# Predictability and pain prediction, perception and behaviour in chronic low back pain patients

by

Richard E. D. Braha

Submitted in partial fulfilment of the requirements
for the degree of Doctor of Philosophy

at

Dalhousie University
Halifax, Nova Scotia
Canada
February, 1995

ISBN 0-612-05252-4

Canada

Name RICHARD BRAHA

*Dissertation Abstracts International* is arranged by broad, general subject categories. Please select the one subject which most nearly describes the content of your dissertation. Enter the corresponding four-digit code in the spaces provided.

PSYCHOLOGY - CLINICAL

SUBJECT TERM

0622

SUBJECT CODE

U·M·I

## Subject Categories

# THE HUMANITIES AND SOCIAL SCIENCES

### COMMUNICATIONS AND THE ARTS

Architecture 0729
Art History 0377
Cinema 0900
Dance 0378
Fine Arts 0357
Information Science 0723
Journalism 0391
Library Science 0399
Mass Communications 0708
Music 0413
Speech Communication 0459
Theater 0465

### EDUCATION

General 0515
Administration 0514
Adult and Continuing 0516
Agricultural 0517
Art 0273
Bilingual and Multicultural 0282
Business 0688
Community College 0275
Curriculum and Instruction 0727
Early Childhood 0518
Elementary 0524
Finance 0277
Guidance and Counseling 0519
Health 0680
Higher 0745
History of 0520
Home Economics 0278
Industrial 0521
Language and Literature 0279
Mathematics 0280
Music 0522
Philosophy of 0998
Physical 0523
Psychology 0525
Reading 0535
Religious 0527
Sciences 0714
Secondary 0533
Social Sciences 0534
Sociology of 0340
Special 0529
Teacher Training 0530
Technology 0710
Tests and Measurements 0288
Vocational 0747

### LANGUAGE, LITERATURE AND LINGUISTICS

Language
- General 0679
- Ancient 0289
- Linguistics 0290
- Modern 0291

Literature
- General 0401
- Classical 0294
- Comparative 0295
- Medieval 0297
- Modern 0298
- African 0316
- American 0591
- Asian 0305
- Canadian (English) 0352
- Canadian (French) 0355
- English 0593
- Germanic 0311
- Latin American 0312
- Middle Eastern 0315
- Romance 0313
- Slavic and East European 0314

### PHILOSOPHY, RELIGION AND THEOLOGY

Philosophy 0422
Religion
- General 0318
- Biblical Studies 0321
- Clergy 0319
- History of 0320
- Philosophy of 0322

Theology 0469

### SOCIAL SCIENCES

American Studies 0323
Anthropology
- Archaeology 0324
- Cultural 0326
- Physical 0327

Business Administration
- General 0310
- Accounting 0272
- Banking 0770
- Management 0454
- Marketing 0338

Canadian Studies 0385
Economics
- General 0501
- Agricultural 0503
- Commerce-Business 0505
- Finance 0508
- History 0509
- Labor 0510
- Theory 0511

Folklore 0358
Geography 0366
Gerontology 0351
History
- General 0578
- Ancient 0579
- Medieval 0581
- Modern 0582
- Black 0328
- African 0331
- Asia, Australia and Oceania 0332
- Canadian 0334
- European 0335
- Latin American 0336
- Middle Eastern 0333
- United States 0337

History of Science 0585
Law 0398
Political Science
- General 0615
- International Law and Relations 0616
- Public Administration 0617

Recreation 0814
Social Work 0452
Sociology
- General 0626
- Criminology and Penology 0627
- Demography 0938
- Ethnic and Racial Studies 0631
- Individual and Family Studies 0628
- Industrial and Labor Relations 0629
- Public and Social Welfare 0630
- Social Structure and Development 0700
- Theory and Methods 0344

Transportation 0709
Urban and Regional Planning 0999
Women's Studies 0453

# THE SCIENCES AND ENGINEERING

### BIOLOGICAL SCIENCES

Agriculture
- General 0473
- Agronomy 0285
- Animal Culture and Nutrition 0475
- Animal Pathology 0476
- Food Science and Technology 0359
- Forestry and Wildlife 0478
- Plant Culture 0479
- Plant Pathology 0480
- Plant Physiology 0817
- Range Management 0777
- Wood Technology 0746

Biology
- General 0306
- Anatomy 0287
- Biostatistics 0308
- Botany 0309
- Cell 0379
- Ecology 0329
- Entomology 0353
- Genetics 0369
- Limnology 0793
- Microbiology 0410
- Molecular 0307
- Neuroscience 0317
- Oceanography 0416
- Physiology 0433
- Radiation 0821
- Veterinary Science 0778
- Zoology 0472

Biophysics
- General 0786
- Medical 0760

### EARTH SCIENCES

Biogeochemistry 0425
Geochemistry 0996
Geodesy 0370
Geology 0372
Geophysics 0373
Hydrology 0388
Mineralogy 0411
Paleobotany 0345
Paleoecology 0426
Paleontology 0418
Paleozoology 0985
Palynology 0427
Physical Geography 0368
Physical Oceanography 0415

### HEALTH AND ENVIRONMENTAL SCIENCES

Environmental Sciences 0768
Health Sciences
- General 0566
- Audiology 0300
- Chemotherapy 0992
- Dentistry 0567
- Education 0350
- Hospital Management 0769
- Human Development 0758
- Immunology 0982
- Medicine and Surgery 0564
- Mental Health 0347
- Nursing 0569
- Nutrition 0570
- Obstetrics and Gynecology 0380
- Occupational Health and Therapy 0354
- Ophthalmology 0381
- Pathology 0571
- Pharmacology 0419
- Pharmacy 0572
- Physical Therapy 0382
- Public Health 0573
- Radiology 0574
- Recreation 0575
- Speech Pathology 0460
- Toxicology 0383

Home Economics 0386

### PHYSICAL SCIENCES

Pure Sciences

Chemistry
- General 0485
- Agricultural 0749
- Analytical 0486
- Biochemistry 0487
- Inorganic 0488
- Nuclear 0738
- Organic 0490
- Pharmaceutical 0491
- Physical 0494
- Polymer 0495
- Radiation 0754

Mathematics 0405
Physics
- General 0605
- Acoustics 0986
- Astronomy and Astrophysics 0606
- Atmospheric Science 0608
- Atomic 0748
- Electronics and Electricity 0607
- Elementary Particles and High Energy 0798
- Fluid and Plasma 0759
- Molecular 0609
- Nuclear 0610
- Optics 0752
- Radiation 0756
- Solid State 0611

Statistics 0463

Applied Sciences

Applied Mechanics 0346
Computer Science 0984
Engineering
- General 0537
- Aerospace 0538
- Agricultural 0539
- Automotive 0540
- Biomedical 0541
- Chemical 0542
- Civil 0543
- Electronics and Electrical 0544
- Heat and Thermodynamics 0348
- Hydraulic 0545
- Industrial 0546
- Marine 0547
- Materials Science 0794
- Mechanical 0548
- Metallurgy 0743
- Mining 0551
- Nuclear 0552
- Packaging 0549
- Petroleum 0765
- Sanitary and Municipal 0554
- System Science 0790

Geotechnology 0428
Operations Research 0796
Plastics Technology 0795
Textile Technology 0994

### PSYCHOLOGY

General 0621
Behavioral 0384
Clinical 0622
Developmental 0620
Experimental 0623
Industrial 0624
Personality 0625
Physiological 0989
Psychobiology 0349
Psychometrics 0632
Social 0451

**DALHOUSIE UNIVERSITY**

**FACULTY OF GRADUATE STUDIES**

The undersigned hereby certify that they have read and recommend to the Faculty of Graduate Studies for acceptance a thesis entitled "Predictability and pain prediction, perception and behaviour in chronic low back pain patients"

by Richard Edward Braha

in partial fulfillment of the requirements for the degree of Doctor of Philosophy.

