia" (p. 353). Jorum (1988b) suggested that the expectation of an unpleasant event, therefore, may result in decreases in pain threshold. He further suggested that the implication of the above results is that anxiety (presented as hyperemotionality) may be a critical factor in the development of hyperalgesia. These findings lead to the implication that pain patients who are distressed by their pain condition and exhibit increased somatic preoccupation (hypervigilance) may be increasing their sensory sensitivity to painful sensations.

It is now recognized that both physical and psychological factors will be present in any chronic pain condition. Consequently, efforts have been made to identify, through the physical examination, those patients who may require a more detailed psychological assessment before undergoing a physical treatment such as surgery (Waddell et al., 1980). This appears to be best done on the basis of establishing the presence of non-organic signs rather than by exclusion, determining the absence of organic signs (Bigos & Battie, 1987; Derebery & Tullis, 1986; Doxey et al., 1988; Main & Waddell, 1984; Waddell et al., 1980; Waddell, 1987). Non-organic signs or symptoms refer to reports of pain or reactions to physical examination that are vague, poorly localized, or deviate from anatomical principles (Waddell et al., 1980; Waddell et al., 1984). Non-organic signs/symptoms have been termed "medically incongruent symptoms" and have also been identified by exaggerated and non-anatomical pain drawings (Ransford et al., 1976; Reesor & Craig, 1988).

Classification of medically congruent vs medically incongruent pain presentation. Reesor & Craig (1988) classified pain patients on the basis of the presence or absence of medically incongruent signs and symptoms. Medically incongruent pain presentation was assessed using three measures that involve different modes of communication: behavioural, verbal self-report, and pictorial. Pain patients were classified as exhibiting a

medically incongruent pain presentation if they exhibited signs that surpassed a set criterion for at least one of the measures. A discriminant function analysis indicated that 85% of the patients were classified correctly according to this system.

The behavioural component was assessed using a measure of nonorganic physical signs present during a physical examination (Waddell et al., 1980). The nonorganic physical signs consist of reports of pain that do not correspond to anatomical principles and include the following symptoms: superficial and deep non-anatomically based tenderness, report of pain during mock examination tests, increase in straight leg raising when the patient is distracted, disturbances of muscle strength or sensation in neighboring areas that do not correspond to neurological or anatomical substrates, and overreaction to examination.

Nonorganic physical signs were more likely to be observed in patients for whom conventional medical treatments had failed (Waddell et al., 1980). Two or greater nonorganic signs were found to correlate with the hypochondriasis and hysteria scales on the Minnesota Multiphasic Personality Inventory (MMPI) but did not correlate with the F or K validity scales suggesting that the signs are not indicative of malingering (Doxey et al., 1988; Waddell et al., 1980). Other studies have failed to find a relationship between nonorganic physical signs and compensation or litigation claims (Leavitt et al., 1982;

Melzack et al., 1985; Reesor & Craig, 1988; and Repco & Cooper, 1983). The presence of multiple nonorganic signs is indicative of patients likely to have a poor result from surgery and who may require a more detailed psychological assessment (Derebery & Tullis, 1986; Doxey et al., 1988; Dzioba & Doxey, 1984; and Waddell et al., 1980). This measure was found to have high reliability across assessments (inter-rater and test-retest reliability coefficients have ranged from .78 to .86) (Reesor & Craig, 1988; Waddell et al., 1980) and high discriminative validity (i.e., did not correlate significantly with objective physical impairment) (Main & Waddell, 1984).

The self-report component of medically incongruent pain presentation was assessed using the Waddell et al., (1984) Inappropriate Symptom Inventory. This measure consists of a list of seven specific questions which inquire about symptoms that are vague, poorly localized, and generally are inconsistent with known physiological and anatomical principles. The scale has been found to have high inter-rater reliability ($K=.58-1.00$, $p<.01$) and high discriminative validity (i.e., very low incidence in patients with clear organic pathology). Derebery & Tullis (1986) consider the measure to be valuable in identifying symptoms related to psychological factors.

Finally, the pictoral component of medical incongruence was assessed by Reesor and Craig with the Pain Drawing using the Ransford et al. (1976) scoring system. The patient is

required to indicate on an outline of a human figure the location and quality of their pain. The scoring system quantifies nonanatomical or exaggerated features of the drawing. A score of three or greater has been associated with decreased likelihood that the patient will respond to conventional orthopoedic treatment (Dzioba & Doxey, 1984; Taylor et al., 1984; Uden et al., 1988). Exaggerated or nonanatomical pain presentation is rare in patients with organic lesions such as a herniated disk (Uden et al., 1988). High scores have been correlated with the hypochondriasis and hysteria scales of the MMPI (Ransford et al., 1976). The Ransford et al., scoring system has been used with high inter-rater reliability (coefficients range from .70 to .89) and high test-retest reliability (coefficients range from .77 to .85) (Reesor & Craig, 1988; Uden et al., 1988).

The assessment of incongruent pain presentation has been of use in identifying patients who are likely to have a poor result to surgical treatment and for whom a psychological consultation would be helpful (Bigos & Battie, 1987; Derebery & Tullis, 1986; Doxey et al., 1988; Waddell et al., 1980; 1984; Waddell, 1987). Incongruent pain presentation is considered to provide information about the patient's emotional response to their illness and perception of their disability (Waddell, 1987; Waddell et al., 1989). Patients with inappropriate pain presentations "can be said to be reacting to life's stresses in a maladaptive way"

(Derebery & Tullis, 1986). Incongruent symptoms have been correlated with higher sensory intensity ratings of pain, more physical impairment and disability, catastrophic cognitions regarding pain, and a sense of helplessness in ability to control pain (Reesor & Craig, 1988). Patients exhibiting nonorganic signs have also been found to have a poor response to physical treatments and to have elevated scores on the hysteria and hypochondriasis scales of the MMPI (Dzioba & Doxey, 1984; Ransford et al., 1976; Taylor et al., 1984; Uden et al., 1988; Waddell et al., 1980).

Pain patients who appear to conform to the hypervigilance model of altered pain perception may be identifiable on the basis of presence of medically incongruent signs and symptoms.

> "The effect of failure to obtain relief from chronic pain may ... lead to a general sensitizing of the patient to all sorts of physiological events (heightened somatic awareness) leading to inappropriate pain perceptions or reports (inappropriate symptoms), inappropriate responses to physical examination (signs) and resulting in a marked exacerbation of the extent of disability for a given level of objective physical impairment" (Main & Waddell, 1984, p. 40).

Reesor & Craig (1988) suggested that pain patients with ineffective coping techniques and maladaptive cognitions (which serve to accentuate their suffering) may come to exhibit pain behaviours out of proportion to the underlying

pathology. The tendency to be anxious and to engage in maladaptive cognitions (e.g., catastrophizing) may draw attention to the pain (i.e., create a state of hypervigilance) and result in hypersensitivity to pain. Furthermore, a vicious circle would be established whereby the patient feels more pain, becomes more anxious and hypervigilant, thus maintaining or exacerbating the chronic pain condition. An adaptation-level effect (i.e., reduced reactivity to painful stimuli) would be more likely to be seen in patients without significant nonorganic signs, who show effective coping strategies, and exhibit low anxiety scores. In this case, a positive cycle could be established whereby the patient's self-efficacy to control pain is reinforced.

Summary and Purpose of the Present Investigation

Two models of altered pain perception in chronic pain patients have been presented: the hypervigilance model and the adaptation-level model. The hypervigilance model has led to the prediction that chronic pain patients will be more reactive to painful stimuli because they tend to direct most or all of their attention to signs of somatic distress. In contrast, the adaptation-level model has led to the prediction that chronic pain patients will be less reactive to painful stimuli because they will judge painful stimuli relative to a higher standard or adaptation-level of pain than people without chronic pain. Both predictions have

been supported in past research but with patients who display different types of pain conditions. In general, patients who report catastrophic cognitions and high levels of anxiety regarding their pain also report greater pain intensity. These patients have been identified by the display of medically incongruent symptoms. However, patients who do not display inappropriate symptoms, engage in adaptive coping strategies, are less anxious, and more efficacious to control their pain appear to be less reactive to painful stimuli. Signal Detection Theory has been used to assess the predictions of the hypervigilance and adaptation-level models in order to separately evaluate sensory sensitivity to pain and response bias. However, methodological variation has rendered the conclusions ambiguous.

The purpose of the present investigation was to evaluate whether the predictions of the two models of pain perception were met by pain patients with different presentations of symptomatology (i.e., those with medically incongruent or congruent symptoms). Pain perception was assessed using SDT methodology in addition to measures of pain threshold and self report of the subjective experience of pain. Cognitive and affective correlates of the pain responses were evaluated in order to define more clearly the conditions under which hypo- or hyperreactivity to pain can be expected in chronic pain patients.

Hypotheses and Design

Because this study involved a partial replication of a previous study conducted by the same research laboratory (Reesor & Craig, 1988), it was expected that the classification system would produce two adequately distinguished groups of pain patients: those with and without medically incongruent symptoms. In accordance with Reesor and Craig's findings, patients with medically incongruent symptoms were expected to report less effective coping styles, be more prone to catastrophizing, and report greater pain intensity than patients without incongruent symptoms. In addition, it was expected that the medically incongruent group would be more anxious and feel less able to control or manage their pain.

An initial assessment of the general hypothesis that chronic pain patients respond differently to pain than pain-free individuals was expected to yield no significant group differences. This was because the patient group would be represented by a heterogeneous selection of pain patients. Rather, the two models of pain perception were expected to be differentially supported by patients with different pain presentations. Patients with medically congruent symptoms were expected to conform to the predictions of the adaptation-level model and those with medically incongruent symptoms were expected to conform to the predictions of the hypervigilance model. The adaptation-level model was anticipated to be reflected by a high threshold for pain and

by a high criterion to report pain from the signal detection analysis. This is because the model refers to judgements of perceptual stimuli relative to the observer's internal standard or adaptation-level. From this model, one would expect the 'medically congruent' group to have a higher criterion to report painful sensations than the 'medically incongruent' or normal control groups.

The hypervigilance model was expected to be reflected by a low threshold for pain in the medically incongruent pain group. The criterion to report sensations as painful from the signal detection analysis was expected to be low relative to the medically congruent and normal control groups. This is because of the hypothesized increased somatic vigilance. In addition, because of research on attention, heightened anxiety and pain sensitivity, it was speculated that the signal detection measure of sensory sensitivity (d') would be higher relative to the other two groups.

A 3 X 2, group by sex, between groups design was used to evaluate the hypotheses. Group 1 consisted of normal control subjects (i.e., those without chronic pain). Groups 2 and 3 consisted of chronic back pain patients, without and with, medically incongruent symptoms, respectively. All groups were age and sex matched. Because this type of design (i.e., quasi-experimental) yields correlational data only, causal relationships may not be interpretted (Campbell & Stanley, 1963). Demographic variables assessed included

age, marital status, socioeconomic status, and ethnicity. Experimental conditions (ambient temperature during a heat detection task) and factors related to chronic pain (duration of the condition, medication use, surgery, subjective disability, and physical impairment) were also assessed.

The dependent variables consisted of three groups of measures: affective, cognitive, and pain measures. General anxiety was assessed in all subjects using the Trait Scale of the State-Trait Anxiety Inventory (Spielberger, 1985). Worry and emotionality specific to chronic pain was assessed in the pain patients using the Pain Experience Scale (Turk & Rudy, 1985). Cognitions associated with chronic pain conditions including coping strategies were assessed with the Coping Strategy Questionnaire (Rosenstiel & Keefe, 1983). Finally, the following pain measures were taken: threshold for radiant heat pain, the signal detection indices of sensitivity (d') and response bias (B), and subjective descriptions of the pain using the Gracely Rating Scales of Sensory Intensity and Affective Distress (Gracely et al., 1979).

METHOD

Subjects

All subjects were recruited from the University Hospital, Shaughnessy Site, a large general hospital in Vancouver, B.C.. Normal control subjects were recruited from the staff of the hospital and from visitors to the hospital. They were eligible to participate if they were: (a) between the ages of 30 and 60 years, (b) fluent in the English language, and (c) not suffering from chronic pain or taking any regular medication. Back pain patients were recruited through the Back Pain Clinic and from consulting physicians associated with the Back Pain Clinic at Shaughnessy Hospital. The Back Pain Clinic conducts comprehensive assessments of chronic back pain patients referred from general practitioners or medical specialists. Pain patients are routinely assessed by one of two teams, each consisting of a general practice physician, an orthopaedic specialist, a psychologist, and a physiotherapist.

Consecutive admissions of back pain patients who met the following criteria were asked to participate in the study: (a) between the ages of 30 and 60 years, (b) not involved in compensation claims or litigation with respect to their back pain, (c) agreeable to abstain from pain medication from midnight the night before their participation in the study, (d) sufficiently fluent in the English language in order to fill out self-report inventories and to understand instructions, and (e) presenting with a chronic pain problem of six months duration or longer. Of those who volunteered,

six were omitted from the sample because they took medication after the time specified and three others were omitted because they were unable to distinguish any of the four stimulus levels administered in the SDT task. A total of ninety subjects produced valid data, thirty in each of three groups with equal numbers of males and females in each group.

The mean age of the entire sample was 40.3 years (SD=7.8, range=30-59 years). Of the control subjects, 30% were married or in common-law relationships, in contrast to the pain patients of whom 68% were married or involved in common-law relationships. Eighty-nine percent of the sample were Caucasian anglophones while 11% reported English as their second language. Socioeconomic status was rated on the Blishen, Carroll, and Moore (1987) index based on 1981 census data. The mean socioeconomic index for the entire sample was 43.22 (SD=14.30). Seventy-two percent were employed and 28% were not working. This group consisted of students, unemployed people seeking work, and homemakers not seeking outside work.

Of the pain patients, the mean self-reported duration of the pain condition was 9.0 years (SD=9.3, range=.5-38 years). Thirty percent reported having undergone previous surgery. Physical impairment (i.e., objective structural limitations) was assessed by the physicians according to criteria outlined by Waddell and Main (1984) which are described more thoroughly below. The measure yields a percentage of bodily impairment (i.e., loss of function). Mean percentages for the sample of

pain patients were 14.3% (SD=5.54) for the men and 15.36% (SD=8.2) for women. Self report of subjective disability was measured by the Oswestry Disability Inventory also described below. Mean percentage of subjective disability for the men was 28.56% (SD=12.73) and 38.63% (SD=14.74) for the women. The above values for objective physical impairment and subjective disability are similar to those obtained by Reesor and Craig (1988) who assessed pain patients from the same facility.

Medication was rank ordered according to the strength of effect on the central nervous system (Yang et al., 1985). Sixty five percent of the sample denied taking medication regularly. Fifteen percent reported taking nonnarcotic analgesics only; 8% reported taking medication with a combined psychotropic and nonnarcotic analgesic action; and 12% reported taking opiate analgesic medication. The percentage breakdown of type of medication for the sample of pain patients is presented in Table 2. Of interest is the absence of anxiolytic or sedative medication and the preponderance of no medication taken for all four groups.