Dated March 17, 1995

External Examiner

Research Supervisor

Examining Committee

DALHOUSIE UNIVERSITY

DATE: 19 March 1995

AUTHOR: Richard E.D. Braha

TITLE: Predictability and pain prediction, perception and behaviour in chronic low back pain patients

DEPARTMENT OR SCHOOL: Psychology

DEGREE: Ph.D. CONVOCATION: Spring YEAR: 1995

Permission is herewith granted to Dalhousie University to circulate and to have copies for non-commercial purposes, at its discretion, the above title upon the request of individuals or institutions.

Signature of Author

## Table of Contents

## List of Tables

## List of Figures

**Abstract**

Theory and research on the psychological consequences of exposure to aversive events provided the background for this dissertation, which predicted that providing information about an impending aversive event would influence predictions about and responses to pain. This dissertation investigated: the effects of stimulus predictability on pain prediction, perception and pain behaviour; whether these effects remained constant across pain from different sources; and the relationship between perceived control, pain perception and pain behaviour. Twenty chronic low back pain patients and 20 matched, pain-free controls participated in a series of experiments which examined these effects. Baseline, between group differences were established in anxiety, depression, pain behaviour, handicap and perceived control over pain. In Experiment 2, in which cold pressor pain was used, there were no differences between groups in pain predictions, in patterns of predicting pain during repeated exposures to a painful stimulus, or in pain thresholds, even after repeated exposure. Experiment 3 confirmed, under longer exposure durations, that there were no differences between groups in pain predictions. Pain patients displayed an increased sensitivity to pain under conditions of low predictability. Both groups predicted significantly more pain and displayed significantly lower pain thresholds under conditions of low versus high stimulus predictability. Experiments 4 and 5 produced similar effects and demonstrated generalization of these findings to different, more clinically relevant, pain stimuli. Pain patients displayed more pain behaviour than did control subjects in all experiments. Neither group's displays of pain behaviour were affected by variations in stimulus predictability. Relations were found, for both groups, between perceived control over pain, pain predictions and pain thresholds but not between perceived control and pain reports or behaviour during acute pain stimulation. There were significant correlations between pain patients' perceptions of pain and their displays of pain behaviour during cold water immersion, but not during step climbing or standing. An argument is presented to suggest that the maintenance of pain and pain behaviour in chronic pain may be better explained by psychosocial and learning theories rather than constitutional theories.

## List of Abbreviations and Symbols

| *Text* | *Meaning* |
|---|---|
| ANOVA | Analysis of variance |
| c.f. | Compare |
| cm. | Centimetres |
| CSQ | Coping Strategies Questionnaire |
| e.g. | For example |
| *df* | Degrees of freedom |
| *F* | Value of the "F" statistic |
| FDI | Functional Disability Inventory |
| Hz | Hertz |
| IASP | International Association for the Study of Pain |
| i.e. | That is |
| l | Litres |
| LCD | Liquid Crystal Display |
| *M* | Mean value |
| MANOVA | Multivariate analysis of variance |
| *N* | Total sample size |
| *n* | Partial sample size |
| ns | No significance |
| *p* | Level of alpha probability |
| *r* | Correlation coefficient |
| *SD* | Standard deviation of the mean |
| *t* | Value of the "t" statistic |
| WHO | World Health Organization |

**Acknowledgements**

I would like to express my sincere gratitude to the members of my thesis committee, each of whom made valuable contributions to this research and to the way I think about psychological events. My thesis supervisor, Dr. Patrick McGrath, provided valuable counsel and generous support throughout my doctoral training. Dr. Vincent LoLordo and Dr. Douglas Cane were unfailing in their support, challenged my ideas, and were always available for stimulating discussion.

I also would like to thank Dr. Michael Sullivan and Dr. Richard Brown for reading my thesis and for their improvements to the text. Dr. Raymond Klein helped make my doctoral training the rich and gratifying experience that it was.

This research could not have been possible without the altruism of the subjects who participated in these experiments. I hope this dissertation does justice to their contributions.

I am indebted to Daniel Boland, M.Sc., M.C.P.A., C.O.M.P., Todd Lewin, B.Sc.PT, M.C.P.A., John Jefferson, M.Sc., Margaret Ashcroft, R.N., A. John Clark, M.D., F.R.C.P.(C), and Dean Tripp, M.Sc. for their assistance in recruiting subjects for this research.

I will always remember my friends and colleagues in the Department of Psychology at Dalhousie University, the Pain Research Lab, and the Psychology Department of the Victoria General Hospital for the generosity, support and encouragement they gave me during my doctoral training.

Last, but not least, I would like to thank my wife, Andrea John, B.A., M.L.S., for her love and unwavering support through almost eight years of graduate training.

Now for the fun part!

# INTRODUCTION

Pain in humans often persists for long periods of time in the absence of any known peripheral or central pathology (Wall, 1994). This persistent pain is called chronic pain. When pain is unresponsive to medical intervention, it is called intractable pain. Many individuals experience pain that is chronic and intractable. Chronic pain can be variable in its course, intensity and duration. In these situations, as Wall (1994) put it, "... a huge burden ... [is typically] placed on clinical psychologists. ... the classical medical profession which is pathologically based has concluded that there is 'nothing wrong' in pathological terms with the great majority of chronic pain patients. ... the only generally accepted alternative is that there must be a design fault in human mental processing which permits the generation or gross exaggeration of pain states ... It becomes the duty of the profession of psychologists to find an answer... (Wall, 1994, p.4)."

The challenge is to determine whether pain patients' responses to their pain reflect, as Wall (1994) put it, "a design fault in human mental processing [i.e., a basic difference in the perception of pain between pain patients and pain-free subjects]", or a normal process of learning and adaptation to an abnormal event.

The purpose of this research is to contribute to the understanding and theory of psychological factors which influence the perception and expression of pain in chronic pain syndromes. In an attempt to elucidate one theoretical factor that may be involved in the persistence of pain and pain behaviour in chronic pain disorders, this dissertation explores the nature and effects of variations in stimulus predictability on acute pain perception and pain behaviour.

### *A brief background of pain*

The International Association for the Study of Pain (Merskey & Bogduk, 1994) defined pain as:

> "An unpleasant sensory and emotional experience associated with actual or potential tissue damage, or described in terms of such damage.
>
> *Note:* Pain is always subjective. Each individual learns the application of the word through experiences related to injury in early life. Biologists recognize that those stimuli which cause pain are liable to damage tissue. Accordingly, pain is that experience which we associate with actual or potential tissue damage. It is unquestionably a sensation in a part or parts of the body, but it is also always unpleasant and therefore also an emotional experience. Experiences which resemble pain, e.g., pricking, but are not unpleasant should not be called pain. Unpleasant abnormal experiences (dysaesthesiae) may also be pain but are not necessarily so because, subjectively, they may not have the usual sensory qualities of pain.
>
> Many people report pain in the absence of tissue damage or any likely pathophysiological cause; usually this happens for psychological reasons. There is usually no way to distinguish their

> experience from that due to tissue damage if we take the subjective report. If they regard their experience as pain and if they report it in the same ways as pain caused by tissue damage, it should be accepted as pain. This definition avoids tying pain to the stimulus. Activity induced in the nociceptor and nociceptive pathways by a noxious stimulus is not pain, which is always a psychological state, even though we may well appreciate that pain most often has a proximate physical cause."

Historically, it was believed that painful stimuli elicited two distinct types of responses in humans. These responses have been described in many ways but almost always referred to pain reflexes and pain behaviours. These responses were described as occurring in a sequential temporal fashion (see Figure 1). Pain reflexes referred to the sensory-physiological events associated with painful stimulation, and pain behaviours were seen as reactions to pain mediated by psychological processes involved in pain perception (Melzack, 1983).

---

Insert Figure 1 about here

---

Even early research was not consistent with this view which conceptualized pain primarily as a sensory phenomenon (cf., Fordyce, 1976; Melzack, 1983). Pain is now conceptualized as a multidimensional phenomenon involving sensory, motivational, affective, and central control

systems which may produce many qualities of pain (Chapman, 1983; Wall, & Melzack, 1989; Wade, Dougherty, Hart, Raffi, & Price, 1992). Further, sensory-discriminative and motivational-affective responses to pain may vary as a function of the pain stimulus (Chapman, 1983; Janal, Glusman, Kuhl, & Clark, 1994). Pain may be laboratory induced or naturally occurring and it may be acute or chronic in nature.