Table 2: Percentage of Medication Use by Patient Group

	Congruent		Incongruent	
Medication	Males	Females	Males	Females
Anti-inflammatory/ Analgesics	31.2	18.8	14.3	6.2
Muscle Relaxants	0	0	6.2	6.2
Opiate Analgesics	6.2	12.5	31.2	14.3
Antidepressants	0	0	0	14.3
No Medication	62.5	56.2	56.2	42.8

n=15 per group

Primary and secondary diagnostic categories (and/or exacerbating factors), as determined by chart review, are listed in Table 3. It should be noted that one of the subjects was missing a primary diagnosis and 15 were not given secondary diagnoses.

Table 3. Percentage Breakdown of Diagnoses in the Patient Sample

Primary Diagnoses		Secondary Diagnoses &/or Exacerbating Factors	
No Clear Findings or Pain Out of Proportion to Pathology	25.4	Physical Deconditioning/ Inactivity/Obesity	35.6
Mechanical Back Pain	16.9	Facet Joint Related	11.1
Facet Joint Related	16.9	Degenerative Changes	11.1
Degenerative Disc	11.9	Discogenic Problem	6.7
Nerve Root Irritation	6.8	Pain Out of Proportion to Pathology	6.7
Soft Tissue Injury	6.8	Arthritis	6.7
Spondylosis	6.8	Depression/Alcohol Abuse	6.7
Bursitis/Fibrositis	3.4	Spinal Stenosis/ Calcification	4.4
Spondylolithesis	1.7	Mechanical Back Pain	4.4
Lumbarization	1.7	Psychological Overlay	2.2
Disc Protrusion	1.7	Nerve Root Irritation	2.2
		Soft Tissue Injury	2.2
n=59		n=45	

Group Assignment

The subjects formed three groups: a normal control group, and two pain patient groups. Pain patients were assigned to two groups (medically congruent or medically incongruent) on the basis of the Nonorganic Physical Signs (Waddell et al., 1980) (Appendix A), the Pain Drawing (Ransford et al., 1976) (Appendix B), and the Inappropriate Symptom Inventory (Waddell et al., 1984) (Appendix C). Nonorganic physical signs were assessed by the physicians in the Back Pain Clinic. Although this measure is included as a routine part of the clinic's assessment, only 44 of the 60 pain patients were assessed on this measure. Of these 44 patients, 20 were assessed by two independent physicians which allowed for the calculation of interrater reliability. The Pearson correlation coefficient on the total score on this measure indicated adequate interrater reliability (r=.77, p<.001) which is similar to that obtained by Reesor and Craig (1988). The Pain Drawing was scored using the Ransford et al. (1976) scoring criteria. Fifty five percent (n=33) of these drawings were scored by two independent raters, the author and a female research assistant. Interrater reliability was high (r=.96, p<.001) as calculated with a Pearson correlation coefficient. The Inappropriate Symptom Inventory was given in the form of an interview by the experimenter.

Patients were assigned to the incongruent group if 2 or more non-organic physical signs were present; 3 or more inappropriate symptoms were reported; or patients scored 5 or

greater on the Pain Drawing according to the Ransford et al. (1976) scoring system. Pain patients were assigned to the congruent group in the absence of these criteria. The precedent for this classification system was set by Reesor and Craig (1988) who, from a discriminate function analysis, reported that 85% of the patients were correctly classified according to this system. Reesor & Craig (1988) assigned patients to the incongruent group if at least one of the three measures indicated an abnormal presentation of the pain in order to keep the groups as distinct as possible.

All three measures indicate exaggerated symptom report or pain presentation but involve three different modes of communication: behavioral, verbal report, and pictoral. The three measures have been found to be moderately correlated (Reesor & Craig, 1988). The relationships among these three measures in the present study are presented in Table 4.

Table 4: Relationships Among Measures of Incongruent Pain

Measure	Non-organic Signs	Inappropriate Symptoms	Pain Drawing
Non-organic Signs	-----	-----	-----
Inappropriate Symptoms	.15 (44)	-----	-----
Pain Drawing Score	.43* (44)	.40** (60)	-----

*p<.01; **p<.001

Of note, the Non-organic Physical Signs were moderately correlated with the Pain Drawing but were not significantly correlated with the Inappropriate Symptom Inventory. The Pain

Drawing and Inappropriate Symptoms were moderately correlated.

Table 5 lists the percentage occurrence of patients exceeding each criterion within the medically incongruent group by sex.

Table 5: Percentage Occurrence of Criteria Within the Incongruent Group

Sex	Non-organic Signs (>1)	Inappropriate Symptoms (>2)	Pain Drawing Score (>4)
Males	13	73	40
Females	33	80	73

n=15

Table 6 represents the percentage of pain patients in the medically incongruent group who satisfied one, two, or three of the criteria. Only those patients for whom all three measures were available are included. Very few of the subjects met all three criteria but, as in Reesor and Craig's data, more women than men met two of the three criteria. None of the patients were classified as incongruent on the basis of the nonorganic physical signs only. Of those identified by only one of the three criteria, seven were classified as 'medically incongruent' on the basis of the inappropriate symptoms, and one on the basis of the pain drawing.

Table 6: Percentage of Patients Meeting Incongruent Criteria

Sex	Number of Criteria: Three	Two	One
Males	0	25	75
Females	15	69	15

(Males, n=8; Females, n=13)

Equipment

Radiant heat was delivered by a Hardy-Wolff-Goodell Dolorimeter (Williamson Development Co.). The dolorimeter was calibrated using a Fischer Scientific Digital Thermoprobe. Stimuli were administered to one of eight 2.0 cm diameter patches of india ink applied to the volar surface of each forearm (four on each arm).

Stimuli

The stimuli selected for the SDT experiment were determined in a pilot study involving a group of 20 normal subjects (i.e., non-pain patients), age and sex matched to the groups used in the SDT experiment. These subjects were recruited from the staff of the Shaughnessy Hospital and were paid $5.00 for their participation. After completing the consent form (Appendix D), faint pain threshold to radiant heat was determined by a staircase method of threshold

determination. Faint pain threshold refers to the level of stimulation at which a "distinct, sharp, very small stab of pain (is) experienced at the exact end of a three second exposure to the stimulus" (Hardy, Wolff, & Goodell, 1952, p. 81). Hardy, Wolff, and Goodell (1952) reported that the threshold for this sensation, called "pricking pain" is easily identified. The staircase method used is called the "Up-Down Method" (Dixon & Massey, 1969) and provides a fast and accurate estimate of threshold. Briefly, it involves increasing the stimulus intensity in 10 mcal/sec/cm^2 unit increments until pain is reported. The intensity of the stimulus is then decreased until no pain is reported. The direction in which the intensity of the stimulus changes continues in this manner until six trials after the first reversal are recorded. Based on the final intensity level administered and the pattern of responding, an accurate estimate of pain threshold can be calculated.

Thresholds were determined after subjects had been familiarized with the range of stimuli and the level of stimulation that they reported to be faintly painful. The mean faint pain threshold was 253.14 mcal/sec/cm^2 (SD=26.50, range=215.0-302.5). There was no significant difference between males and females (t=.02, p>.05). On the basis of this average threshold and the range, four stimuli were selected for the SDT experiment which were administered to all subjects. These four stimuli spanned the average 'normal' pain threshold such that two were above and two below in

addition to encompassing the range. Stimuli intensities were spaced at equal intervals (30 mcal/sec/cm^2 apart) and were: 210, 240, 270, and 300 mcal/sec/cm^2. This was to increase the likelihood that the pain threshold would be spanned by these four stimuli for all the subjects. Hardy, Wolff, and Goodell (1952) reported that the just noticeable difference for pricking pain is 7 mcal/sec/cm^2 on average.

Procedure

The Back Pain Clinic conducts their assessment over two consecutive days. During the first day of assessment, eligible patients were informed about the study and requirements and asked if they would be willing to participate during the second day of their assessment. Those who agreed were given the consent form (Appendix E) and asked to return it when they took part in the study the following day.

During the one hour experiment, subjects underwent the same series of events. First, india ink was used to paint four, 2 cm diameter spots on the volar surface of each forearm. While these dried, subjects completed the self-report questionnaires. Demographic information and information related to their pain condition was then collected, followed by the Inappropriate Symptom Inventory which was given in the form of an interview. While the instructions for the pain perception task (Appendix F) were read, the subject's skin temperature was taken.

After hearing the instructions, all subjects were given an ascending series of stimuli and were asked to verbally describe the sensations they were experiencing. When they identified the point at which a faint prickly sensation was perceived, it was emphasized to them that this was the 'signal' that we wanted them to detect. It was stressed that they were required to distinguish between heat and the first hint of a prickly sensation which is considered to be the beginning of pain. Several more randomly presented stimuli intensities were presented around the reported faint pain level until the subject responded in a relatively consistent fashion and had confidence that they knew what they were trying to detect.

Threshold for faint pain was then determined for each subject using the Up-Down Method that was used in the pilot study. This was followed by the signal detection experiment of which the four stimulus levels selected (210, 240, 270, and 300 mcal/sec/cm^2) from the pilot study were administered in 10 random blocks of eight stimuli each. Twenty trials were administered for each stimulus intensity making a total of 80 experimental trials. Prior to the administration of the experimental trials, 4 practice trials per stimulus intensity were administered making a total of 16 practice trials (Appendix G). The duration of each stimulus was 3 seconds with a 12 second interstimulus interval and subjects were told to move the heat gun to a different spot for each trial, thus rotating among the eight locations on the forearms. On each

trial, subjects were required to make a binary decision as to whether they felt pain or not. Approximate time to complete exposure to the stimuli in the SDT task was 30 minutes.

Upon the completion of the pain perception task, subjects rated the most intense stimulus received during the experiment on the Gracely Rating Scales of sensory intensity and unpleasantness. Finally, subjects were thoroughly debriefed (Appendix H) and paid $20.00 for their participation.

The Pain Drawing and Assessment of Nonorganic Physical Signs were administered by the Back Pain Clinic Staff during the two day assessment. The Normal Control Group underwent the same series of events except they did not complete any information relevant to chronic pain conditions (consent form, Appendix I).

The author assessed 25 subjects while a female research assistant thoroughly trained in the experimental procedures assessed 35. There were no systematic differences between the data collected by each experimenter as assessed by t-tests on the means of pain threshold and the signal detection indices.

SDT Measures of Discriminability and Response Bias

Initially, the average pain threshold for the nonpatient sample in the pilot study was used as the cutoff point for designating 'hits' and 'false alarms'. By design, the study included two stimulus intensities above this threshold and two below. Stimuli judged to be 'painful' above this level were called 'hits' and those judged to be 'painful' below this

level were considered to be 'false alarms'. Two additional cutoffs were set for the definition of 'hits' and 'false alarms' in order to calculate, along with the original d' and beta measures, three separate measures for d' and beta. The two additional cutoffs were between the lowest stimulus level and the other three stimuli levels and the highest stimulus level and the lower three. Again, stimuli judged to be painful that were above a specified cutoff were considered to be 'hits' and stimuli judged to be painful that were below the cutoff were considered to be 'false alarms'. These measures were then averaged to produce one d' and beta measure for each subject. By this method, the resulting averaged measures were more stable (i.e, less skewed and less spread out) than any of the three measures by themselves.

Given that the purpose of this study was to assess the relative judgements of painful stimuli by chronic pain patients vs control subjects, it was possible to consistently specify the presence or absence of a signal on the basis of the comparison group. This represents an important methodological innovation in the application of SDT to pain research. The use of this method, which sets a fixed comparison level (or baseline) on the basis of the comparison group, conforms exactly to the assumptions and requirements of a SDT task. This allows for the unambiguous interpretation of the d's and betas in a manner not really possible in past SDT investigations of pain.

Because the judgements of the stimuli are relative to set cutoff points, the averaged d' measure is interpretable in terms of the consistency of judgements made. The higher the d' measure, the more consistent the judgements were. Consistency in judgements is a reflection of how well the subject was able to distinguish or discriminate between heat and the first trace of pain. Because stimuli levels and instructions to subjects were held constant in this investigation, the ability to consistently distinguish heat from faint pain is interpreted to reflect greater sensitivity to differences in stimulus levels or to detect the first trace of pain upon a background of sensory noise (i.e., heat). The criterion, beta, reflects the tendency to report pain sensations such that the lower the criterion set, the less stimulation needed to call the stimulus painful.

Measures of Impairment and Disability

1) The Physical Impairment Index (Waddell & Main, 1984) (Appendix J).

Physical impairment refers to objective structural limitations or loss of ability because of anatomical or pathophysiological abnormality. The measure provides a percentage of physical impairment which is based on objective evidence including the pain pattern, time pattern, presence of a previous fracture, previous surgery, signs of root compression, and straight leg raising both with and without distraction. This combination of physical characteristics was

selected by Waddell and Main (1984) following a regression analysis which identified them as yielding the best prediction of impairment. Interrater reliability for each of the characteristics ranged from 77 to 100% agreement (Main & Waddell, 1984). This measure was completed by two independent examiners in the present study on 41% of the patient sample (n=11). Interrater reliability was high (r=.94) as calculated on the overall total scores using a Pearson correlation coefficient. This level of interrater reliability was the same as that reported by Reesor & Craig (1988).

2) The Oswestry Low Back Pain Disability Questionnaire (Fairbank, Couper, Davies, and O'Brien, 1980) (Appendix K).

Disability refers to the subjective report of loss of function due to a back pain problem. This self report inventory assesses the extent to which everyday activities are compromised by the patient's back pain problem. It consists of ten separate scales which assess different areas of everyday living including: need for analgesic medication, personal care, lifting, walking, sitting, standing, sleeping, sexual activity, social life, and travelling. Patients endorse one of six statements in each area reflecting increasing levels of disability. The inventory is scored to yield a percentage of self reported disability.

This measure has been found to reflect recovery from an acute back pain problem and to be stable (i.e., test-retest

reliability, r=.99) in chronic conditions (Fairbank et al., 1980). Reesor (1990) reported the Oswestry to discriminate extensive from moderate or minimal back pain. The measure has been demonstrated to have internal consistency (Fairbank et al., 1980).

Main and Waddell (1984) have suggested that objective physical impairment and subjective disability can be compared. They reported that physical impairment accounts for less than half of the reported disability which also includes psychological factors involved in chronic pain.

Self Report Measures

1) The Gracely Rating Scale (Gracely, Dubner, & McGrath, 1979) (Appendix L).

Subjects rated the most painful stimuli as to its sensory intensity and unpleasantness on the Gracely Rating Scale retrospective to the administration of all the stimuli. Each scale has 13 descriptors that have been quantified in the form of ratio scales and for which reliability and validity have been demonstrated (Gracely et al., 1979). These scales have been preferred over other types of rating scales because of their psychophysical properties (Chapman et al., 1985).

2) The Coping strategy Questionnaire (Rosensteil & Keefe, 1983) (Appendix M).

This is a 42 item questionnaire that assesses the frequency that patients report using one of seven strategies to cope with pain: diverting attention, coping self-statements, praying or hoping, increasing behavioral activities, reinterpreting the pain sensations, ignoring the pain sensations, and catastrophizing. There are also two measures of coping strategy efficacy: ability to decrease pain and ability to control pain. There is high inter-item correlation (alpha coefficient = .71 - .85) indicating that the test is internally reliable (Rosenstiel & Keefe, 1983).