At one time it was believed that reported pain should be in direct proportion to the extent of tissue damage. It was believed that as tissue damage increased, there would be an increase in pain, disability and handicap (Gamsa, 1994; Turk, & Rudy, 1987). This belief in a positive linear relationship between tissue damage, pain and handicap has been long dispelled. Numerous studies have shown that in most cases there is little relationship between the extent or magnitude of tissue damage and pain report or suffering (Craig, 1984; Oostdam & Duivenvoorden, 1987; Turk, Rudy, & Stieg, 1988). In addition, there is not a clear or consistent relationship between patients' reports of pain and disability and handicap (Craig & Patrick, 1985; Dunn-Geier, McGrath, Rourke, Latter, & D'Astous, 1986; Keefe, Salley Jr., & Lefebvre, 1992). Not surprisingly, studies of normal pain perception and of clinical pain phenomena have found little evidence for a relationship between pain intensity and either the magnitude or occurrence of pain behaviours (e.g., Campbell, Carstens, & Watkins, 1991; Jahanshahi, & Philips, 1986; Keefe, Bradley, & Crisson, 1990; Waddell, Main, Morris, Dipaola, & Gray, 1984). And pain

behaviour, rather than reported pain intensity, is often associated with the handicap and hence suffering which is prevalent in many chronic pain conditions (Anderson, Bradley, McDaniel, Young, Turner, Agudelo, Keefe, Pisko, Snyder, & Semble, 1987; Connally, & Sanders, 1991; Reesor & Craig, 1988; Romano, Syrjala, Levy, Turner, Evans, & Keefe, 1988).

Although the relationships between nociception, pain perception and pain behaviour may not be as puzzling as they once were (cf., Melzack, & Wall, 1982, Chapter 11; Weisenberg, 1980), these relationships still constitute a theoretical challenge for science and for psychology in particular (Wall, 1994).

***Pain behaviour***

There is no universally employed taxonomy for defining pain behaviour. This may be because the term "pain behaviour" refers to a broad range of responses. These responses may be characterised along five dimensions (Fordyce, 1976): 1. verbal complaints of pain and suffering; 2. non-language paraverbal sounds (e.g., moans, sighs); 3. body posturing and gesturing (e.g., limping, rubbing, grimacing, and guarding); 4. displays of functional limitations (e.g., time lying in bed) and; 5. behaviours designed to reduce pain (e.g., medication use, visits to physician). Pain behaviours involve physiological, verbal, and motoric systems.

Some researchers have differentiated between cognitive and behavioral or primarily motoric pain behaviours, while others have made a distinction

between covert and overt pain behaviours to explain the same phenomenon (Turk & Flor, 1987). An overt-motoric and covert-subjective dichotomy seems to accommodate all points of view.

Keefe and Block's (1982) seminal, and narrower, conceptualization of pain behaviour has been one of the most useful heuristics because it was based on careful scientific observation (Craig, 1992). This conceptualization delineated five prototypical pain behaviours: grimacing, rubbing, bracing, guarded movement, and sighing. Researchers have modified these criteria for specific chronic pain conditions and, for example, have made a distinction between passive and active rubbing and included rigidity as another behaviour (e.g., Anderson, Bradley, McDaniel, Young, Turner, Agudelo, Keefe, Pisko, Snyder, & Semble, 1987). The term pain behaviour herein will refer to overt-motoric pain behaviours since, with few exceptions, current usage appears governed by Keefe and Block's taxonomy.

### *Brief history of pain behaviour and related constructs*

Fordyce (1976; Fordyce, Fowler, & DeLateur, 1968) referred to the operant conditioning of "pain behaviours". Consequently, he is credited with the introduction of the current usage of the term to refer to responses elicited by painful stimuli which are under operant or instrumental control (see Figure 2). In Fordyce's view, painful stimuli elicit two types of responses: responses which are under reflexive or respondent control and responses which are under

operant control.

---

Insert Figure 2 about here

---

More recently, Fordyce has made a distinction between this conceptualization and a broader definition of pain behaviour (Vlaeyen, Van Eek, Groenman, & Schuerman, 1987) which includes the following explanation:

> "...pain behaviour is the interaction between the individual and the surrounding world. Pain behaviour is defined as any and all outputs of the individual that a reasonable observer would characterize as suggesting pain, such as (but not limited to) posture, facial expression, verbalizing, lying down, taking medicines, seeking medical assistance, and receiving compensation (Loeser & Fordyce, 1983, p.334)."

Fordyce's more recent essays focus more on communication and motivation rather than pure operant aspects of pain behaviours.

Fordyce's contribution has been in limiting conjecture about pain and maintaining that research and treatment should focus on objective, observable and reliable phenomena. Although the utility of this behavioral approach has been disputed (Merskey, 1992), most descriptions of pain behaviour remain predominantly focused on overt motoric behaviours.

The broader construct of "illness behaviour" may be traced to at least as far back as the 1950's (Turk, & Flor, 1987; Waddell, Pilowsky, Bond, 1989). Parsons (1958) coined the term "sick role" to refer to the way society exempts patients from responsibilities because of illness. Mechanic (1962) broadened the concept of sick role to include a range of behaviours which characterised patients who adopted the sick role. Mechanic called these behaviours "illness behaviours". Pilowsky (1978) described a range of specific illness behaviours which were maladaptive or not conducive to recovery. He called these behaviours "abnormal illness behaviours". Although all these terms refer to related constructs which often subsume the construct of pain behaviour, they also incorporate anthropological, sociological, and psychiatric factors and the validity of these heterogenous constructs has not been well established (e.g., Waddell, Pilowsky, & Bond, 1989).

### *Pain behaviour measurement*

As indicated, there is no universally employed taxonomy for defining pain behaviour. Researchers have used several diverse taxonomies in constructing both self-report and observational measures of pain expression (cf., Craig & Prkachin, 1983) and pain behaviour. This has resulted in diverse measures of pain behaviour. Several of the most commonly used measures of pain behaviour evaluate theoretically independent constructs (Vlaeyen, Van Eek, Groenman, & Schuerman, 1987; Turk & Flor, 1987; Turk, Wack, & Kerns,

1985). Compounding this diversity, researchers have employed patient self-report, physician report, spousal report, retrospective ratings, and observational methods for measuring pain behaviour (e.g., Anderson, Bradley, McDaniel et al, 1988; Appelbaum, Radnitz, Blanchard, & Prins, 1988; Waddell, & Richardson, 1992; Kerns, Haythornthwaite, Rosenberg, Southwick, Giller, & Casey Jacob, 1991; Kleinke, & Stephenson Spangler, 1988 ). The extent to which pain behaviours refer to a homogeneous entity has been examined empirically only recently (cf., Keefe, Bradley, & Crisson, 1990; Vlaeyen, Pernot, Kole-Snijders, Schuerman, Van Eek, & Groenman, 1990). These theoretical and methodological problems alone may account for many of the inconsistencies in clinical research data which follow.

***The need for this research***

Both pain and pain behaviours are commonly understood to underscore a large proportion of the suffering and handicap associated with chronic pain (Anderson, Keefe, Bradley, McDaniel, Young, Turner, Agudelo, Semble, & Pisko, 1988; Connally, & Sanders, 1991; Öhlund, Lindström, Areskoug, Eek, Peterson, & Nachemson, 1994; Reesor & Craig, 1988; & Waddell, Pilowsky, & Bond, 1989). Pain and pain behaviours are primary targets for treatment regimes (Fordyce, 1976; Keefe & Block, 1982). However, despite considerable theoretical foundations (e.g., Rachman & Lopatka, 1988; Philips, 1987; Schmidt, 1987; Fordyce, 1976), and more or less reliable assessment of pain behaviours

(Schmidt, 1987; Fordyce, 1983), there is little empirical evidence to support theoretical accounts (Schmidt, 1987) of why these phenomena persist. There are few experimental studies of factors which control the maintenance of pain or pain behaviours in chronic pain disorders (Craig, 1992).