The factor structure of the Coping Strategy Questionnaire has been cross validated on five different chronic pain patient samples (total n=620) (Lawson et al., 1990). From this investigation, a three factor structure of cognitive coping strategies was recommended. The first component identified includes the following scales: ignoring pain sensations, coping self statements, and reinterpreting pain sensations. It was characterized as reflecting a conscious, active use of cognitive strategies or coping "processes" to manage pain. The second dimension identified refers to a self-evaluative component consisting of the patients' ratings of their abilities to control and decrease the pain. The third factor represents scales reflecting passive styles of coping and relate to the specific cognitive content of the coping strategies (i.e., praying, hoping, and diverting

attention to other matters such as mental games, music, books). It was recommended that two scales be treated as separate measures since they were not consistently related to the above three factors. They are the scale assessing behavioural coping strategies, which is not surprising since these really cannot be characterized as cognitive constructs as such, and catastrophizing which is characterized as being more reflective of emotional factors (Lawson et al., 1990). The catastrophizing scale has been found to be related to the emotional and behavioural adjustment to pain in chronic pain conditions (Keefe & Dolan, 1986; Keefe et al., 1987; 1989; Reesor & Craig, 1988; Rosentiel & Keefe, 1983; and Turner & Clancey, 1986).

3) The Pain Experience Scale (Turk & Rudy, 1985) (Appendix N).

This is a 19 item self-report inventory designed to assess the cognitive-evaluative reaction to chronic pain. Factor analysis has revealed two reliable scales: an emotionality scale (alpha = .91, $p<.001$) representing distress about the pain (e.g., "This pain is driving me crazy") and a worry scale (alpha = .74, $p<.001$) representing long term concerns about how the pain is affecting the patient's life (e.g., "I worry about my family"). Test-retest reliability (two week interval) is high ($r = .89$, $p. < .001$ and $r = .81$, $p<.001$ for each scale respectively) and the scales are sensitive to cognitive-behavioral treatment.

4) The State-Trait Anxiety Inventory (Spielberger, 1985) (Appendix O).

Only the 'Trait' portion of this measure was administered. This self-report inventory consists of 20 statements to assess the degree to which the respondent is anxiety prone. The subject indicates the degree to which each statement is an accurate description of him/herself. The scale has high internal consistency, test-retest reliability, and construct validity and is considered to be an excellent measure of trait anxiety (Buros, 1978).

Statistical Analysis.

Demographic variables which were continuous in nature (age and socioeconomic status) and testing conditions (room temperature during testing and skin temperature of each subject) were analysed first using 3 X 2 (group X sex) ANOVAs. Categorical demographic variables (marital status, ethnicity, and employment status) were analysed separately using Chi Square statistics. This was followed by an analysis of patient characteristics. Categorical data (presence or absence of previous surgery) was again analysed using nonparametric statistics. Interval data (duration of the pain condition, strength of analgesic medication, percentage of physical impairment, and percentage of subjective disability) were analysed using 2 X 2 (pain group by sex) ANOVAs.

Dependent measures were divided conceptually into three groups: pain, cognitive, and affective measures. The pain measures were analysed as follows: first, the entire patient group (n=60) was compared to the control group (n=30) on pain measures in 2 X 2 (group by sex) analyses of variance. Then the patients were analysed as separate groups according to the 'congruent/incongruent' distinction with the control group in 3 X 2 (group by sex) analyses of variance. In the above analyses, pain threshold was analysed separately in an ANOVA because it was assessed on a separate set of stimuli. In addition, it is considered to be redundant with the signal detection measures, d' and beta (Clark, 1987). The remaining pain measures were all derived from the same set of stimuli and were, therefore, entered into multivariate analyses. The Gracely Rating Scales of Sensory Intensity and Unpleasantness were first converted to z-scores and averaged as they were highly correlated (r=.58, p<.001) to produce a composite measure of 'subjective pain rating'. The SDT indices, d' and beta, calculated relative to the mean pain threshold of the normal control sample, were entered into a MANOVA along with the subjective pain rating and were followed up by univariate analyses where appropriate. The mean of the three d' and beta measures were analyzed similarly.

The five cognitive variables (cognitive processes, cognitive content, self-efficacy, behavioural coping strategies, and catastrophizing) were all derived from the same questionnaire, the Coping Strategy Questionnaire. These

tive variables were entered into a 2 X 2 (pain group by sex) MANOVA which was followed by univariate analyses.

The affective variables were analysed in three separate ANOVAs. This was because one of the measures (The State-Trait Anxiety Inventory) was administered to all three groups and the Pain Experience Scale, which yields two measures, was administered only to the patient groups.

The above series of analyses were followed by a set of correlational analyses in order to look at the data in a descriptive way. Interrelationships among the dependent measures were examined as well as relationships between disability/physical impairment measures and dependent measures, and the relationships among the three measures of medical incongruity and the dependent measures.

Finally, a post hoc analysis was conducted on three selected subgroups of subjects. Pain patients were selected who had received a final diagnosis from the Back Pain Clinic as exhibiting no apparent organic pathology or who were complaining of discomfort that was "out of proportion" to the detectable pathology. Eighteen such patients (9 males; 9 females) were identified. In order to form comparison groups, equivalent numbers of normal control subjects and pain patients who had received clear organic diagnoses were randomly selected. The first series of analyses described above were completed on this new grouping of the subject pool.

RESULTS

Analysis of Demographic Variables.

Continuous demographic data, age and socioeconomic status (SES), were analysed using 3 X 2 (group by sex) ANOVAs. No significant main effects or interactions emerged on these variables. Testing conditions (room temperature and skin temperature) were similarly analysed and, again, no systematic differences were revealed. Means and standard deviations for the demographic variables are presented in Table 7.

Table 7: Means and Standard Deviations: Continuous Demographic Data

	Group					
	Control		Congruent Pain		Incongruent Pain	
Variable	Males	Females	Males	Females	Males	Females
Age (years)						
x	41.4	39.4	38.1	43.7	39.6	39.8
sd	9.0	8.6	5.6	8.0	7.8	7.8
SES[a]						
x	46.1	49.8	43.8	38.0	42.8	38.6
sd	14.2	11.9	14.4	17.0	14.4	13.8

n=15 per cell
(a) higher scores refer to higher levels of SES

Categorical data (marital status, ethnicity, and employment status) were analysed by group and by sex using Chi Square statistics. A significant group effect was found for marital status [$X^2(2)=11.97$, $p<.01$]. Examination of the data revealed that more subjects in the control group were single than in the patient groups. No significant group effects were

found for ethnicity and employment status and no sex differences on any of the above variables emerged. The percentage breakdown by group and sex for categorical demographic data is presented in Table 8.

Table 8: Percentage Breakdown of Categorical Demographic Data

	Group					
	Control		Congruent Pain		Incongruent Pain	
Variable	Males	Females	Males	Females	Males	Females
Marital Status (Single)	73	67	27	33	40	27
Ethnicity (Caucasian)	100	87	80	100	100	93
Unemployed	20	7	33	33	33	40

n=15 per cell

Analysis of Patient Characteristics.

The patient groups were assessed with respect to the parameters of their pain conditions. Categorical data (presence or absence of previous back-related surgery) were analysed using Chi Square statistics. No group or sex main effects emerged from this analysis. Interval data (duration of pain condition, strength of analgesic medication, percentage of objective physical impairment, and percentage of subjective disability) were analysed using 2 X 2 (pain group by sex) ANOVAs. It should be noted that 54% of the data for

the measure of physical impairment was missing because the physicians did not complete the examinations. Table 9 lists the means and standard deviations of the above variables in addition to the results of the univariate analyses.

No significant main effects or interactions were found for the duration of the pain conditions, strength of medication consumed, and degree of objective physical impairment. However, significant main effects for both group and sex were found for the measure of subjective disability. Examination of the data revealed that in comparison to patients exhibiting medically congruent symptoms, patients with incongruent symptomatology also reported more functional disability. In addition, females were found to report more functional disability than males.

Measures of the loss of function due to a low back pain condition have also been referred to as measures of severity (Waddell et al., 1984; Reesor & Craig, 1988). The relationship between the severity of the pain condition, as measured by objective and subjective loss of function, and incongruent medical signs has been evaluated in previous investigations (Waddell et al., 1984; Reesor & Craig, 1988). Moderate correlations were reported among these measures with the exception of that between the Physical Impairment Index and the Non-organic Physical Signs (Reesor & Craig, 1988). The relationships found in the present study are presented in Table 10. Of note, the Physical Impairment Index is not significantly correlated with the Pain Drawing or the Non-

Table 8. Patient Characteristics: Means and Univariate Analyses

	Pain Group				Source					
	Congruent		Incongruent		Group		Sex		Group X Sex	
Variable	Males	Females	Males	Females	F(1,56)	p	F(1,56)	p	F(1,56)	p
Duration (years)										
x	8.1	6.0	10.3	11.6	2.49	.120	.02	.880	.49	.489
sd	7.5	8.6	8.2	12.9						
Medication Strength[a]										
x	.47	.47	.80	.93	2.14	.149	.06	.808	.06	.808
sd	.83	.92	1.26	1.16						
Oswestry Disability										
x	22.5	31.3	34.6	45.9	13.51	.001	7.70	.007	.12	.728
sd	11.5	11.0	14.0	18.5						
Physical Impairment[b]										
x	13.6	14.5	15.0	16.2	.31	.583	.15	.70	.003	.955
sd	4.4	8.5	6.8	7.9						
n	5	6	7	9						

n=15 per cell
(a) Higher scores reflect greater strengths of analgesic medication
(b) Note: unequal n; F(1,23)

organic Physical Signs whereas the Oswestry Disability Questionnaire is moderately correlated with all three measures.

Table 10: Correlations Among Measures of Physical Limitation and Incongruent Signs

	Incongruent Pain Measures		
Measures of Physical Limitation	Pain Drawing	Non-organic Signs	Inappropriate Symptoms
Physical Impairment Index (n=27)	.29	.24	.36*
Oswestry Disability Questionnaire (n=60)	.44***	.52***	.35**

* $p<.05$; ** $p<.01$; *** $p<.001$

Analysis of Dependent Measures.

Group Differences: Pain Measures.

Means and standard deviations for all pain measures (pain threshold, d' and beta calculated relative to the average pain threshold of the normal control group, mean d' and mean beta calculated from the three cutoff levels, and subjective pain rating) are presented in Table 11.

Table 11. Means and Standard Deviations for Pain Measures

	Group					
	Control		Congruent Pain		Incongruent Pain	
Variable	Males	Females	Males	Females	Males	Females
Threshold ($mcal/sec/cm^2$)						
x	263.47	260.10	273.95	282.99	268.19	271.56
sd	24.77	40.04	39.80	26.08	33.51	45.90
d'						
x	2.38	2.38	1.99	2.62	2.31	2.47
sd	.79	.83	.61	.84	.97	.64
Mean d'						
x	2.52	2.51	2.21	2.85	2.20	2.41
sd	.62	.66	.54	.63	.87	.47
Beta						
x	30.53	15.91	22.68	42.66	34.27	35.60
sd	49.35	39.17	44.02	52.14	49.65	52.92
Mean Beta						
x	38.89	19.16	22.10	44.44	28.05	32.51
sd	24.93	26.21	28.58	27.80	31.84	31.34
Subjective Pain Rating*						
x	.07	.22	-.41	.20	-.35	.28
sd	.90	.64	.81	.95	.68	1.12

* reported as z-scores; n=15 per cell

Pain patients were first compared as a general group to the control subjects on the pain measures. Because of unequal numbers in each group, the assumption of homogeneity of variance was assessed using the Box M test which revealed that the variances for the pain measures did not differ significantly between the groups. Threshold was then analysed in a 2 X 2 (group by sex) ANOVA which revealed no significant main effects or interactions (see Table 13). The SDT indices calculated using the mean pain threshold of normal control subjects as a cutoff were first analyzed with the subjective pain rating in a 2 X 2 MANOVA which yielded no signficant findings (see Table 12). Given the negative result, the mean d' and mean beta measures were used in place in order to control for lost power because of the high variability in the d' and beta measures. The results of this analysis also appear in Table 12. As can be seen, this MANOVA revealed no significant group or sex effects; however, a significant group by sex interaction was found when the more stable averaged measures of d' and beta were used.

Table 12. MANOVA Summary Table for Pain Measures With Pain Patients Pooled

Source	Wilks Lambda (S=1, M=1/2, N=41)	F	p
MANOVA Using d' and Beta Measures			
Group	.97	.79	.504
Sex	.94	1.65	.183
Group X Sex	.96	1.10	.358
MANOVA Using Mean d' and Beta Measures			
Group	.98	.60	.614
Sex	.93	2.09	.108
Group X Sex	.90	3.10	.031

Given the significant finding on the MANOVA when the averaged d' and beta measures are used, follow-up univariate analyses were conducted, as presented in Table 13. The analyses revealed that the group by sex interaction is represented by the mean criterion measure (beta). Examination of the means indicated that within the control group, men set higher criteria to report sensations as painful than women. However, within the patient group, men set lower criteria to report painful sensations than women.

Table 13. Univariate Analyses: Pain Measures With Pain Patients Pooled.

	Source					
	Group		Sex		Group X Sex	
Variable	F(1,86)	p	F(1,86)	p	F(1,86)	p
Mean d'	.41	.522	2.09	.152	2.31	.132
Mean Beta	.19	.667	.25	.621	6.76	.011
Subjective Pain Rating[a]	1.20	.275	4.03	.048	1.52	.222
Threshold[b]	2.42	.124	2.42	.124	.36	.550

(a) Calculated on z-scores
(b) Not included as a part of the MANOVA

The absence of a group effect for pain measures was hypothesized to reflect the heterogeneity observed in the pain patients' manner of pain presentation. Therefore, pain patients were divided into two equal groups on the basis of the presence or absence of medically incongruent signs and symptoms and the above analyses were repeated. Threshold for faint pain was first analysed in a 3 X 2 (group by sex) ANOVA. Again, no main effects or interactions were evident from these analyses which are presented in Table 15. Signal Detection indices (d' and beta calculated relative to the mean pain threshold of normal control subjects) were again analysed with the subjective pain rating using a 3 X 2 MANOVA (see Table 14). As can be seen, this analysis yielded no significant group effects or group by sex interactions. However, a

borderline significant finding was evident for sex differences. Again, in order to control for lost power due to the high variability in d' and beta, the analysis was repeated using the averaged d' and beta measures. These results also appear in Table 14 which again revealed no significant overall group differences on pain measures. However, the main effect for sex was stronger and significant in this analysis and, although not statistically significant according to conventional guidelines, there is a suggestion of a trend in the data with respect to an interaction effect. Because the pooled d' and beta measures are more stable and, therefore, have greater power, they were be used in subsequent analyses.

Table 14. MANOVA Summary Table for Pain Measures With Pain Patients Separated into Medically Congruent and Incongruent Groups

Source	Wilks Lambda	F	p
MANOVA Using d' and Beta Measures			
Group	.97	.42	.865
Sex	.91	2.63	.056
Group X Sex	.95	.75	.611
MANOVA Using Mean d' and Beta Measures			
Group	.95	.66	.679
Sex	.90	3.13	.030
Group X Sex	.89	1.83	.097

Univariate follow-up tests were examined given the significant sex effect in the MANOVA using the averaged SDT indices. The results of these analyses are presented in Table 15 and indicate a sex effect for the measures of d' (sensory sensitivity) and Subjective Pain Rating. Inspection of the

means of these variables showed that women were better able to distinguish the pain signal from the heat and also rated the stimuli as more intense and distressing than the men. As mentioned above, it is recognized that a significant overall group by sex interaction was not found; however, the trend found in the analysis is qualitatively similar to that which was found to be significant when the pain patients were pooled.