Experimental evidence from studies of normal pain and other aversive events suggests that psychological processes can affect perception and behaviour. These data indicate that a subjects' perceptions of control over an aversive event such as pain, and the predictability of the aversive stimuli, may be related to pain perception and pain behaviour. If this is the case, then these variables may help to explain the absence of a direct relationship between pain perception and pain behaviour in chronic pain sufferers. However, the precise role of perceived control and predictability in the perception and expression of chronic pain remains unclear. A clear understanding of these constructs, and theoretical relations between them, is necessary in order to appreciate the evidence which links these variables to responses to pain and in particular, to pain behaviours.

Next, operational definitions are given for the psychological constructs of perceived control, prediction, and predictability and relations between these variables are discussed.

### *Perceived Control*

Control is a broad and ill defined psychological construct (Syme, 1989).

It refers to the ability to anticipate and influence, change or alter the course of an event. Perceived control refers to the degree to which individuals believe they are able to anticipate, influence, change or alter the course of an event.

It has been demonstrated repeatedly that the degree of control subjects have over an aversive event or a stimulus will alter their behaviour (Arntz & Schmidt, 1989). Traditional instrumental views of learning could not account for how an organism learned the degree of control it had over events in the universe. The traditional instrumental view was governed by the temporal contiguity between response and reinforcement (Maier, 1989). According to this view, learning occurred only when a response had been made. Once a response had been made, the conditional probability of reinforcement governed all instrumental learning.

For an organism to learn the degree of control it has over events, it is now recognized that the organism needs to be sensitive to the conditional probability of reinforcement given that no response has been made, and to the conditional probability of reinforcement given that a response has been made. This finding implicates cognitive processes in learning. To learn that one has no control over a reinforcer or event, one needs to be as sensitive to what happens when one does not make a response, as to when one does make a

response. Maier (1989, p. 75) explains:

> "To learn that one has no control the organism must be sensitive to both of the probabilities and their *relationship*, because the absence of control is defined by the equality of these two probabilities. To say that one has no control is to say that the outcome is the same whether or not a response occurs."

Many of the consequences of exposure to aversive events are attributable in part to changes in the subject's expectations (e.g., Maier, 1989; Abramson, Garber, & Seligman, 1980). Estimating probabilities involves making predictions about future events. Accurate predictions of future events can provide information for the organism to avoid or escape the event.

From this theoretical position, it would be predicted that a history of no control over an aversive event (absence of a response contingency) would increase the likelihood of inaccurate future expectancies. Expectancies of future lack of control (i.e., that the occurrence of the event will not be contingent on responses) prior or during exposure to an aversive event would bias behaviour during the aversive event.

Thus, many researchers (e.g., Maier, 1989; Phillips, 1989) now consider the organism's expectation or predictions about future events (contingency or non-contingency) to be the critical mediating cognitive event in determining behaviour in aversive conditions. Central to this view is not what events actually occur or have occurred but rather, what the subject perceives to have occurred or perceives will occur and the term "prediction" is defined as the

subjective (covert) estimation of this future event.

### *Predictability*

The process of predicting future events (e.g., outcome) involves the appraisal of information from internal and external sources. Predictability may be defined as the availability of this information.

Put another way, predictability refers to the availability of signs that reliably signal the beginning or end, increase or decrease in intensity of a future event (e.g., a noxious stimulus) (Miller, 1979; Arntz, & Schmidt, 1989). Clearly, both predictions and the predictability of aversive events alter subjects' perceptions of control and subsequently alter subjects' behaviour under aversive conditions. Although predictability influences prediction, the reverse is not true. Although actual control over aversive stimuli such as pain is achieved by preventing pain (avoidance) or preventing pain increases through withdrawal (escape), predictability appears to be the critical element in the way perceptions of control mediate behaviour (Arntz, & Schmidt, 1989). In fact, some researchers have hypothesized that actual control over an aversive event may simply be a function of the predictability of the event (e.g., Phillips, 1989). It is the case that the predictability of the aversive stimulus reliably mediates behaviour even in the absence of actual control.

The next sections discuss the evidence for this argument which comes from three areas of research: predictability in non-pain laboratory studies,

predictability in laboratory pain studies, and predictability in clinical pain studies. This research makes plausible a theoretical model which asserts that predictability is a major control variable in the perception of pain and the maintenance of pain behaviour in chronic pain.

### *Predictability in non-pain laboratory studies*

Research on the effects of predictability on fear or learned helplessness accounts for most of the published non-pain laboratory studies using human subjects. Research with non-human subjects is another matter. The predictability of aversive events paradigm (i.e., event covariation) has been employed to study numerous experimental phenomena in animals including: stress responsivity, stress-induced analgesia, learned helplessness, escape behaviour, avoidance behaviour, pain, weight loss, gastrointestinal pathology (i.e., gastric acid secretions), stomach lesions and pituitary-adrenal functioning. To review the findings from non-human research is beyond the scope of this thesis and the reader is referred to, Abbott, Schoen, and Badia (1984) and Arthur (1986) for select reviews of this area. Conversely, human studies on predictability are noteworthy here.

***Learned helplessness***. Learned helplessness is a phrase first used by Overmier and Seligman (1967) and Seligman and Maier (1967) to describe dogs who, in the laboratory, failed to display escape-avoidance responding when given escapable shock, after they had been exposed to repeated

uncontrollable shocks (i.e., an aversive event). Researchers have reported an analogous response in human subjects (cf., Abramson, Garber, & Seligman, 1980). The original learned helplessness hypothesis proposed that learning that outcomes were uncontrollable produced motivational, cognitive, and emotional deficits. The absence of appropriate responding that was the essence of the learned helplessness phenomenon was viewed as a cognitive phenomenon. As Abramson, Garber, and Seligman (1980, p.4) explained:

> "... The organism must come to *expect* [original italics] that outcomes are uncontrollable in order to exhibit helplessness."

Although there has been evidence for alternate hypotheses (cf., Maier & Jackson, 1979), consensus seems to have supported this notion (see for example Abramson, Seligman, & Teasdale, 1978 and Maier, 1989 for review and critique of this literature) and has contributed towards a refined and reformulated learned helplessness hypothesis (cf., Abramson, Garber, & Seligman, 1980).

Although there is some dispute over just what type of deficit is produced by the interference effect (e.g., Balleine, & Job, 1991), current theory focuses on attributional changes in human subjects as a cornerstone of the learned helplessness phenomenon. Learned helplessness is more likely to occur in individuals who make internal, stable and global attributions for aversive events (cf., Sacks, & Bugental, 1987; Follette, & Jacobson, 1987).

Presumably, following repeated exposure to uncontrollable aversive events, these appraisal attributes produce a deficit in using signals about outcome (i.e., predictability information), helpless predictions (i.e., assessment of outcome expectancies), and low sense of control over the aversive event (Roth & Bootzin, 1984). These data may be interpreted as suggesting that the predictability of the aversive event, or at least subjects' ability to employ information about outcome, is key to understanding subjects' responses to aversive events. Similar data are reported in the literature on fear and panic attacks.

***Fear and panic attacks.*** Perceived control and the predictability of aversive consequences have been shown to exert powerful mediating effects in subjects' responses to fearful (i.e., aversive) events as well. Research findings with sufferers of panic attacks illustrate this point.

Several different types of panic attacks have been identified (cf., Sheehan & Sheehan, 1983; also see the American Psychiatric Association's, 1994, "Diagnostic and Statistical Manual for Mental Disorders, Fourth Edition" for description of panic attacks). Different attacks occur under different contextual circumstances (Rachman, 1988). Under circumstances of low predictability, attacks are more severe (Sheehan & Sheehan, 1983). Rachman and Levitt (1985) have shown that the provision of safety signals (i.e., signals which are reliably temporally associated with escape) to claustrophobic subjects was followed by a significant increase in predictions of safety in future exposure

to the same stimuli. In further experiments, Rachman and Levitt (1985) showed that unexpected or unpredicted panics were followed by higher reports of fear.

These data once again illustrate the importance that reliable information about the outcome of aversive events has in mediating behavioral responses to aversive situations. The unavailability of this information (i.e., low predictability) or subjects' deficient processing of this information (i.e., cognitive deficits) is associated with severe behavioral manifestations (e.g., learned helplessness and panic attacks). Both of the latter have been associated with subjects' reports of low sense of control in an aversive situation (Rachman, 1990).

Conversely, Averill (1973) and Thompson (1981), in separate reviews of the controllability literature, concluded that controllability does not reliably decrease the impact of aversive events. However, both reviewers' broad definitions of controllability may have obscured the positive effects of control by including in their reviews unrelated literature. Much of this literature confounded control and predictability: when an organism can reliably stop an aversive event (i.e., control it) the organism can also predict when it stops, but not vice versa.

Considerable research has examined the effects of predictability of the aversive event on both fear and learned helplessness, but far less research has investigated the generalizability of these effects to other aversive stimuli or events. Miller's (1981) assertion that the effects of providing temporal information about aversive events were unclear remains valid.

The question remains: to what extent does the predictability of aversive events influence laboratory pain perception and clinical pain phenomena? Few studies have addressed these questions.

### *Predictability in laboratory pain studies*

It has long been believed that control over a painful stimulus would decrease reactions to pain in the laboratory (Thompson, 1981; Averill, 1973). This belief has spawned, according to Arntz and Schmidt (1989), over 30 empirical laboratory investigations on the effect of control over painful stimuli. Most of this research has examined the effects of subject versus experimenter controlled escape or avoidance on reported pain.

Few studies have specifically investigated the effects of predictability in laboratory pain perception, let alone pain behaviour. Once again, predictability may be defined as the availability of information that reliably signals the beginning or end, increase or decrease of the noxious stimulus.

Rachman and Lopatka (1988) tested a model of pain prediction based on their work with fear which found that the overprediction of fear is common and that fearful people tend to overpredict fear. They queried whether the same patterns of behaviour occurred under different aversive events. In previous research, they observed that predictions of fear tended to increase after underpredictions and remained constant after correct matches (Rachman & Lopatka, 1988). They found that chronic pain patients were more accurate in

their predictions of pain than fear patients were in their predictions of fear, although pain patients were observed to make similar patterns of predictions as fear patients: that is, 1. after underpredictions, future predictions of pain tended to increase; 2. after overpredictions of pain future predictions of pain tended to decrease and; 3. after correct matches, future predictions of pain tended to remain constant. Although the data indicated that pain patients were more able, than were fear patients, to use information gleaned from past experience, the absence of pain- and fear-free comparison groups precluded the identification of abnormal patterns of prediction for either group.

Philips (1987) and others (e.g., Eich, Reeves, Jaeger, & Graf-Redford, 1985; Linton & Melin, 1982), have argued, primarily from a theoretical perspective, that the memory of past pain influences an individual's willingness to expose himself to stimuli previously associated with pain. These memories, amongst other cognitive events, function as covert signals and alter an individual's expectations or predictions about the effects of exposure and subsequently, alter the individual's feelings of control over the painful stimuli (Philips, 1987).

If covert internal signals alter individual feelings of control over pain, then it is plausible that external signals would alter feelings of control and possibly behavioral responses to pain.

There are only two studies which have examined the effects of stimulus predictability on pain perception.

Crombez, Baeyens and Eelen (1994) examined the effects of providing sensory and temporal information about a heat stimulus to 42 pain-free college undergraduates' perceptions of pain. They found that providing sensory information before exposure produced lower reports of pain and, that although providing a warning signal had no effects on pain perceptions per se, the provision of this temporal information resulted in less anxiety both during and between exposures to the stimuli.

Weisenberg, Wolf, Mittwoch, and Mikulincer (1990), reported that some, but not all, of their 50 healthy male subjects displayed a significant increase in sensitivity to a shock stimulus when they were not provided with a warning signal which reliably preceded stimulus onset.

Laboratory pain research has examined the relationship between perceived control and pain, the effects of expectancies on future predictions of pain and the effects of sensory and stimulus onset predictability on pain perception with pain-free subjects. No research has directly investigated the effects of stimulus duration or offset predictability on either pain perception or on pain behaviour in pain-free subjects or chronic pain patients.

Given the impressive magnitude of effects observed with human subjects under conditions of no predictability for other aversive stimuli (e.g., in learned helplessness experiments) and strong correlations between perceived control and reported pain (discussed later), there is adequate evidence from laboratory studies to implicate temporal predictability as a potential control variable in pain

perception and displays of pain behaviour.

### *Predictability in clinical pain studies*

Although the literature is replete with clinical observations and correlational studies which have examined the relationship between self-report or observational measures of control and pain, there are few well controlled experiments which have investigated the relationship between perceived control and clinical pain, let alone the relationship between stimulus predictability and clinical pain.

***Relationship between control, perceived control, pain perception and pain behaviour in clinical pain studies.*** Radnitz, Appelbaum, Blanchard, Elliot, and Andrasik (1988) found reductions in observed pain behaviour but not pain intensity ratings in patients who received self-regulatory treatment versus patients who received prescribed treatment regimens. This indicated that patients who were given at least some degree of actual control displayed fewer pain behaviours than patients who were not given actual control; although reports of pain remained unaffected. In this study, the primacy of cognitions (i.e., perceived control) over actual control was not supported; although the data did indicate discordance between measures of pain intensity and pain behaviour as previously reported.

Toomey, Mann, Abashian, and Thompson-Pope (1991) found that patients who scored low on the internality dimension of the Pain Locus of

Control scale reported higher levels of pain, but they did not find any relationship between patients' perceptions of control over their pain and levels of pain behaviour. They cautioned, however, that their measure of pain behaviour was not based on behavioral observation, but on a poorly constructed patient self-report scale.

Conversely, Gil, Keefe, Crisson, and Van Dalfsen (1987), reported that subjects' perceptions, appraisals and expectancies, rather than actual availability of resources with which to cope with pain, were related to pain behaviour. That is, subjects' perception of control rather than their actual control over pain were related to the extent of displayed pain behaviours.

Crisson and Keefe (1988) found that subjects who displayed high external loci of control reported greater pain intensity ratings. Although a strong relationship between locus of control and predictability was not established, it was intriguing that they also found a strong relationship between locus of control and subjects' rated ability to control their pain. That is, subjects who scored high on measures of external locus of control rated their ability to control or decrease their pain as low, relative to subjects who scored low on measures of external locus of control.

Anderson, Keefe, Bradley, McDaniel, Young, Turner, Agudelo, Semble, and Pisko (1988) reported that measures of helplessness (i.e., perceptions of no control) predicted pain behaviour and disability. They found that higher reports of helplessness were associated with more pain behaviour and

disability.

Two other studies provided stronger, albeit again indirect, evidence that stimulus predictability may have an effect on pain perception and pain behaviour in chronic pain.

Schwartz, DeGood, and Shutty (1985), reported that patients' beliefs or perceptions about how long their pain would last were related to treatment compliance and recovery. Patients who believed their pain would last a long time were less compliant and recovered more slowly than did patients who believed their pain would not last a long time. Williams and Keefe (1991), reported that patients who believed their pain was "mysterious", that is patients who did not believe their pain was predictable (amongst other attributes), were less likely to report that coping strategies were effective in controlling their pain. Because it may be argued that patients' beliefs are formed, in part, by information gleaned from the environment (the reader will recall that the availability of information from the environment is what defines stimulus predictability), these data provided indirect evidence that stimulus predictability may exert effects on pain perception and pain behaviour, though these beliefs still only represent predictions. For this reason, no valid conclusions could be made from these two studies about the direct effects of stimulus predictability on pain perception or pain behaviour.

Thus, although several studies have investigated the relationship between actual control, perceived control, predictions, beliefs and pain, the

findings have not been consistent and the data remain equivocal. No study has directly investigated the influence of stimulus predictability on pain perception and pain behaviour in chronic pain. The notable absence of appropriate control groups in clinical pain studies (Gamsa, 1994), for example, pain-free groups, has impeded the affirmation and advancement of pain theory.