Table 15. Univariate Analyses: Pain Measures

	Source					
	Group		Sex		Group X Sex	
Variable	F(2,84)	p	F(1,84)	p	F(2,84)	p
Mean d'	1.14	.324	4.36	.040	1.98	.144
Mean Beta	.17	.840	.15	.696	4.10	.020
Subjective Pain Rating[a]	.63	.533	6.44	.013	.74	.479
Threshold[b]	1.62	.203	.16	.691	.22	.799

(a) Calculated on z-scores
(b) Not included as a part of the MANOVA

Relationships Among the Pain Measures.

Intercorrelations among these measures were evaluated with Pearson correlation coefficients which are presented in Table 16. In this table, the subjective pain rating from the Gracely Rating Scale is presented in its two components: sensory intensity and unpleasantness or affective distress. Of note, a moderate positive correlation was found between the

pain threshold and the pain report criterion but no significant association was found between pain threshold and discriminability. The relationship between the criterion and pain threshold suggests that pain threshold is primarily represented by a response bias to report sensations as painful.

Also found was a moderate correlation between d' (sensory discrimination) and beta (pain report criterion). This correlation is interpretted to mean that those subjects who set a higher criterion to report pain were also more consistent in their judgements. That is, those who set a high criterion to report pain had fewer false alarms relative to the hits in detecting pain. A low but significant negative correlation was found between the rating of sensory intensity and pain threshold suggesting that those with low pain thresholds also tended to report greater subjective intensity of pain. Finally, a low positive relationship was found between d' (sensory discrimination) and self-report of affective distress or unpleasantness caused by pain. This would suggest a slight tendency for those who are more sensitive to painful stimuli to also be more distressed by the pain.

Table 16. Correlation Matrix: Pain Measures

	Mean d'	Mean Beta	Threshold	Sensory Intensity	Affective Distress
Mean d'	----	----	----	----	----
Mean Beta	.50***	----	----	----	----
Threshold	.12	.52***	----	----	----
Sensory Intensity	.16	-.14	-.20*	----	----
Affective Distress	.18*	-.04	-.02	.58***	----

n=90; *<.05; ***<.001

Group Differences: Cognitive Measures.

The means and standard deviations of the five measures obtained from the Coping Strategy Questionnaire are presented in Table 17. The five measures are cognitive coping processes (i.e., active coping strategies such as reinterpretation of the pain and coping self-statements), strategies with specific cognitive content (i.e., passive coping strategies such as praying, hoping, and diverting attention), self-efficacy to control the pain, behavioural coping strategies, and catastrophizing cognitions. Higher scores reflect greater self-reported use of each component.

Table 17. Means and Standard Deviations for Cognitive Measures

	Group			
	Congruent Pain		Incongruent Pain	
Variable	Males	Females	Males	Females
Processes				
x	39.73	45.07	39.67	47.33
sd	12.34	14.80	15.30	16.95
Content				
x	17.00	23.07	21.47	29.87
sd	10.71	12.09	10.94	14.29
Efficacy				
x	4.93	6.53	4.80	5.40
sd	2.25	1.36	2.60	2.06
Behavioural Coping				
x	12.40	17.93	13.73	16.33
sd	6.81	6.69	5.40	5.27
Catastrophizing				
x	7.47	7.13	8.40	12.07
sd	5.76	7.62	5.65	9.11

n=15 per cell

These variables were entered into a 2 X 2 (pain group by sex) MANOVA (see Table 18). No significant main effects or interactions were revealed through these analyses. However, there is a trend in the data to suggest some sex differences.

Table 18. MANOVA Summary Table for Cognitive Measures

Source	Wilks Lambda	F	p
Group	.88	1.40	.241
Sex	.83	2.09	.081
Group X Sex	.95	.52	.761

It was decided to look at the univariate analyses with a view to examining the variables for the apparent trend

differentiating the sexes. Results of these analyses are presented in Table 19.

Table 19. Univariate Analyses: Cognitive Measures

	Source					
	Group		Sex		Group X Sex	
Variable	F(1,56)	p	F(1,56)	p	F(1,56)	p
Content	3.26	.077	5.37	.024	.14	.710
Process	.08	.777	2.84	.098	.09	.763
Efficacy	1.34	.251	4.05	.049	.84	.364
Catastro-phizing	2.50	.119	.81	.373	1.16	.285
Behaviour	.01	.933	6.70	.012	.87	.355

The apparent sex difference appears on the following variables: cognitive content, efficacy to manage the pain, and behavioural coping strategies. More women than men admitted to using coping strategies (such as distracting themselves by engaging in other behavioural or cognitive activities) and to be more self-efficacious to manage their pain. Because these differences were not found to be statistically significant on the multivariate tests, they will only be discussed in a qualitative way.

Relationships Among the Cognitive Measures.

Interrationships among the cognitive measures were assessed using Pearson Correlation coefficients which are presented in the form of a matrix in Table 20. Included in this matrix is an overall composite score called 'coping' which reflects the sum of all the subscales of the Coping Strategy Questionnaire.

Table 20. Correlation Matrix: Cognitive Measures

	Content	Process	Efficacy	Catastro-phizing	Behaviour	Coping
Content	----	----	----	----	----	----
Process	.61***	----	----	----	----	----
Efficacy	.18	.12	----	----	----	----
Catastro-phizing	.26*	.08	-.31**	----	----	----
Behaviour	.55***	.36**	.38***	-.01	----	----
Coping	.83***	.86***	.31**	.04	.89***	----

n=60; *p<.05; **p<.01; ***p<.001

High positive correlations were found between the overall 'coping' composite measure and the coping strategies representing specific cognitive content and processes in addition to behavioural strategies. This would suggest that the more weighted subscales on the questionnaire are those actually reflecting coping strategies for pain. Efficacy reflects how well the coping strategies are perceived to work and catastrophizing, in effect, reflects 'non-coping'.

Moderate to high positive correlations were found among the coping subscales including efficacy. A moderate to low negative correlation was found between catastrophizing and efficacy which suggests that the more a person catastrophizes about his/her pain, the less efficacious he/she feels in being able to manage the pain.

Group Differences: Affective Measures.

The means and standard deviations for the three measures of affect, the Trait Scale of the State-Trait Anxiety Inventory and the two subscales of the Pain Experience Scale (Worry and Emotionality) are presented in Table 21. The Trait Anxiety measure (STAI) was analysed in a 3 X 2 (group by sex) ANOVA. No significant main effects or interactions were revealed in these analyses. Because the Pain Experience Scale evaluates distress specific to chronic pain, it was not administered to the control group. Two-way ANOVAs were conducted on each measure. No significant main effects or interactions emerged on any of the variables.

Table 21. Means and Standard Deviations: Affective Measures

	Group					
	Control		Congruent Pain		Incongruent Pain	
Variable	Males	Females	Males	Females	Males	Females
Trait Anxiety						
x	36.07	33.47	34.80	35.47	35.73	36.53
sd	7.04	6.52	9.06	9.20	8.66	6.66
Worry						
x	---	---	2.37	3.01	3.28	3.10
sd	---	---	1.13	1.34	1.50	1.38
Emotionality						
x	---	---	2.03	2.78	2.49	3.03
sd	---	---	1.34	1.59	1.40	1.60

Note: Higher scores reflect higher levels of affect.
n=15 per cell

Relationships Among the Affective Measures.

Interrationships were again assessed using Pearson correlation coefficients which appear as a correlation matrix in Table 22. High positive correlations were found among all three measures.

Table 22. Correlation Matrix: Affective Measures

	STAI (n=90)	Pain Experience Scale (n=60)	
	Trait Anxiety	Worry	Emotionality
Trait Anxiety	----	----	----
Worry	.66***	----	----
Emotionality	.75***	.76***	----

***p<.001

Additional Correlational Analyses.

Relationships Among the Dependent Measures.

It was of interest to examine the relationships among the different dependent measures as well as between the dependent measures and the measures of severity and symptom presentation. Although this kind of analysis becomes more liberal with number of correlations calculated, the goal was to identify possible trends in the data for heuristic purposes.

Table 23 presents the Pearson correlation coefficients between the pain measures and the measures of cognitive coping and affect. Again, the subjective pain ratings, derived from the Gracely Rating Scales, are presented in their component scales: Sensory Intensity and Affective Distress. Of note, is the absence of significant correlations among these measures with the exception of a small positive relationship between pain threshold and cognitive content suggesting that those with higher pain thresholds also report using coping strategies with specific cognitive content. In addition, a low positive correlation between catastrophizing and reported sensory intensity of the pain stimuli was found suggesting a tendency for those who catastrophize about their pain condition to also report a higher sensory intensity of external pain stimuli.

Among the affective measures, again there is a notable absence of relationship with the pain measures with the exception of low positive correlations between the self-report

of sensory intensity and the subscales of the Pain Experience Scale. These relationships suggest a slight tendency for those who are more worried and emotional about their pain condition to also report higher sensory intensity ratings of external pain stimuli.

Table 23. Relationships Between Pain Measures and Cognitive and Affective Measures

	Pain Measures				
	Threshold	Mean d'	Mean Beta	Sensory Intensity	Affective Distress
Cognitive Measures					
Content	-.22*	.02	-.01	.17	-.08
Processes	-.14	-.10	-.10	-.01	-.12
Efficacy	-.11	-.02	-.18	-.18	-.17
Catastrophizing	-.12	.15	.02	.33**	.04
Behavioural Coping	-.04	.00	.04	-.09	-.15
Overall Coping	-.14	-.02	.02	-.01	-.12
Affective Measures					
Trait Anxiety	-.04	-.01	-.03	.13	.08
Worry	-.04	.12	.00	.28**	.10
Emotionality	.06	.14	.05	.31**	.18

$n=60$; *$p<.05$; **$p<.01$

Relationships between the cognitive and affective variables, as evaluated with Pearson correlation coefficients,

revealed moderate to high correlations between catastrophizing and all three affective measures. Catastrophizing correlated at .68 ($p<.001$) with both Worry and Emotionality and at .50 ($p<.001$) with the Trait Scale of the STAI. No significant relationships were found for any of the other cognitive variables and the affective measures. This supports a current view of the Coping Strategy Questionnaire that the Catastrophizing scale represents emotional factors and not a cognitive construct as such (Lawson et al., 1990).

Relationship Between Dependent Measures and Measures of Severity and Symptom Presentation.

The relationships between measures of severity (Physical Impairment Index and the Oswestry Disability Questionnaire) and symptom presentation and the dependent measures were evaluated using Pearson Correlation coefficients which appear in Table 24. The measures of severity were not at all associated with the pain variables. This was also true for the measures of symptom presentation with the exception of a small negative correlation between pain threshold and Non-organic Physical Signs. That is, the lower the pain threshold, the more non-organic physical signs were displayed.

Low to moderate positive correlations were found between the coping factor reflecting specific cognitive content and both measures of severity and symptom presentation. This factor consists of the subscales assessing praying/hoping and diverting attention to other mental activities. Of interest is a consistent positive association between the Pain Drawing

as scored by the Ransford et al. (1976) scoring method and measures of affect including the catastrophizing scale of the Coping Strategy Ouestionnaire. This would seem to indicate that this method of scoring the pain drawing reflects a strong affective component of chronic pain conditions. The other two measures of symptom presentation (Nonorganic Physical Signs and Inappropriate Symptoms) were unrelated to measures of affect. Finally, it is interesting to note a low to moderate level of positive association between objective physical impairment and worry specific to the pain condition itself but an apparent absence of association to subjective disability. Emotionality regarding the pain condition was, however, positively associated with subjective disability but not physical impairment.

Table 24. Correlations Among Measures of Severity and Symptom Presentation and Dependent Measures

Dependent Variable	Measures of Severity: Impairment[a]	Measures of Severity: Disability	Measures of Symptom Presentation: Pain Draw	Measures of Symptom Presentation: Non-organic Signs	Measures of Symptom Presentation: Inappropriate Symptoms
Pain Measures					
Threshold	-.12	.13	-.04	-.29*	-.16
Mean d'	-.14	.14	-.08	-.05	-.07
Mean Beta	-.20	.19	-.07	-.09	-.12
Sensory Intensity	.15	.20	.12	.22	.18
Affective Distress	.30	.14	.14	.12	.08
Cognitive Measures					
Content	.33*	.44***	.30*	.36**	.30*
Processes	.03	.22*	.29*	.28*	.01
Efficacy	.22	-.09	-.07	-.06	-.24*
Catastrophizing	.13	.25*	.33**	.27*	.24*
Behaviour	.24	.14	.12	.21	-.05
Coping	.17	.29*	.19	.30*	.04
Affective Measures					
Trait Anxiety	.15	.09	.32**	.00	.03
Worry	.35*	.18	.31**	.09	.17
Emotionality	.13	.30**	.30**	.11	.11

$n=60$; (a) $n=27$
*$p<.05$; **$p<.01$; ***$p<.001$

Post Hoc Analyses.

The classification scheme used in this study was based on the 'inclusionary' criteria used in a previous investigation which sought to identify pain patients for whom psychological factors played a larger role in their pain condition (Reesor & Craig, 1988). This system was successful in distinguishing two groups of pain patients designated as those with and without medically incongruent symptoms. The two groups in the earlier study were differentiated on psychological factors such as catastrophic cognitions regarding pain, low self-efficacy to control pain, and higher subjective ratings of pain intensity.

Because group differences were not found when the pain patients were differentiated on the basis of their symptom presentation in the present study, patients in this sample were reclassified on the basis of 'exclusionary' criteria. That is, patients diagnosed with no apparent organic pathology or whose complaints of physical discomfort were "out of proportion" to detectable pathology were selected (i.e., 'functional' patients). Nine males and nine females received such diagnoses which were arrived at through team conferences involving an orthopaedic surgeon, general practice physician, physiotherapist, and psychologist. Fifteen of the 18 'functional' patients identified received the primary diagnosis of "no clear organic cause". The remaining three were deemed to report discomfort and disability "out of proportion to the detectable pathology". Five of the females

and six of the males identified as 'functional' were also classified as displaying medically congruent signs and symptoms. The rest displayed medically incongruent signs and symptoms and thus, were not differentiated by the presence or absence of medically incongruent signs and symptoms.

These 'functional' patients were compared on all measures to a randomly selected control group and a pain group who had received organic diagnoses (i.e., 'organic' patients). Group differences were analysed using univariate analyses for all the variables. It is recognized that this does not represent a conservative examination of the data, however, the intention was to explore possible trends and to generate new research goals.

Continuous demographic data were analysed using two-way (3 X 2) ANOVAs and categorical data with Chi Square statistics. No significant main effects or interactions emerged on any of these variables which included age, socioeconomic status, and ethnicity. Marital status, however, again emerged as a group difference [$X^2(2)=9.45$, $p<.01$] reflecting that the normal control group were mostly single.

Patient characteristics (duration of condition, medication strength, physical impairment, and subjective disability) were analysed similarly with two-way ANOVAs for continuous variables and nonparametric statistics for the categorical variable (presence of previous surgery). No group or sex differences arose on any of these analyses, however, a group by sex interaction was found for the reported duration

of the pain conditions [$F(1,32)=4.37$, $p<.05$). Examination of the means revealed that women in the group without organic diagnoses reported longer durations of having the pain problem than the men. Within the group of patients who had received organic diagnoses, men reported longer durations of their pain problem than the women. Of note, there were no differences with respect to the levels of subjective disability or objective physical impairment. Means and standard deviations of the above patient characteristics are presented in Table 25.