### *Research questions*

The exact nature of the relationship between perceived control, stimulus predictability, pain perception and pain behaviour remains unclear and several questions remain unanswered. 1) What are the effects of stimulus predictability on pain perception and pain behaviour? 2) Are these effects constant across different pain stimuli? 3) What is the relationship between perceived control, pain perception and pain behaviour? No experiment has examined these questions.

### *Overview*

This thesis explores the nature and effects of stimulus predictability on pain predictions, pain perception (i.e., pain thresholds and pain reports) and pain behaviour during exposure to three different sources of pain.

Experiment 1 establishes the demographic, psychological and psychosocial characteristics of the study samples. Experiment 2 explores patterns of predicting pain during exposure to cold water immersion.

Experiments 3, 4 and 5 explore the effects of stimulus predictability during cold water immersion, step-ups and stationary standing, respectively. A final data-based section examines relations between perceived control over pain, pain predictions, pain thresholds, pain ratings and pain behaviour in Experiment 2, and presents correlations between measures of pain perception and pain behaviour during cold water immersion, step-climbing and standing.

Each data-based chapter presents sections on methods, results, conclusions and discussion specific to the experiment under study. A final section presents general discussion of the significance of these experiments, with consideration of existing literature, limitations of the findings, and directions for future research.

### *Design*

A combination of correlational and experimental research designs were used with subjects suffering from chronic pain and pain-free, control subjects. The project was conducted in two phases of research. Experiment 1 was conducted in clinical settings and Experiments 2 through 5 were conducted in a university laboratory setting.

Experiment 1 employed a case control design to establish demographic characteristics and assess beliefs about the extent of control over pain, self-reported pain behaviour and handicap. Experiment 2 employed a 2 X (3) mixed factorial design to examine patterns of predicting pain. Subject grouping was

the between subjects factor and trial was the repeated measures factor. Studies 3 to 5 employed a series of 2 X 2 X (3) mixed factorial experiments to examine the effects of stimulus predictability on pain perception and pain behaviour using both experimental and more natural pain stimuli. Subject grouping and counterbalanced-order were the two between subjects factors and level of stimulus predictability was the within subjects factor across all three experiments. Predicted pain, pain thresholds, reported pain, and pain behaviours were the four dependent variables under study during these experiments.

***Relevance***. This research evaluated between-group differences in relationships between perceived control, pain prediction, pain perception and pain behaviour and the effects of stimulus predictability on pain perception and pain behaviour during exposure to three different pain stimuli. The following experiments show the effects of direct variation of temporal predictability on pain perception and pain behaviour. The use of the same subjects between clinical and laboratory phases of the research provided an opportunity to examine the concordance between clinical questionnaire data and laboratory-based behavioral observations of pain behaviour. Results gleaned from the study of chronic pain patients and matched controls, during acute pain, in controlled laboratory experimentation, will help clarify what, if any, differences exist between these two groups in basic responses to pain, and will contribute greater specificity to theoretical models of chronic pain.

Chronic pain can be variable in its course, intensity and duration (i.e., it can occur under conditions of low predictability). Based on the theoretical arguments and research presented from, for example, the animal research on exposure to aversive stimuli, learned helplessness theory, and clinical pain studies, it was hypothesized that pain patients' responses to their pain may be, in part, a consequence of chronic exposure to a low predictability (at times inescapable, at times uncontrollable) aversive event. Comparison with pain-free subjects, under conditions which would be painful to both groups, was necessary to determine whether pain patients' responses to pain and to stimuli which exacerbated their chronic pain, were attributable to an abnormal response to pain, or to factors unrelated to the perception of pain.

### *Pilot studies*

Three undergraduate research projects, numerous test trials with pain-free subjects, and one study where a chronic pain patient was put through the entire series of experiments provided pilot data for this dissertation.

In two related studies, Prostack, McGrath and Murray (1990) examined the psychometric properties of three different methods for eliciting pain reports and pain related thoughts from pain-free adult subjects who had been subjected to cold pressor pain. Their research provided an opportunity to test the viability and optimal operating ranges for newly constructed cold pressor apparatus, newly acquired audio and visual monitoring and data recording systems, and to

determine the normal range of responses to the cold pressor task. Fox (1991) investigated the range and nature of behavioral responses to the cold pressor task, examined the suitability (for this research) of three different observational methods for assessing pain behaviours and established preliminary psychometric properties of modifications to the pain behaviour rating system which was employed in the current study.

As modifications were made to equipment, measures, design and procedures, pain-free subjects were recruited to test and standardize procedures and run through relevant portions of the experiments. When the final methodology was established, one chronic pain patient (recruited as described in Subjects) was run through the entire study to ensure the standardization of procedures.

### *Hypotheses*

Hypotheses are listed numerically, by variable domain, under the experiment that addressed the specific research question.

## METHOD

This section describes the general methodology used across all studies. General procedures employed in dealing with issues related to consent, remuneration, setting and debriefing are described in this section alone.

Because the same subjects participated in each experiment, subject recruitment and characteristics are also described in this section. Similarly, psychometric and laboratory measures and apparatus are described under this general heading. However, unique and specific methodological procedures and results are described separately for each experiment.

### *Subjects*

Forty subjects, who comprised two groups, participated in the five experiments between February 1992 and April 1993. Twenty subjects were patients who were suffering from chronic pain and social handicap, as the term is defined below, and comprised the pain group. Twenty age and education matched subjects, who were not suffering from any type of chronic pain or handicap, comprised the control group.

Because chronic, intractable, low back pain is a multifaceted disorder (Troup & Videman, 1989; Merskey, 1986), because research findings had not supported a linear relationship between the magnitude of lesion, pain intensity and pain behaviour in chronic low back pain (Oostdam & Duivenvoorden, 1987), because there was a high prevalence of pain behaviour in this diagnostic group (Connally & Sanders, 1991) and because a reasonable number of these patients were available locally, patients diagnosed with this disorder were selected for study.

***Referral sources***. Nine pain treatment centres in the metropolitan Halifax region were approached for subjects between April, 1991 and February, 1992. All nine centres agreed to participate in the research. These included Halifax Physiotherapy/Sport Injuries and Work Hardening Centre, The Canadian Back Institute, the Pain Management Clinic of the Victoria General Hospital, the Pain Management Programme and the Department of Rehabilitation Psychology of the Nova Scotia Rehabilitation Centre, The Brighton Centre for Integrated Health, Renova Physiotherapy, Armdale Physiotherapy, Sackville Physiotherapy and Truro Physiotherapy. Ultimately, only Halifax Physiotherapy/Sport Injuries and Work Hardening Centre, The Canadian Back Institute, and the Pain Management Clinic of the Victoria General Hospital were able to refer patients for participation in this research. Table 1 presents a break-down of the total number of candidates interviewed and the final number of subjects who participated from each clinic. There were no drop-outs from the study.

Table 1

Number of subjects from each of the three source clinics

| Clinic | Number of subjects interviewed | Number of subjects in final sample |
|---|---|---|
| Halifax Physiotherapy[a] | 16 | 15 |
| The Canadian Back Institute | 4 | 4 |
| Victoria General Hospital[b] | 3 | 1 |
| N.S. Rehabilitation Centre[c] | 1 | 0 |

[a] Halifax Physiotherapy, Sport Injuries and Work Hardening Centre. This centre actually referred 16 patients but one subject was dropped from all analyses because of an inability to locate a suitable control subject. [b] Pain Management Clinic of the Victoria General Hospital (of the 3 patients referred to the study, one refused to participate when it was clear that there would be no treatment benefits to him and another did not meet the selection criteria). [c] Nova Scotia Rehabilitation Centre (patient did not meet the selection criteria).

***The pain group***. Twenty male subjects were recruited from the Halifax Physiotherapy, Sport Injuries and Work Hardening Centre, The Canadian Back Institute, and the Pain Management Clinic of the Victoria General Hospital.