Table 25. Patient Characteristics: Means and Standard Deviations

	Diagnostic Groups			
	Functional		Organic	
Variable	Males	Females	Males	Females
Duration (years)				
x	4.70	14.07	14.56	8.95
sd	3.28	14.52	9.02	12.23
Medication Strength				
x	.44	.33	1.22	.67
sd	.73	.71	1.39	.87
Subjective Disability				
x	26.56	36.00	30.00	37.67
sd	17.73	15.94	12.00	7.94
Physical Impairment[a]				
x	16.25	13.00	15.50	12.00
sd	4.65	7.80	5.45	12.73

$n=9$ per cell; (a) unequal n

Table 26. Pain Measures: Means and Univariate Analyses by Diagnostic Groups

	Group						Source					
	Control		Functional		Organic		Group		Sex		Group X Sex	
Variable	Males	Females	Males	Females	Males	Females	F(2,48)	p	F(1,48)	p	F(2,48)	p
Threshold (mcal/sex/cm^2)												
x	262.68	261.94	248.77	244.80	277.60	297.00	5.68	.006	.22	.623	.54	.584
sd	29.00	42.43	25.60	31.33	52.88	29.54						
d'												
x	2.38	2.49	2.26	2.40	2.09	2.84	.20	.820	3.57	.065	1.41	.255
sd	.65	.69	.78	.64	.44	.70						
Beta												
x	40.43	20.38	9.74	19.36	24.02	49.43	3.43	.040	.49	.486	3.50	.038
sd	29.00	42.43	25.60	31.33	52.88	29.54						
Subjective Pain Rating												
x	-.17	.09	-.31	-.04	-.35	.48	.35	.708	3.68	.061	.64	.538
sd	.78	.71	.74	.71	.99	1.19						

n=9 per cell
(a) presented as z-scores

Group Differences: Pain Measures

The results of the univariate analyses on the pain measures are presented in Table 26. A significant group difference was found for pain threshold [$F(2,48)=5.68$, $p<.01$)] and for the mean pain report criterion (beta) [$F(2,48)=3.43$, $p<.05$]. The Newman-Keuls Multiple Comparison procedure (two-tailed) was used to identify where the differences existed. The mean pain threshold for the 'organic' group was significantly greater than both the 'functional' and normal control groups ($p<.05$). The mean pain threshold for the 'functional' group was lower than the normal control group, however, the difference was not significant. The 'organic' group set a significantly higher mean criterion to report pain than the 'functional' group. Although the normal control group had a mean criterion level inbetween the two patient groups, the differences were not significant.

There were no statistically significant sex differences, however, a possible trend existed on d' (sensory discrimination) with females being slightly better able to distinguish heat from faint pain. An additional trend differentiating the sexes appeared on the subjective ratings of the pain stimuli with females rating the stimuli as slightly more intense and distressing than the males. A significant group by sex interaction appeared with the pain report criterion (beta) suggesting, as in the first set of analyses, that although men without chronic pain tend to be less likely to report painful sensations than women, men with

Table 27. Cognitive Measures: Means and Univariate Analyses by Diagnostic Group

	Patient Group				Source					
	Functional		Organic		Group		Sex		Group X Sex	
Variable	Males	Females	Males	Females	F(1,22)	p	F(1,22)	p	F(1,22)	p
Content										
x	20.22	30.89	16.89	24.00	1.85	.183	5.60	.024	.22	.639
sd	11.64	12.44	9.35	11.40						
Process										
x	41.11	54.56	39.33	45.78	1.48	.233	5.26	.029	.65	.426
sd	16.19	14.29	8.57	11.71						
Efficacy										
x	6.33	6.22	4.33	6.22	1.83	.185	1.45	.238	1.83	.185
sd	2.29	2.54	2.45	1.39						
Catastro-phizing										
x	8.33	8.67	7.33	9.22	.01	.933	.18	.673	.09	.768
sd	7.62	8.23	4.61	9.34						
Behaviour										
x	11.89	18.67	12.44	13.56	1.38	.249	4.14	.050	2.13	.154
sd	2.47	5.07	8.03	6.25						

n=9 per cell

chronic pain are more likely than women to report painful sensations. No interactions were evident on any of the other variables.

Group Differences: Cognitive Measures

Means and results of the univariate analyses for the Coping Strategy Questionnaire appear in Table 27. No group differences or group by sex interactions appeared on any of the measures. A significant sex difference emerged on the self-reported use of coping strategies with specific cognitive content, styles of cognitive coping strategies, and the use of behavioural strategies. Examination of the means revealed that on all three measures women reported using the coping strategies more than men.

Group Differences: Affective Measures

Means and univariate analyses for the affective measures are presented in Table 28. No significant main effects or group by sex interactions were evident on any of the three measures. However, a possible trend differentiating the sexes appeared on emotionality with women slightly more inclined to report higher levels of emotionality regarding their chronic pain problem.

Group Differences: Measures of Medically Incongruent Symptoms

It was of interest to see if the three measures of medically incongruent symptoms distinguished patients without organic diagnoses from those with organic diagnoses. No main effects or interactions appeared on any of the three measures

Table 28. Affective Measures: Means and Univariate Analyses by Diagnostic Group

	Group						Source					
	Control		Functional		Organic		Group		Sex		Group X Sex	
Variable	Males	Females	Males	Females	Males	Females	F(1,22)	p	F(1,22)	p	F(1,22)	p
Trait Anxiety[a]												
x	35.89	31.89	33.33	36.22	39.56	37.33	1.75	.184	.28	.600	.96	.390
sd	7.86	5.35	6.12	9.44	10.04	6.44						
Worry												
x			2.63	2.78	3.27	3.10	1.10	.302	.00	.980	.12	.732
sd			1.31	1.80	.74	1.40						
Emotionality												
x			1.73	2.80	2.58	3.24	2.03	.164	3.64	.065	.21	.646
sd			1.12	1.68	1.26	1.28						

(a) F calulated with (2,48) degrees of freedom for group and (1,48) for sex
n=9 per cell

Table 28. Measures of Medically Incongruent Symptoms: Means and Univariate Analyses by Diagnostic Group

	Patient Group				Source					
	Functional		Organic		Group		Sex		Group X Sex	
Variable	Males	Females	Males	Females	F(1,32)	p	F(1,32)	p	F(1,32)	p
Pain Drawing										
x	2.67	3.38	1.00	5.20	.12	.735	1.86	.182	.46	.500
sd	3.27	3.25	1.16	4.38						
Non-organic Physical Signs										
x	.67	.88	.14	.40	1.43	.245	.31	.586	.00	.954
sd	1.03	1.46	.38	.89						
Inappropriate Symptoms										
x	2.00	2.25	1.86	3.20	.04	.836	1.08	.306	.39	.537
sd	1.79	1.67	1.68	1.64						

n=9 per cell

suggesting that they are indeed assessing different constructs of a chronic pain problem (see Table 29). Given the very small n and obvious lack of power, the only possible exception may be the Nonorganic Physical Signs which seems to indicate a possible trend. Examination of the means shows that the group without clear organic diagnoses tend to exhibit more nonorganic physical signs.

Summary of Findings

The results of this study may be summarized as follows:

1) There were no differences between chronic pain groups and the normal control group on the demographic variables (age, socioeconomic status, ethnicity, and employment status) except for marital status. The normal control group consisted largely of single people whereas the patient groups were mostly married or involved in common-law relationships.

2) The comparison of pain-free individuals with the pain patients pooled as a general group revealed no significant group effects for the pain measures.

3) The distinction of pain patients into those with and without medically incongruent symptoms yielded significant group differences only on a measure of subjective disability. Those patients who exhibited medically incongruent symptoms also reported greater subjective disability than the patients who did not exhibit incongruent symptoms. There were no significant group differences on measures of pain perception, coping strategies, or affective distress. The groups also did not differ on a measure of objective physical impairment nor did the classification system distinguish between 'organic' and 'functional' diagnostic groups.

4) The distinction of pain patients according to 'organic' vs 'functional' diagnostic groups yielded significant group differences on measures of pain threshold and pain report criterion (beta). Patients with 'organic' diagnoses had higher pain thresholds and higher pain report

criteria than both the control group and the 'functional' patient group, which had lower pain thresholds and criteria to report pain than the control group. The criterion to report pain differed significantly between the two patient groups only, however. There were no group differences on disability, objective physical impairment, the presence of medically incongruent symptoms, self-reported use of coping strategies or on measures of anxiety. Finally, there was a significant group by sex interaction for the reported duration of the pain conditions. Women without clear organic diagnoses reported longer durations of their pain conditions than men, whereas men with 'organic' diagnoses reported longer durations of chronic pain than women.

5) Significant sex differences were found for self-reported subjective disability with women reporting greater loss of function than men. Gender differences were also evident for the measures of d' and subjective rating of pain. That is, women were more consistent in distinguishing heat from the first trace of pain and judged the stimuli to be more intense and unpleasant than men. Additionally, there was a trend for women to admit to using cognitive coping strategies, where cognitions are diverted to other mental activities, and behavioural coping strategies more often than men. Women reported greater efficacy to manage their pain (i.e., decrease or control the pain) than men. Finally, a significant group by sex interaction was found for the measure of pain report criterion when the pain patients were pooled into one group.

Within the normal control group, women set lower pain report criteria than men but within the chronic pain groups, women set higher pain report criteria than men.

6) The three measures of medically incongruent symptom presentation were unrelated to measures of pain perception but did show some association to the cognitive and affective variables. All three were positively associated with catastrophizing and with the use of coping strategies reflecting specific cognitive content such as praying, hoping, and, generally diverting attention to other mental events. The Pain Drawing and Non-organic Physical Signs were positively associated in a small way with coping strategies reflecting the conscious use of coping styles such as ignoring and reinterpreting the pain sensations and using coping self statements. The Inappropriate Symptom Inventory formed a small negative association with a measure of the patient's perception of his/her efficacy to manage (i.e., control and decrease) the pain. Of note, only the Pain Drawing was positively associated with all three measures of affect (general anxiety, and worry and emotionality specific to chronic pain).

7) The measures of severity of the pain condition (Physical Impairment Index and Oswestry Disability Questionnaire) were unrelated to measures of pain perception. However, a positive association was found for both measures with the use of coping strategies of specific mental content (praying, hoping, and distraction to other matters). There

was a small positive association between subjective disability and catastrophizing and the use of conscious cognitive coping styles. Finally, objective physical impairment was positively associated to worry specific to chronic pain (e.g., "I worry about my family") and subjective disability was positively related to emotionality about the pain (e.g., "I think, 'This pain is driving me crazy'").

8) The measures of pain perception were mostly unrelated to cognitive and affective variables with the exception of a small negative relationship between pain threshold and the use of coping tactics of diverting attention to other mental content. That is, those with lower thresholds reported greater use of praying, hoping, and attempts to concentrate on other matters. Additionally, those who were inclined to catastrophize about their pain also reported greater subjective experiences of the sensory intensity of the pain stimuli. Worry and emotionality about the pain were also associated with higher ratings of the sensory intensity of pain, although to a lesser degree. Finally, catastrophizing formed a strong positive association with all three measures of affect (general anxiety, worry, and emotionality).

DISCUSSION

Pain Perception in Chronic Pain Patients

The results of the present investigation confirm the expectation that chronic pain patients, as a heterogeneous sample in terms of their clinical presentation, do not have altered pain perception. There were no differences between pain-free individuals and the entire sample of chronic pain patients on measures of pain threshold, discriminability (sensory sensitivity), bias to report sensations as painful, or the subjective ratings of pain intensity and unpleasantness. As noted, the sample of pain patients was mixed in terms of the patients' patterns of pain presentation and diagnostic groups. Past investigations which did report altered pain perception in chronic pain patients have selected pain patients from relatively homogeneous samples. For example, some investigators selected patients with clear organic diagnoses (Cohen et al., 1983; Lipman et al., 1987; Naliboff et al., 1981; and Yang et al., 1983; 1985) and others selected patients with less clear physical pathology and whose pain conditions have been found to be highly associated with stress and anxiety (Brands & Schmidt, 1987; Malow et al., 1980; Malow & Olson, 1981; Peters et al., 1989; Scudds et al., 1987; 1989).

Because of literature suggesting that cognitive appraisal and emotional reactions (i.e., helplessness, catastrophizing, and anxiety) to chronic pain contribute more to the variance in pain perception and disability than does the degree of

apparent physical pathology, it was expected that the distinction of patients into two groups on the basis of the presentation of medically incongruent signs and symptoms would yield results similar to the two groups of investigations referred to above (Barnes et al., 1989; Flor & Turk, 1987; Lacroix et al., 1990; Lee et al., 1989; Main & Waddell, 1984; Polatin et al., 1989; Turk & Rudy, 1987; and Waddell, 1987). Patients exhibiting medically incongruent signs and symptoms were expected to be hypervigilant for painful sensations and therefore, to be more responsive to painful stimuli (i.e., have lower pain thresholds and lower criteria to label sensations as painful). Those patients who did not exhibit signs and symptoms incongruent with underlying anatomy and physiology were expected to be less responsive to painful stimuli (i.e., have higher pain thresholds and higher criteria to label sensations as painful) in accordance with the predictions of the adaptation-level model.

However, the distinction of pain patients into those with and without medically incongruent symptoms did not differentiate the groups on measures of pain perception as hypothesized. Rather, the distinction of pain patients into groups based on the presence or absence of a diagnosable organic cause differentiated the patients in their responses to painful stimuli. Patients with clear organic findings had significantly higher pain thresholds than both the control group and the patients without apparent organic etiology. The responses of the 'organic' patients conformed to the

prediction of the adaptation-level model. In contrast, pain patients with no clear physical pathology ('functional' patients) were found to have significantly lower pain thresholds relative to the 'organic' patient group (i.e., those with organic diagnoses). In addition, the 'functional' patients had lower pain thresholds than the normal control group, but this difference was not statistically significant. Because the responses of these patients were not significantly different from the normal control sample, the prediction of the hypervigilance model was not supported.

Signal detection analysis of the data indicated that the 'organic' patients set significantly higher response criteria (i.e., were less inclined) to report sensations as painful than the 'functional' patients. The mean response criterion for the normal control group was between the two patient groups; however, the criterion to report pain differed significantly between the two patients groups only. No differences were found for the discriminability measure which indicates that the groups did not differ in their sensory sensitivity to the stimuli.

Correlational analyses revealed a high positive correlation between the pain threshold and response bias to report pain but no relationship to discriminability. The finding that the threshold measure is largely reflected by the propensity to report pain rather than sensory sensitivity is supported by previous investigations (Clark & Mehl, 1971; Clark & Yang, 1983; Yang et al., 1985). This result has been

interpreted as support for the SDT supposition that d' and beta represent independent parameters (Yang et al, 1985).

The link between 'organicity' and pain report has been found in previous investigations. Relative to people without chronic pain, higher pain threshold and tolerance levels have been consistently found in chronic pain patients with obvious organic pathology (Cohen et al., 1983; Lipman et al., 1987; Naliboff et al., 1981; and Yang et al., 1983; 1985). In contrast, other investigations have reported pain patients with less clear organic pathology to have lower pain thresholds and tolerance levels. Although the 'functional' patient group had lower pain thresholds than the normal control sample in the present study, the difference was not significant. This lack of significant finding may be attributable to the type of stimulus used in the present investigation. Previous research providing support for the hypervigilance model not only assessed chronic pain patients without clear organic pathology, but also used tonic pain stimuli. Because of the similarity of the experience of pain produced by tonic pain induction techniques to chronic pain conditions, they may be more likely to heighten anxiety and vigilance for those sensations. Given the consistency in the pattern of results to previous research, it seems likely that patients without a clear organic diagnosis may be more vulnerable to any pain stimuli but particularly to tonic pain stimuli.

Signal Detection investigations of pain perception in chronic pain patients are generally consistent with the present study in the finding that patients with clear organic dysfunction have a higher pain report criterion than normal control subjects, and that patients with less obvious physical pathology tend to have a lower pain report criterion than people without chronic pain (Cohen et al., 1983; Malow et al., 1980; Malow & Olson, 1981; Naliboff et al., 1981; and Yang et al., 1983; 1985). The results of the present study revealed that the differences in pain threshold were primarily associated with differences in the response bias to report sensations as painful. However, the results of the present investigation differ from past SDT studies on chronic pain populations with respect to the discriminability of the pain stimuli. All of the previous SDT studies found significant differences between chronic pain patients and people without chronic pain on the measure of discriminability, with chronic pain patients being less able to discriminate between stimuli (Cohen et al., 1983; Malow et al., 1980; Malow & Olson, 1981; Naliboff et al., 1981; Yang et al., 1983; 1985). In contrast, significant differences were not found on the discriminability measure in the present investigation.

The discrepancy in findings concerning the d' measure between this research and past investigations may be due to a number of factors. First, the present investigation exerted greater control over medication than was done in previous research. There is good reason to believe that a lack of

control over medication could bias findings. Yang et al., (1979) found that the administration of morphine resulted in an increase in pain threshold and response bias and a decrease in discriminability of radiant heat stimuli. Valium was found to result in increased response criterion to report sensations as painful only and a placebo control did not result in significant alterations in pain responsiveness over time. Most of the SDT studies investigating pain perception in chronic pain patients did not mention the use of medication by their pain population and it cannot be assumed that the patients were not taking any medication for their pain at the time of testing (Cohen et al., 1983; Malow et al., 1980; Naliboff et al., 1981).

Yang et al., (1985) reported that the pain patients they tested were requested not to take any pain medication on the day of testing and they estimated that all patients were medication-free for at least eight hours. The minimum amount of time lapsing in the present investigation for medication intake was nine hours; however, the majority of the patients tested in the present investigation were not taking any regular medication at all and thus, may represent a 'cleaner' sample. This could be an artifact of the selection criteria (i.e., because patients were requested to not take their medication from midnight the night before testing, patients who did not take medication anyway were more likely to volunteer). Therefore, the possible existence of analgesic medication in the pain populations of past SDT studies may

have contributed to their poorer discriminability of painful stimuli in contrast to the results of this study.

A second factor that may have contributed to differences in results in the d' measure also concerns the selection criteria for subjects. Because a relationship between age and discriminability has been reported in past research (Clark & Mehl, 1971), subjects were selected for the present study who were between the ages of 30 and 60 years and the groups were matched for age. In fact, a small but significant negative correlation was found between age and d' in the present study ($r=-.25$, $p<.01$, $n=90$) suggesting that older subjects showed poorer discriminability of the stimuli. Malow et al. (1980) tested chronic pain patients whose mean age was 28 years (s.d.=9.1) and compared their responses to the control group whose mean age was 19 years (s.d.=1.2). Chronic pain patients tested in the Yang et al. (1985) study ranged in age from 26 to 70 years whereas the control subjects ranged in age from 18 to 65 years. Other investigations did not report the ages of their subjects (Naliboff et al., 1981; Malow et al., 1980). The tendency for past investigations to have tested an older patient group and compared their responses to a younger control group may have contributed to the differences found in discriminability. Control over age differences and medication intake may account for the lack of significant findings in the current study for the measure of discriminability.

The SDT methodology used in the present study is notable for the use of a control sample in the definition of hits and

false alarms. The "floating" or individual baseline used by other researchers has compromised the interpretation of the signal detection measures in past SDT investigations. The current paradigm avoids this problem since all of the subjects were given the same stimulus levels and all of the d's and betas were calculated relative to the same cutoff points. This is a characteristic not found in previous SDT studies of pain perception and allows for the unambiguous interpretation of group differences in d' and beta. Thus, the current finding of no group differences in the d' measure is likely a more valid representation of the sensory sensitivity of chronic pain patients to radiant heat stimuli relative to the normal control group than that reported in previous research.

In summary, the results of the present investigation provide support for the adaptation-level model of pain perception in chronic pain patients, but only for a subgroup of pain patients. The distinction of patients by assessing 'inclusionary' criteria (i.e., identifying the presence of medically incongruent signs and symptoms) did not result in group differences in pain perception as hypothesized, however. Rather, the use of 'exclusionary' criteria (i.e., absence of clear pathophysiological causes for the pain condition) resulted in the distinction of pain patients in terms of their responses to painful stimuli. The adaptation-level model was hypothesized to be represented by a higher pain threshold and a higher criterion to report sensations as painful in comparison to pain-free people. This prediction was met by

patients with a clear organic basis for their condition. The hypervigilance model was hypothesized to be reflected by a low pain threshold and a lower criterion to report sensations as painful relative to pain-free individuals. Although the pattern of results is consistent with this prediction between patients without clear organic diagnoses and the normal control sample, the differences were not statistically significant. The implications of these findings and a discussion of the significance of the evaluation of medically incongruent symptomatology will be addressed below.

Medically Incongruent Symptom Presentation, Disability, and Psychological Distress

The classification of pain patients into those with and without medically incongruent signs resulted in significant group differences on their subjective report of disability only. This result is similar to that reported by Reesor & Craig (1988). They also reported clear group differences on a measure of objective structural limitations or physical impairment. The finding of no group differences on objective physical impairment in this study may be due to the significant percentage of missing data (i.e., 54%). In addition, Reesor & Craig found significant group differences on cognitive measures after partially out the variance due to objective physical impairment. Patients with a medically incongruent pain presentation were found to engage in more maladaptive cognitions (i.e., catastrophizing), ineffective

coping strategies (e.g., praying and hoping), and to report a lower sense of self-efficacy to control the pain relative to patients who did not display incongruent symptoms (Reesor & Craig, 1988). Although statistical significance was not reached in the present study on measures of coping and pain-related cognitions, the direction of group differences was consistent with Reesor & Craig. Patients with medically incongruent symptoms tended to catastrophize more about the pain, reported less efficacy to control the pain, and were more inclined to use passive coping strategies (i.e., praying and hoping).

The lack of significant findings on cognitive measures in the present study may be attributable to the smaller number of subjects tested per group. Reesor & Craig assessed forty pain patients in each group in contrast to the thirty tested in the present study. However, a power analysis based on their findings revealed that enough power should have been achieved with thirty subjects in each group (power estimated at .94). Other possible reasons for the lack of significant group differences may be that slightly different pain populations were assessed. No compensation/litigation patients were assessed in the present study and many patients who volunteered were not taking regular medication for their pain problem, unlike Reesor & Craig's sample. This may have resulted in the selection of a sample of patients who were more self-reliant on effective coping strategies and thus, were less likely to catastrophize or to depend on passive

coping strategies like praying and hoping.

The finding that the measures of incongruent pain primarily distinguished patients on self-perceived disability is supported by past research. Measures of incongruent pain presentation (nonorganic physical signs, inappropriate symptoms, and the pain drawing) have been found to be mostly predictive of the patients' report of disability and to a lesser degree, physical impairment (Main & Waddell, 1984; Waddell et al., 1989). A small and marginally statistically insignificant correlation was found between disability and physical impairment in the present investigation (r=.27, p=.08, n=27). The same degree of association was reported by Main & Waddell (1984); however, with their sample of 200 patients, the result was found to be significant.

The relationship between the degree of physical impairment and measures of medically incongruent pain presentation is not clear in past research. Although Reesor found low but significant correlations between physical impairment and both the self report of inappropriate symptoms and the pain drawing, the results of the present study revealed only a low correlation between impairment and the self report of inappropriate symptoms. Further, physical impairment was found to have a low correlation with passive styles of cognitive coping strategies and to 'worry' about the pain condition but was not significantly associated with any of the other cognitive or affective variables in the present study. Waddell & Main (1984) found that "most of the

psychometric variables correlate significantly with inappropriate signs, inappropriate symptoms, and disability, but hardly at all with the degree of physical impairment." (p. 32). Additionally they did not find a significant association between the pain drawing and physical impairment, unlike Reesor & Craig (1988). Using the same data from Waddell & Main's (1984) study, however, Waddell et al. (1989) divided patients into two groups on the basis of the sum of inappropriate signs and symptoms. Patients who had less than two inappropriate signs and symptoms were found to be less physically impaired than patients who had more than five inappropriate signs and symptoms. Thus, the relationship between objective structural limitations and medically incongruent signs and symptoms is not entirely clear. Because there may be a systematic relationship, however, it should be assessed with a view to covarying it out of the analyses of psychological factors if appropriate.

Physical impairment and subjective disability appear to assess different aspects of a chronic pain condition. In the present study, physical impairment was primarily associated with worry about the pain which reflects long term concerns (e.g., "I worry about my family"; "I wonder how long this will last"). In contrast, disability was associated with catastrophizing cognitions and heightened emotionality (i.e., feelings of frustration, depression, anger, anxiety, and self-pity). Other investigators have reported a link between self-report of disability and depression (manifested mainly as

frustration and anger), increased somatic vigilance, abnormal pain drawings, mistrust of health care professionals, naive schemas regarding pain, increased medication use, and continuous pain reports of high intensity (Barnes et al., 1989; Leavitt, 1990; Lee et al., 1989; Greenough & Fraser, 1989; Polatin et al., 1989; Gallon, 1989; Lacroix et al., 1990; Bigos et al., 1991).

Waddell et al., (1989) consider medically incongruent signs and symptoms (or magnified illness behaviour) to be a form of communication between the patient and the physician. They are essentially a more emphatic expression of the level of disease severity which is a reflection of the patients' distress about the problem. Measures of magnified illness behaviour are said to be primarily associated to disability and secondarily to psychological distress (Waddell et al., 1989). This was supported by the present study as, although the assessment of medically incongruent symptoms primarily distinguished patients' on self perceived disability, each separate measure (i.e., the pain drawing, nonorganic physical signs, and inappropriate symptoms) was also found to be associated with measures of psychological distress. The pain drawing was found to have a consistent association to affective distress (trait anxiety, worry and emotionality about the pain, and catastrophic cognitions) in the present study. This result supports the findings of previous investigations which report a relationship between abnormal pain drawings and the hysteria and hypochondriasis scales of

the MMPI (Dzioba & Doxey, 1984; Murphy & Cornish, 1984; Ransford et al., 1976; and Taylor et al., 1984). In addition, the pain drawing has been found to be predictive of a poor response to treatment (Polatin et al., 1989; Uden et al., 1988).

The nonorganic physical signs were found to reflect the use of various coping strategies (praying, hoping, diverting attention, reinterpreting pain sensations, coping self-statements, and ignoring the pain), but also to a tendency to catastrophize about the pain. Lacroix et al. (1990) reported that the nonorganic physical signs were related to lower education and naive schemas regarding pain and they suggested that the physical signs may reflect the behavioural consequences of poor understanding of their condition. Main & Waddell (1984) reported that the nonorganic physical signs and inappropriate symptoms were related to depressed mood and heightened somatic awareness. Inappropriate symptoms were associated with passive coping strategies (i.e., praying, hoping, and diverting attention), a low sense of efficacy to control pain, and catastrophic cognitions in the present study. Thus, it is reasonable to consider measures of incongruent pain presentation as assessments of the patient's perception and expression of disability which is reflective of his/her concern and distress about the problem.

The patient groups identified as 'organic' and 'functional' in the present study were not distinguished on the measures of incongruent pain presentation or on any of the

cognitive or affective measures. This finding is similar to that reported in previous research (Flor & Turk, 1987; Leavitt & Garron, 1979). Waddell et al. (1980) found no significant correlation between the presence of nonorganic signs and clear organic etiology although the nonorganic signs were less common in cases with obvious pathophysiolology. Doxey et al. (1988) reported that patients with unclear physical pathology may not necessarily present with more psychological distress but that psychological distress, if present, may play an important role in the maintenance of disability in that group.

The correlational nature of this study prevents causal interpretations of the data, however, relationships among variables lead to speculations as to the nature of those relationships. The findings of this study in conjunction with past research suggests that the presence or absence of a clear organic diagnosis may result in alterations in how pain is perceived and reported. In contrast, the presentation of medically incongruent signs and symptoms (which appear to be independent of the physical status of the patient) are reflections of the patients concern and distress regarding his/her pain and disability. The hypervigilance model refers to an alteration in pain perception due to a shift in attention to signs of somatic distress (Chapman, 1986). The absence of a clear organic diagnosis may be more likely to lead to increased somatic vigilance, particularly if the patient has a naive schema about the pain (i.e., that it is either physical or psychological) and is determined to find

physical pathology. Psychological factors (i.e., anxiety, depression, poor coping skills etc.) may not necessarily result in increased somatic vigilance since they may be related to how the pain and disability are affecting the individual's daily life rather than establishing the specific cause of the pain. In the absence of increased somatic vigilance, judgements of pain appear to be based on the principles of the adaptation-level model.

The role of cognition and emotion in the experience of pain.

It is of interest that essentially no relationship between measures of pain related cognitions and the SDT measures of pain perception was found. That is, it appears that pain related cognitions and anxiety are unrelated to the response bias to report pain or to discriminability (i.e., sensitivity to painful stimuli). It should be noted, however, that the measures of pain related cognitions and anxiety were relevant to the patient's clinical condition and may simply not be related to a task involving laboratory induced pain. As well, the measure of pain used here concerned pain threshold rather than the supra-threshold levels of pain the patients must manage.

More interesting is the presence of an association between measures of pain related worry, emotionality, and catastrophizing and the subjective ratings of the sensory intensity of pain. Those patients who reported higher levels

of affective distress about their pain condition also rated the painful stimuli as subjectively more intense. This finding is similar to that reported in the past where catastrophic cognitions and perceived helplessness to control pain have been associated with higher ratings of sensory intensity of pain, increased functional disability, increased pain report, and decreased pain tolerance (Bandura, 1987; Flor & Turk, 1987; Halsam, 1966; Hill et al., 1952; Keefe et al., 1989; Lepanto et al., 1965; Mendler & Watson, 1966; Reesor & Craig, 1988; Spinhoven et al., 1989; Szpiler & Epstein, 1976). It appears, therefore, that while cognitive and affective factors are associated with the subjective experience of pain, they are not necessarily associated with general pain sensitivity or the response bias to report pain. This may account for the findings that cognitive-behavioural programs for pain management result in improved mood, increased coping, decreased medication use, and less functional disability despite no clear improvement in pain itself (Skinner et al., 1990).