Subjects were selected from lists of patients who met the following inclusion and exclusion criteria. Subjects had to be male, between 19 and 65 years of age, speak English fluently, and had to be seeking treatment for on-going, chronic, benign, low back pain. Suitable chronic benign low back pain diagnoses included Chronic Mechanical Low Back Pain (533.X1), Acute Low

Back Strain (531.X8), or Recurrent Low Back Strain (532.X7b) as defined by the International Association for the Study of Pain criteria (Merskey, 1986). Candidates had to be in pain for at least three months; and apart from complete recovery, could have been in any stage of treatment. Also, subjects had to be suffering handicap as a result of their pain. Handicap was determined during Experiment 1 according to World Health Organization (1980) guidelines. Subjects were excluded if there was: a history of hypertension; presence or history of cardiac or vascular disease, stroke, rheumatic fever, severe or allergic reactions to cold; previous frostbite in the left hand or arm; left hand or arm abnormality such as disease, surgery or chronic pain; currently suffering from a major affective or psychotic disorder; pain due to malignancy, herniated disc, or systemic disorder; any other equally painful or debilitating medical disorder including Osteophyte, Lumbar Spondylolysis, Degenerative Spinal Stenosis, Sacralization, Degenerative Facet Tropism, Acute Low Back Strain of less than three months duration, Acute Trauma, or Ankylosing Spondylitis of the lumbar region; or if there was previous experience with ice water immersion procedures. Appendix A presents the Subject Selection Checklist used to identify potential subjects.

***Control group***. Twenty male subjects were recruited from the pain group's age and education cohort (plus or minus five years in age and three years in level of education). With the exclusion of the criteria "suffering from low back pain", and the inclusion of the matching criteria, control group subjects

met the same inclusion criteria as pain patients. Also, control subjects met the same exclusion criteria as pain patients, with the added exclusion criteria that no control subject suffered from any painful condition which endured for more than seven days within the twelve month period preceding the study.

Control subjects were recruited by two methods. First, all pain patients who participated in this research were asked to recommend a same sex friend for inclusion in the study. Nine patients agreed to this and all 9 referrals were successfully recruited for this study. Second, 12 control group subjects who had no affiliation to the Pain Research Laboratory were recruited, "off the street", by the principal investigator and his colleagues. Eleven of these subjects successfully completed the study. One control candidate was eliminated after recruitment but prior to participation in the experiments because he had imbibed several alcoholic beverages prior to his arrival at the laboratory.

Table 2 presents means and standard deviations in age and level of education for each group. There were no significant differences in age or level of education between groups. Appendix B presents paired raw data for each subject on the two matched variables.

Table 2

Mean age and level of education for pain and control groups

| | Group | |
|---|---|---|
| Variable | Pain | Control |
| Age | | |
| Mean | 35.95 | 33.35* |
| Standard deviation | 7.57 | 9.83 |
| Education | | |
| Mean | 10.10 | 11.55* |
| Standard deviation | 2.13 | 1.79 |

Note. Age and level of education are reported in years.
* n.s.

***Measures: self-report inventories***

A standardized battery of paper and pencil tests was administered to all subjects during Experiment 1. The battery included self-report measures which assessed: beliefs about the extent of personal control over pain (perceived or sense of control), coping styles, self-reported pain behaviour, current level of disability and handicap, and depressive and anxious symptomatology (to assist in establishing the representativeness of the samples to existing research). Following Experiment 5, subjects were also administered a semi-structured interview which provided a check on the efficacy of the design and experimental

manipulations employed.

***Coping Strategy Questionnaire.*** The Coping Strategy Questionnaire was developed by Rosenstiel and Keefe (1983) specifically for use with chronic low back pain patients. It has been widely used (cf., Keefe, Crisson, Urban, & Williams, 1990; Reesor, & Craig, 1988) and has consistently demonstrated good psychometric properties relative to convergent measures (e.g., Main & Waddell, 1991; Lawson, Reesor, Keefe, & Turner, 1990; Keefe, Caldwell, Queen, Gil, Martinez, Crisson, Ogden, & Nunley, 1987). It consists of 44 self-report items (scored on a seven point Likert scale) which comprise seven cognitive strategy scales (6 items per scale) and two perceived pain control scales. The coping scales included measures of: diverting attention, reinterpreting pain sensations, coping self-statements, ignoring pain sensations, increasing activity levels, praying or hoping, and catastrophizing. The two perceived pain control scales measure subjects' perceived control over pain (this scale is also used as a pain self-efficacy scale) and perceived ability to decrease pain (this scale is also used as a sense of control scale). Appendix C presents the Coping Strategies Questionnaire.

***Pain Behaviour Checklist.*** The Pain Behaviour Checklist, a 20 item checklist of common pain behaviours, was developed by Turk, Wack, and Kerns (1985). Patients indicate the degree to which they engage in various pain behaviours which comprise four categories: distorted ambulation or posture, negative affect, facial/audible expressions of distress, and avoidance of

activity. This test has been found to have good internal consistency and test-retest stability (Turk, Wack, & Kerns, 1985) and has also displayed evidence of convergent validity (Romano, Syrjala, Levy, Turner, Evans, & Keefe, 1988). Appendix D presents a copy of the Pain Behavior Check List.

***Beck Depression Inventory (BDI).*** The Beck Depression Inventory (Beck, Ward, Mendelson, Mock, & Erbaugh, 1961) was used as a measure of depressive symptomatology. This scale consists of 21 items which assess the severity of different symptoms of depression. Subjects are asked to endorse statements that best describe how they have been feeling recently. Total sores may range from 0 to 63. Higher scores indicate more severe depression. The BDI has been used extensively in research with both chronic low back pain patients and non-depressed subjects and has demonstrated adequate psychometric properties (Beck, & Steer, 1988). This instrument is not included in the Appendix because it is widely available.

***State-Trait Anxiety Inventory (STAI).*** The Trait sub-test of the State-Trait Anxiety Inventory (Spielberger, Gorsuch, & Lushene, 1970) was used as a measure of anxious symptomatology. This sub-test consist of 20 items which assess the frequency with which subjects are bothered by symptoms of anxiety. Total scores may range from 0 to 80. Higher scores indicate more severe generalized anxiety. The STAI has been used extensively in research with chronic low back pain patients and non-anxious subjects. This instrument is not included in the Appendix because it is widely available.

These scales were selected on the basis of five criteria: 1) applicability of scale to low-back pain samples, 2) quality and availability of psychometric studies on scale construction and other reliability and validity studies, 3) availability of sample-appropriate normative data, 4) unique contribution of scale to test battery used in this research and, 5) ease of administration and scoring of scale.

***Demographic data***. Subjects were also asked to complete a short demographic data questionnaire which provided information on subject's: age, gender, marital status, level of education, date of onset of pain, other medical diagnoses (if known), type and quantity of medication used, and employment status. Appendix E presents the demographic data questionnaire which was labelled, Medical Information.

***Handicap***. Handicap was determined from clinician's ratings of patients' functional status based on WHO (1980) criteria for handicap. Appendix F presents the handicap questionnaire developed for this purpose.

***Self-reported disability and handicap***. The Functional Disability Inventory (FDI) (Walker & Greene, 1991) was modified for use in this research as a measure of self-reported disability and handicap. The modified FDI was called the, "Self-reported Disability and Handicap Scale", and consisted of a 15 item self-report inventory with four, forced-choice, Likert responses. Subjects were asked to endorse the extent to which their current level of pain had created or would create difficulties doing 15 specific activities (see Appendix G). Items

were scored from zero (no trouble) to four (impossible). The modified FDI instructions resulted in a scale that assessed the impact of subject's current level of pain on normal physical and social activities which are often referred to as functional disability. The FDI has shown adequate psychometric properties (Walker & Greene, 1991).

***Measures: laboratory***

The following measures were used during Studies 2 to 5.