Gender Differences in the Experience and Expression of Pain

The results of the present study showed no overall gender differences for pain threshold or the criterion to report pain. However, within the chronic pain group, women were better able to discriminate between heat and faint pain than men suggesting that they were more sensitive to the stimuli. In addition, women generally rated the pain stimuli as more

intense and unpleasant than men. Finally, of interest in the present study, is the significant group by sex interaction for the inclination to report painful sensations. Within the normal control group, men were less inclined to report painful sensations than women but within the chronic pain groups, men were more inclined to report painful sensations than women. None of the previous SDT investigations of chronic pain populations have evaluated sex differences.

Research evaluating sex differences in pain perception in the past has been inconsistent, with some investigators reporting no gender differences for pain threshold and tolerance levels (Clark & Mehl, 1971; Clausen & King, 1950; Hardy, Wolff, & Goodell, 1952; Notermans & Tophooff, 1967; and Sherman & Robillard, 1967) and others reporting women to have lower pain thresholds and tolerance levels than men (Brennem et al., 1989; Hall & Stride, 1954; Rollman, & Harris, 1987; Stevens, 1967). Archer (1976) reported that females were found to have lower thresholds for many sensory modalities including touch, pain, hearing, taste, smell, and rod vision. Rollman & Harris (1987) noted that although there are some inconsistencies in the research on gender differences in pain perception, most of the data indicates a sex difference in the direction of females having lower thresholds and tolerance levels than men for heat, electric shock, and mechanical pressure pain. Additionally, they found that females rated electric shock as subjectively more painful than males. Rollman & Harris (1987), however, indicated that it remains

unclear to what extent sensory and nonsensory factors contribute to the reported sex differences in pain perception. The results of the present investigation suggest that the relationship between gender, chronic pain, and pain perception is complex and more research is needed to clarify the results.

Significant gender differences were found in this study for the self report of disability, with women reporting more functional disability than men. That women tend to be more outspoken about their discomfort and disability has been supported by other research (Lee et al., 1989). The greater tendency toward self disclosure in women may account for the observed trends differentiating gender for the reported use of coping strategies. Women were found to report using passive cognitive coping strategies (i.e., praying, hoping, and diverting attention to other matters) and behavioural coping strategies more often than men. In addition, women reported a greater sense of self-efficacy to manage the pain than men. There was no apparent trend for sex differences in the tendency to catastrophize. Because these findings are trends only, little credence may be given them. However, they are suggestive of overall sex differences in the expression and experience of pain and disability.

Summary and Conclusions

The purpose of this investigation was to evaluate the supposition that pain perception is altered in chronic pain patients. Two models were presented which yield opposing predictions regarding how the perception of pain is altered. The hypervigilance model led to the prediction that chronic pain patients would have lower pain thresholds and would be more likely to report signs of somatic distress than pain-free individuals because of increased somatic vigilance (Chapman, 1986). The adaptation-level lodel, in contrast, led to the prediction that chronic pain patients would have higher pain thresholds and would be less likely to label somatic sensations as painful than pain-free individuals. This is because, relative to their internal discomfort, additional painful stimuli would be judged as innocuous (Rollman, 1979). Both models had received support in past research but because of methodological inconsistencies, it was unclear under which conditions pain patients would be over- or underresponsive to painful stimuli. The present study was designed to examine under what circumstances the predictions of each model are met.

The results of this investigation revealed that patients with clear physical pathology had higher pain thresholds than pain-free individuals which was primarily represented by a higher criterion by which to report sensations as painful. The responses of these patients conformed to the prediction of the adaptation-level model. Patients with unclear physical

pathology, however, were found to have significantly lower pain thresholds and were more inclined to label sensations as painful relative to 'organic' pain patients but were not significantly different in their responses to the normal control sample. Thus, the prediction of the hypervigilance model was not supported in this study. It should be noted, however, that this finding may be partially dependent upon the type of pain stimulus used in this study (i.e., a phasic pain stimulus).

The findings of this study differentiated pain patients in their responses to painful stimuli suggesting that pain perception may be altered in chronic pain patients. However, rather than a change in sensitivity to painful stimuli, differences in pain threshold were found to be primarily reflective of the response bias to report sensations as painful. It is possible that the absence of an organic explanation for the pain leads people to shift their attentional focus to signs of somatic distress in an effort to identify a physical cause. This attentional shift may result in the overriding of the use of an adaptation-level in the judgement of perceptual stimuli. That is, although they may have a higher adaptation-level from which to judge painful stimuli, their intense focus on somatic distress results in increased pain report. The use of a tonic pain stimulus which may engender greater distress in vulnerable patients may have yielded statistical support for the hypervigilance model as has been found in previous research.

The presence of a medically incongruent pain presentation and psychological variables (cognitions, pain coping strategies, and distress) did not distinguish pain patients on pain perception measures contrary to the hypotheses. In fact, psychological variables were mostly unrelated to pain response (i.e., threshold, discriminability, and response bias) with the exception that worry, heightened emotionality, and catastrophizing cognitions were related to higher ratings of the sensory intensity of the painful stimuli. Rather, patients with medically incongruent signs and symptoms were found to report greater functional disability than those without incongruent symptoms. In addition, although not statistically significant, they tended to catastrophize more about the pain, to report less efficacy to control the pain, and to be more inclined to use passive coping strategies such as praying and hoping. Finally, the measures of medically incongruent symptoms were found to be associated with measures of emotional distress regarding the patients' pain problems.

In conjunction with past research which supports these findings, the categorization of pain patients into those with and without a medically incongruent pain presentation appears to distinguish them in terms of, primarily, their subjective report of disability and, secondarily, the degree of psychological distress they are experiencing regarding their condition. Thus, the expression of an exaggerated pain presentation appears to be more reflective of the concerns about how the chronic pain problem is affecting the

individual's daily life and is an attempt by that individual to express his/her distress to the health care professional. These concerns may not necessarily result in increased somatic vigilance and are as likely to occur in patients with or without clear organic pathology. The existence of psychological distress (poor coping ability, anxiety, and depression), however, appears to affect the experience of pain in that the pain is rated as being more intense.

Gender differences were found in this investigation with women reporting greater functional disability than men. In addition, women were better able to discriminate painful stimuli implying they are more sensitive. Finally, women rated the stimuli as more intense and unpleasant than men. A significant gender by group interaction was found for the response bias to report sensations as painful. Within the group of pain-free individuals, men were less likely to label sensations as painful than women. However, within the chronic pain groups, men were more likely to label sensations as painful than women. Past research on gender differences in pain experience and report have been mixed; however, women are generally reported to have lower pain thresholds and tolerance levels than men. The relationship between gender, chronic pain, and pain perception remains unclear and more controlled research is needed to clarify these results.

The results of this investigation support the current trend in the literature toward multidimensional assessments of pain problems. It is recognized that two-dimensional models

of pain are overly simplistic and attempts are being made to adopt multidimensional models that assess psychological, socioeconomic, and physiological factors as they relate to pain and chronicity (Main & Waddell, 1984; Turk & Rudy, 1987a; 1987b; Waddell et al., 1989). Simple dichotomous classification schemes (whether organic/functional or medically incongruent/congruent) for chronic pain are insufficient in characterizing the dimensions of the problem for that individual. However, the assessment of medically incongruent signs and symptoms is valuable in identifying patients who are more distressed by their plight and who may need additional help in learning how to cope.

Multidimensional explanations of pain (i.e., explanations of the cognitive and affective roles in pain in addition to physiological explanations) need to be given to all pain patients so that they do not become dependent upon finding a sole physical cause and resent or reject any other explanations for their continued discomfort. It is unlikely that altered pain perception is a major factor in the maintenance of chronic pain but rather, is an indication of the individual's appraisal of the problem. Future research should address the causal speculations arising out of this correlational study. For example, it would be valuable to establish what factors lead to an increase in somatic vigilance, how this may affect a patient's experience and report of pain, and what kinds of preventive strategies would alleviate excessive somatic vigilance.

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APPENDIX A

Nonorganic Physical Signs
(Waddell et al., 1980)

Note: These signs are evaluated during routine physical examination. If present, any individual sign is scored as 1.

A. Overreaction to examination
- Facial expression
- Muscle tension and tremor
- Collapsing
- Sweating

B. Tenderness
- Superficial
- Nonanatomic

C. Pain Reported on Simulation Tests (i.e., bogus tests)
- Axial loading
- Rotation

D. Distraction Tests
- Straight leg raising

E. Regional Disturbances
- Widespread Weakness
- Sensory Disturbances

APPENDIX B

Scoring Criteria for the Pain Drawing (Ranstord et al., 1976)

1. Unreal Drawings (poor anatomic localization, scores 2 unless indicated)
   a. total leg pain
   b. lateral whole leg pain (trochanteric 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 at least four modalities suggested in instructions (scores 1)

2. Drawings showing "expansion" or "magnification" of pain
   a. back pain radiating to iliac crest, groin, or anterior perineum (each scores 1)
   b. anterior knee pain (scores 1)
   c. anterior ankle pain (scores 1)
   d. pain drawn outside the outline (scores 1 or 2 depending on extent)

3. "I particularly hurt here" indicators (each scores 1)
   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 or 2 depending on extent)

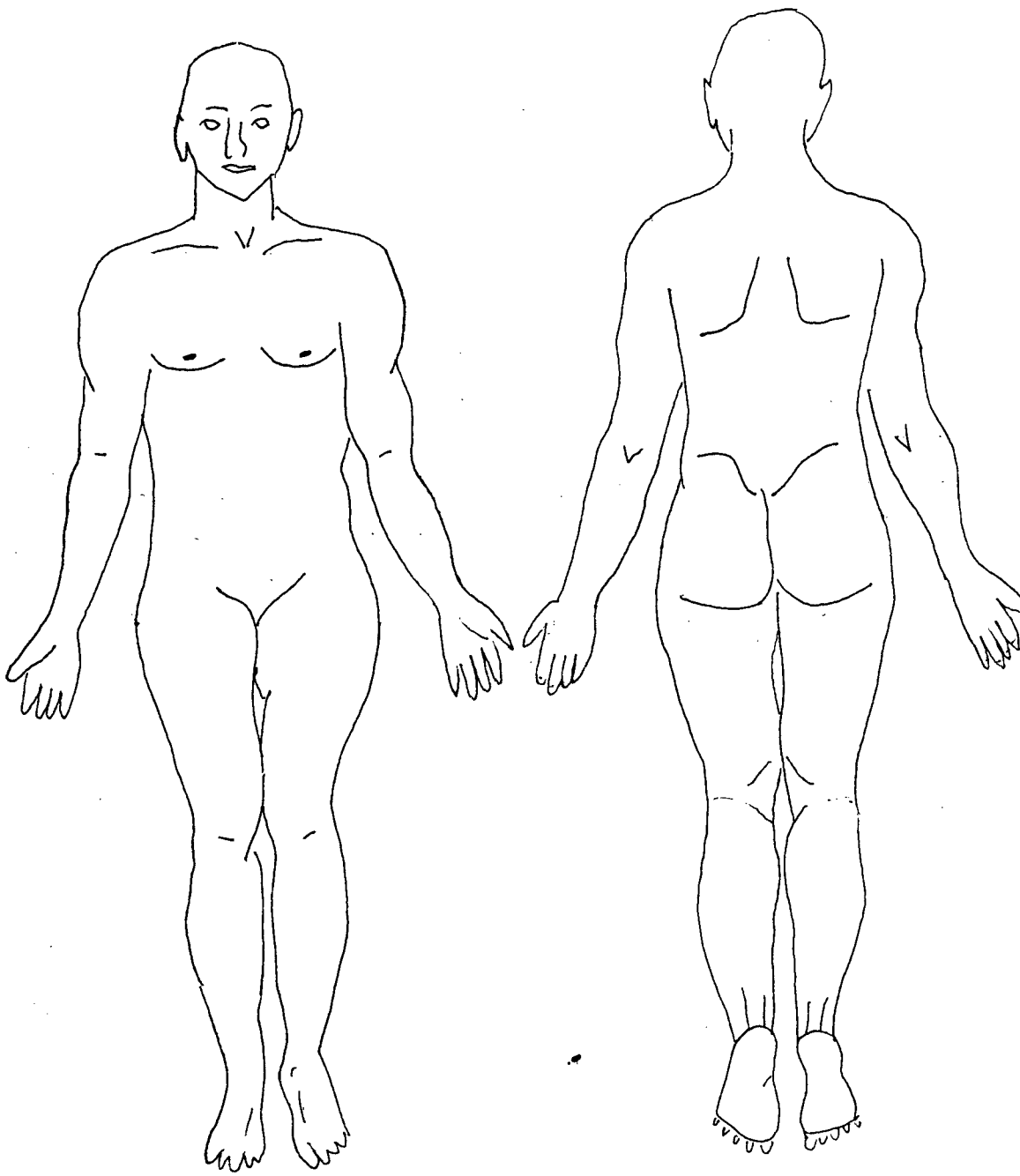
APPENDIX B

The Pain Drawing

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 and Needles ooooo Burning xxxxx Stabbing /////

Aching ^^^^^



APPENDIX C

Inappropriate Symptom Inventory
(Waddell et al., 1984)

Interview Questions ("yes" scores 1 unless otherwise indicated)

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" scores 1)

6. Have any of the treatments you've had for the pain helped you in any way? ("no" scores 1)

7. Have you ever had to go to the emergency department because of your back pain?

APPENDIX D

Consent Form for Pilot Study Subjects

Heat Discrimination Study

Kenneth D. Craig, Ph.D.
Department of Psychology
UBC ph. 228-3948

Mary L. Mahon, M.A.
Department of Psychology
UBC ph. 228-5581

The purpose of this study is to find out what the average faint pain threshold is for heat stimuli. Faint pain threshold refers to the point where you feel a small, distinct, pricking sensation at the end of a three second exposure to a heat source. Heat will be generated by a light beam that is shone on the skin of your forearm which will be painted black with an easily removed water-based paint. Intensities will range from warm to faintly painful. Stimuli last three seconds or less if you choose to stop it sooner. After each stimulus, you simply have to indicate whether you felt a prickly sensation or not and you will have 12 seconds between stimuli to make this judgement. This experiment will take 20 minutes of your time for which you will be paid $5.00. You are free to withdraw from the experiment at any time and you will still be paid for your participation.

Data obtained in this experiment will be kept confidential and used for research only. To ensure anonyity, volunteers will be identified by a number. Thank you for your time and if you have any questions about this study, do not hestitate to ask.

I agree to participate in this study subject to the condition that the information is kept in confidence and used for research only. I am aware that I can stop my participation at any time without penalty. I also acknowledge that I have received a copy of this form.

Signature.....

Date.....

APPENDIX E

Consent Form for Chronic Pain Participants

Heat Discrimination Study

Kenneth D. Craig, Ph.D
Department of Psychology
UBC ph. 228-3948

Mary L. Mahon, M. A.
Department of Psychology
UBC ph. 228-5581

We are interested in how different chronic pain conditions affect a person's ability to discriminate between different heat intensities. We are also interested in whether perceptions of various levels of heat are affected by your thoughts and moods. This research may contribute to more effective treatments for chronic pain conditions. For this reason, we are requesting 1 hour of your time for which you will be paid $20.00 for your participation.

Your participation will involve having four black spots painted on each forearm. The black paint is easily removed with soap and water. Heat will be generated by a light beam that is shone on one of these black spots and intensities will range from warm to mildly painful. Stimuli will last three seconds or less if you choose to stop it sooner. Your task is to distinguish between heat sensations and the first hint of faint pain. This faint pain sensation for heat has been described as a distinct, sharp, pricking sensation. After each stimulus, you simply have to indicate whether you felt a prickly sensation or not and you will have 12 seconds between stimuli to make this judgement. You will also be asked to fill out some short questionnaires that evaluate your thoughts, moods, and pain experience. In order to evaluate different pain conditions, we need to look at diagnostic, laboratory, and medical examination data related to your back problem from the Shaughnessy Hospital. We will be happy to answer any further questions you have about the study and a detailed explanation of the hypotheses and research will be given at the end of your participation.

All of the information you provide will be kept confidential and used for research only. To ensure anonymity, volunteers will be identified by a number. We would appreciate your help and cooperation but you are free to refuse or stop your participation at any time. You will be paid $10.00 for participating even if you decide part way that you do not want to finish the experiment. Since this study is independent of the Shaughnessy Hospital, whether you choose to participate or not will in no way affect your treatment at the hospital. Thank you for your time.

I agree to participate in this study and give permission to the Shaughnessy Hospital 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 my participation at any time without jeopardy to medical care. I also acknowledge that I have received a copy of this form.

Signature.....

Date.....

APPENDIX F

Instructions for Pain Perception Task

We are interested in how well you can distinguish heat from a prickly sensation that we consider to be the first trace of pain. This procedure is not a test of your ability of how much pain you can take, but rather is a test of your ability to perceive the first trace of pain. This faintly painful feeling has been described as a distinct, sharp, very small pricking sensation. The first trace of this means when you just feel the pin-prick at the exact end of the three seconds that the heat is on. Your task is detect this sensation which will be felt in addition to the warmth and heat. It is not easy and, therefore, you will have to concentrate closely on the sensations you are experiencing.

A variety of heat intensities will be applied to your arm. Some will feel only warm, others hotter, and some will also feel like the heat has focussed in on your skin and given you a bit of a pin prick. Your task is to simply judge whether you felt the pin prick just at the end of the stimulus or not. The heat is produced by a light bulb that will go on for exactly three seconds. You are to place the end of the heat gun directly on the surface of your skin. The end of the heat gun is covered by a heat resistant ring so it will not feel hot against your skin. I will press this red button and the light will stay on for three seconds. For each stimulus, change the heat gun to the next spot. Always move to a next spot because otherwise, one spot will become sensitive.

Because this is not an easy task, it is important for you to be familiar with the type of sensations you will be feeling. I will start at a low level. You should feel some warmth. (Administer stimulus at 150). Now I will give you a warmer one. (administer stimulus at 240). Did you feel a prickly sensation toward the end of the three seconds? O.K. I will give you some more examples. Look for the prickly sensation at the end of the stimulus. If you find any of them too uncomfortable, simply take the heat gun away from your skin.

(Administer a range of stimuli, emphasizing the ones where the subject reports the pin prick)

Good, you seem to have the idea. We will now just do some more of the same thing. All you have to do is put the heat gun mouth on a different black spot each time and concentrate on the sensation. You will have 12 seconds between each stimulus to judge whether you felt that first trace of pain (the pin-prick) or not.

(Administer two runs of the Up-Down Threshold determination).

Data Sheet for SDT Task

SDT DATA SHEET

SEX_____ SKIN TEMPERATURE_____.
AGE_____ ROOM TEMPERATURE_____.
CONTROL GROUP___EXPERIMENTAL GROUP____.
MEDICATIONS: TYPE_____.
DOSAGE_____.
DEMOGRAPHICS:

MARITAL STATUS_____.
ENGLISH SECOND LANGUAGE_____.
EMPLOYMENT STATUS_____.
HAD PREVIOUS SURGERY_____.
MULTIPLE SURGERIES_____.
FINANCIAL COMPENSATION_____.

PRACTICE TRIALS:

1. 2 ___	9. 2 ___	17. 1 ___	25. 3 ___.
2. 3 ___	10. 3 ___	18. 2 ___	26. 4 ___.
3. 1 ___	11. 1 ___	19. 3 ___	27. 1 ___.
4. 4 ___	12. 4 ___	20. 4 ___	28. 2 ___.
5. 4 ___	13. 3 ___	21. 4 ___	29. 3 ___.
6. 2 ___	14. 1 ___	22. 1 ___	30. 4 ___.
7. 1 ___	15. 4 ___	23. 2 ___	31. 2 ___.
8. 3 ___	16. 2 ___	24. 3 ___	32. 1 ___.

EXPERIMENTAL TRIALS:

1. 3 ___	9. 2 ___	17. 1 ___	25. 2 ___	33. 3 ___.
2. 2 ___	10. 3 ___	18. 4 ___	26. 3 ___	34. 4 ___.
3. 1 ___	11. 1 ___	19. 3 ___	27. 4 ___	35. 1 ___.
4. 4 ___	12. 4 ___	20. 2 ___	28. 1 ___	36. 2 ___.
5. 3 ___	13. 3 ___	21. 2 ___	29. 1 ___	37. 1 ___.
6. 4 ___	14. 1 ___	22. 4 ___	30. 3 ___	38. 2 ___.
7. 2 ___	15. 4 ___	23. 3 ___	31. 4 ___	39. 4 ___.
8. 1 ___	16. 2 ___	24. 1 ___	32. 2 ___	40. 3 ___.
41. 3 ___	49. 2 ___	57. 4 ___	65. 2 ___	73. 1 ___.
42. 4 ___	50. 1 ___	58. 2 ___	66. 4 ___	74. 2 ___.
43. 1 ___	51. 4 ___	59. 1 ___	67. 1 ___	75. 3 ___.
44. 2 ___	52. 3 ___	60. 3 ___	68. 3 ___	76. 4 ___.
45. 2 ___	53. 4 ___	61. 4 ___	69. 1 ___	77. 4 ___.
46. 1 ___	54. 2 ___	62. 1 ___	70. 4 ___	78. 1 ___.
47. 4 ___	55. 1 ___	63. 3 ___	71. 2 ___	79. 2 ___.
48. 3 ___	56. 3 ___	64. 2 ___	72. 3 ___	80. 3 ___.

APPENDIX H

Debrieting ot Participants

Heat Discrimination Study

Kenneth D. Craig, Ph.D.
Department ot Psychology
UBC ph. 228-3948

Mary L. Mahon, M.A.
Department ot Psychology
UBC ph. 228-5581

Thank you for your participation in this study. The purpose of this study was to test your threshold for faint pain using radiant heat. Therefore, we asked you to identify the point where you felt a distinct pin-prick at the end of a three second exposure to a light beam.

There is research to suggest pain perception is altered in chronic pain patients but it is unclear as to how it differs from people without chronic pain. This study is a preliminary study for a major research project that is designed to look at differences in pain sensitivity among different types of chronic pain patients. The sensitivity ot pain patients will be compared to the sensitivity of people who do not experience chronic pain. On the basis of the average pain threshold that we establish in this preliminary study, different levels of heat intensities will be selected for a subsequent test of both chronic pain patients and a non-pain group. This research will contribute to our understanding of how pain perception is affected in people who experience chronic pain.

If you are interested in further information, we would be happy to answer your questions.

APPENDIX I

Consent Form for Control Subject

Heat Discrimination Study

Kenneth D. Craig, Ph.D.
Department of Psychology
UBC ph. 228-3948

Mary L. Mahon, M.A.
Department of Psychology
UBC ph. 228-5581

We are interested in whether people experiencing chronic pain differ from pain-free individuals as to their ability to discriminate between different heat intensities. In order to do this, we need to test the heat discrimination ability in people without chronic pain conditions which is why you are being asked to volunteer. We are also interested in whether perceptions of various levels of heat are affected by your thoughts and moods. For this reason, we are requesting 1 hour of your time for which you will be paid $20.00 for your participation. This research will contribute to a greater understanding of chronic pain and may lead to more effective treatments.

Your participation will involve having four black spots painted on each forearm. The black paint is easily removed with soap and water. Heat will be generated by a light beam that is shone on one of these black spots and intensities will range from warm to mildly painful. Stimuli will last three seconds or less if you choose to stop it sooner. Your task is to distinguish between heat sensations and the first hint of faint pain. This faint pain sensation for heat has been described as a distinct, sharp, pricking sensation. After each stimulus, you simply have to indicate whether you felt a prickly sensation or not and you will have 12 seconds between stimuli to make this judgment. You will also be asked to fill out some short questionnaires that evaluate your thoughts, moods, and pain experience. We will be happy to answer any further questions you have about the study and a detailed explanation of the hypotheses and research will be given at the end of your participation.

All of the information you provide will be kept confidential and used for research only. To ensure anonymity, volunteers will be identified by a number. We would appreciate your help and cooperation but you are free to refuse or stop your participation at any time. You will be paid $10.00 for participating even if you decide part way that you do not want to finish the experiment. Thank you for your time.

I agree to participate in this study subject to the condition that the information is kept in confidence and used for research only. I am aware that I can stop my participation at any time without penalty. I also acknowledge that I have received a copy of this form.

Signature.....

Date.....

APPENDIX J

Physical Impairment Index
(Waddell & Main, 1984)

Mathematic constant			28
Pain pattern	Low back pain	0	
	Back and referred leg pain	8	
	Root pain	-2	
Time pattern	Recurring	4	
	Chronic	8	
Previous fracture	Transverse process	1	
	Wedge compression	2	
	Fracture dislocation	6	
Previous back surgery	None	0	
	One	3	
	More than one	6	
Root compression	None	0	
	Doubtful	1	
	Definate	2	
	Subtotal	+	
Lumbar flexion	____ cms X 2	-	
Straight leg raising, left (checked with distraction)	____ /10	-	
Straight leg raising, right (checked with distraction)	____ /10	-	
	Subtotal	-	
Approximate total bodily impairment			%

Note: Spinal stenosis with neurogenic claudication should be coded as Back + referred leg pain and scored as 8.

The left hand column lists the clinical observations for which the corresponding loading for each observation is entered in the right hand column, which is added up to give approximate total bodily impairment.

APPENDIX K

Oswestry Low Back Pain Disability Questionnaire
(Fairbank et al., 1980)

The following are statements 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 box which applies to you. If two statements in any one section seem to apply to you, pick one which most closely describes your problem.

1. **Pain Intensity**
   - I can tolerate the pain I have without having to use pain killers.
   - The pain is bad but I manage without taking pain killers.
   - Pain killers give moderate relief from pain.
   - Pain killers give very little relief from pain.
   - Pain killers have no effect on the pain and I do not use them.

2. **Personal Care (Washing, Dressing, etc.)**
   - I can look after myself normally without causing extra pain.
   - I can look after myself normally but it causes extra pain.
   - It is painful to look after myself and 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.

3. **Lifting**
   - I can lift heavy weights without 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, eg. on a table.
   - 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.

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

5. **Sitting**

I can set in any chair as long as I like.
I can only sit in my favourite chair as long as I like.
Pain prevents me 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.

6. **Standing**

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

7. **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 of sleep.
Pain prevents me from sleeping at all.

8. **Sex Life**

My sex life is normal and causes no extra pain.
My sex life is normal but causes some extra 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.

9. **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 my 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 of my home.
I have no social life because of pain.

10. **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.

APPENDIX L

Gracely Rating Scale
(Gracely et al., 1979)

From each column below, choose one word that best describes the most painful stimulus presented.

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

Scoring for Gracely Rating Scales

SENSORY INTENSITY		UNPLEASANTNESS	
Extremely Intense	59.5	Very Intolerable	44.8
Very Intense	43.5	Intolerable	32.3
Intense	34.6	Very Distressing	18.3
Strong	22.9	Slightly Intolerable	13.6
Slightly Intense	21.3	Very Annoying	12.1
Barely Strong	12.6	Distressing	11.4
Moderate	12.4	Very Unpleasant	10.7
Mild	5.5	Slightly Distressing	6.2
Very Mild	3.9	Annoying	5.7
Weak	2.8	Unpleasant	5.6
Very Weak	2.3	Slightly Annoying	3.5
Faint	1.1	Slightly Unpleasant	2.8
No Sensation	0	No Discomfort	0

APPENDIX M

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 are experiencing pain, a 3 indicates that you sometimes do that when you experience pain, and a 6 indicates you always do it when you experience pain. Remember, you can use any point along the scale.

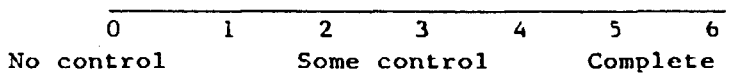
0	1	2	3	4	5	6
Never do			Sometimes do that			Always do that

WHEN I FEEL PAIN...

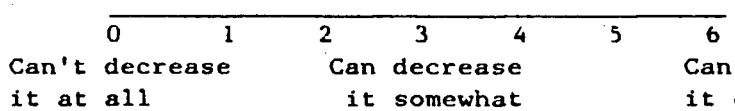
____ 1. I try to feel distant from the pain, almost as if the pain was in somebody else's body.
____ 2. I leave the house and do something, such as going to the movies or shopping.
____ 3. I try to think of something pleasant.
____ 4. I don't think of it as pain but rather as a dull or warm feeling.
____ 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 for awhile.
____ 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 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 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 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.



Based on all the things you do to cope, or deal with 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 the scale.



Key to Coping Strategy Questionnaire

Cognitive coping strategies:

1. Diverting attention: 3, 9, 12, 26, 27, 38
2. Reinterpreting the pain sensations: 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

Behavioural coping strategy

1. Increased behavioural activities: 2, 7, 34, 39, 40, 42

Effectiveness ratings

1. Control over pain
2. Ability to decrease pain.

APPENDIX N

PAIN EXPERIENCE 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 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 me 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 in the 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 for the Pain Experience Scale

Scale 1: Emotionality

(Q1 + Q3 + Q4 + Q6 + Q7 + Q9 + Q10 + Q12 + Q13 + Q15 + Q16 + Q19) / 13

Scale 2: Worry

(Q2 + Q5 + Q8 + Q11 + Q14 + Q17) / 6

APPENDIX O

Trait Anxiety Questionnaire
(Speilberger, 1985)

A number of statements which people have used to describe themselves are given below. Please read each statement and then put a checkmark in the appropriate box to the right of the statement to indicate how you generally feel. There are no right or wrong answers. Do not spend too much time on any one statement but give the answer which seems to describe how you generally feel.

	Almost never	Sometimes	Often	Almost always
1. I feel pleasant				
2. I tire quickly				
3. I feel like crying				
4. I wish I could be as happy as others seem to be				
5. I am losing out on things because I can't make up my mind soon enough				
6. I feel rested				
7. I am "calm, cool, and collected"				
8. I feel that difficulties are piling up so that I cannot overcome them				
9. I worry too much over something that really doesn't matter				
10. I am happy				
11. I am inclined to take things hard				
12. I lack self-confidence				
13. I feel secure				

	Almost never	Sometimes	Often	Almost always
14. I try to avoid facing a crisis or difficulty				
15. I feel blue				
16. I am content				
17. Some unimportant thoughts run through my mind and bother me				
18. I take disappointments so keenly that I can't put them out of my mind				
19. I am a steady person				
20. I get in a state of tension of turmoil as I think over my recent concerns and interests				