***Pain behaviour***. A modification of the observational measurement system developed by Keefe and Block (1982) was employed to record overt pain behaviours (Braha, Goodman, & McGrath, 1993). Keefe and Block's (1982) method was developed specifically for use with chronic low back pain patients in clinical settings. In this system, subjects are observed while engaged in a standard set of daily activities: sitting; walking; reclining; and standing. Sessions are scored by either the clinician during the activity, or video-taped and scored later. Keefe and Block (1982) used a time sampling procedure to record pain behaviours. Unfortunately, sitting, reclining and walking are not practical or amenable to experimental manipulation. Conversely, step-climbing elicits pain behaviour in many chronic low back pain patients, is practical, and more amenable to experimental manipulation than either sitting or walking. Although these activities elicit pain behaviour in chronic low back pain patients, they do not usually produce pain or pain

behaviour in normals. Cold water immersion has been shown to elicit pain and pain behaviour in both patients and non-patient groups alike and is a good experimental stimulus because it is amenable to parametric manipulation. Thus, to allow for the direct comparison of pain perception and pain behaviour between chronic low back pain patients and normal control subjects, we replaced sitting, reclining and walking with cold water immersions and step-ups and we retained the stationary standing activity. The original scoring system and operational definition of each behaviour were modified for use with the new activities. These changes permitted standardized recording of behaviour across the new activities, the recording of more subtle expressions of pain, and minimized redundancy between the categories of pain behaviour. The modifications maintain the overall construct of pain behaviour as delineated by Keefe and Block (1982). However, under the modified system, a blind rater scores the frequency and duration of pain behaviours and all behaviours are recorded and scored using real-time rather than time-sampled observations. The five behaviours originally delineated by Keefe and Block (1982) are recorded as well as two new behaviours. Guarding, bracing, rubbing, facial expression, and sighing were the original 5 behaviours to which were added back and hand movements to comprise the seven behaviours scored with the modified system. Appendix H includes the rating manual and describes the development of the scoring system.

All reported inter-rater reliability estimates using the Keefe and Block

(1982) system have reflected over 90 percent agreement between raters (e.g., Keefe & Block, 1982; Keefe, Crisson, & Snipes, 1987; Keefe, Wilkins, & Cook, 1984). We found similar, albeit less impressive data with the use of the modified system. Table 3 presents inter-rater reliability coefficients for the modified scoring system.

Table 3

Pearson product-moment inter-rater reliability coefficients for the pain behaviour rating system during cold pressor, step-up and standing activities

| Behaviour | Cold pressor | Step-ups | Standing | Average* |
|---|---|---|---|---|
| Guarding | .93 | .95 | .98 | .91 |
| Bracing | .93 | .86 | .91 | .9? |
| Rubbing | .93 | .95 | .88 | .93 |
| Grimacing | .91 | .97 | .41 | .81 |
| Sighing | n/a | .86 | .72 | .83 |
| Arm movement | .88 | 1.00 | n/a | .34 |
| Back movement | .86 | .89 | .97 | .71 |
| Total score | .89 | .91 | .92 | .78 |

* Average column coefficients include data from all of the Pain Research Laboratory's experience using this method. The average column *is not* an average of the values presented in the other columns, but includes these values in the determination of the "average" coefficients.

Table 4 presents percent agreement between raters during training and for data used in this research.

Table 4

Average inter-rater agreement at end of training period and from data coded for this study

| Behaviour | % Agreement (Training period) | % Agreement (Coding Tapes) |
|---|---|---|
| Guarding | 88% | 83% |
| Rubbing | 92% | 86% |
| Bracing | 85% | 88% |
| Grimacing | 91% | 80% |
| Sighing | 89% | 86% |
| Arm movement | 85% | 75% |
| Back movement | 90% | 80% |

Note. % agreement = (% agreement / % agreement + % disagreement) X 100.

***Total pain behaviour score***. For each experiment, analyses using each of the seven pain behaviour subscales were conducted. However, because of reliable high intercorrelations between many of the subscales, multicolinearity between subscales, and because presenting results from each separate analysis would be lengthy and consistently did not offer any information not derivable from the total pain behaviour scores, results for each experiment are presented only from analyses which used the total pain behaviour score.

***Pain intensity***. Subjects' perceptions of pain intensity were assessed using an 11 point numerical scale which was a modification of the original 101-point Numerical Rating Scale (NRS-101) (Jensen, Karoly, & Braver, 1986). The scale had two anchor or reference points: a rating of "0" referred to "no pain" and a rating of "10" referred to the worst imaginable pain (i.e., " pain as bad as it can be"). Subjects were asked to use the scale both to predict the intensity of pain associated with the experimental procedure and to rate the pain they experienced.

***Pain threshold***. Pain thresholds were assessed using standard methods (e.g., Boureau, Luu, Doubrere, 1991; Efran, Charney, Ascher, & Lukens, 1989). Subjects were asked to indicate precisely when the stimulus they were experiencing began to be painful. Pain thresholds were measured in seconds. During Experiment 3 which used a cold pressor stimulus, timing for thresholds began the moment the subjects' arm made contact with the water. During Experiment 4 which used a step-up stimulus, timing for thresholds began the

moment the subjects' leading foot was raised off the floor. During Experiment 5, which used a stationary standing stimulus, timing for thresholds began the moment the instruction to begin was issued.

### *Apparatus and materials*

***Audio***. A *Sony Radio-Cassette-Corder*, am/fm radio stereo cassette recorder (model number CFS-1020) with detachable two-way speaker system, was used to record and playback the instructional tape used during the laboratory experiments. One speaker was located in the laboratory control room and enabled the experimenter to monitor the experiments while the second speaker was located in the laboratory test room to guide the subject through the experiments.

***Cold pressor immersion apparatus***. A cold pressor immersion apparatus designed according to standard specifications (cf., Turk, Meichenbaum, & Genest, 1983; Efran et al., 1989) was used to induce the experimental pain stimulus. The subject's non-dominant arm was positioned on a cradle which was hinged to the top of the apparatus. The cradle was lowered slowly into the water until the subject's arm was immersed in the water up to the mid-forearm region (approximately 30 cm from the fingertips). The water temperature was maintained at between one and four degrees celsius. Maximum duration of immersion for all experiments was 60 seconds. An *EHEIM Bestell* external water pump (model number 2016 series 781: 0.5 amp, 25 watt, 60 Hz) was

used to circulate the water in the cold pressor tank and thus minimize temperature variations in the tank.

A separate tank, identical to the above described apparatus, was filled with room temperature water and used to standardize subject's surface skin temperature and familiarize subjects with procedures prior to the experiments.

***Countdown timer***. A digital countdown timer with 1.53 centimetre liquid crystal displays and slave controls for operation from the control room served as the visual display in Studies 3, 4, and 5. A *Micronta* LCD dual memory digital clock timer microchip processor (model number 63-884 distributed by Radio Shack Canada) operated the device which was constructed specifically for use in this research.

***Disinfectants***. Common table salt (50ml sodium chloride/ 50l water) was added to the cold pressor tanks to expedite thawing of the ice. *Formulator System* deodorizer disinfectant containing quaternary ammonium chlorides (n-Alkyl [40% $C_{12}$, 50% $C_{14}$, 10% $C_{16}$] Dimethyle Benzyle Ammonium Chlorides 0.15%) was added as a disinfectant. *Formulator* (lot C011021), manufactured and distributed by G.H. Wood, is appropriate for cleaning and disinfecting.

***Intercom***. An *Archer* four station wired intercom (model number 43-223A distributed by Radio Shack Canada) was used to communicate with subjects in the test room during the laboratory phase of this research.

***Instructional audio tape***. Pre-recorded instructional audio tapes guided subjects through each experiment. One tape was recorded for each of the two

counter-balanced orders in which subjects received the experimental treatments. Appendix I presents a copy of the script used in recording the tape for the first counterbalanced order.

***Orientation audio-video tape.*** A short (4 minute 17 second) colour VHS video tape was prepared to familiarize subjects with the setting, apparatus and experimental procedures they would be asked to follow. The video tape presented subjects with a brief explanation of the nature of the experiments they would be participating in, the sequence of events which would ensue, training and review of what would be expected of them during the experiments and the proper use of each apparatus. Appendix J presents a copy of the video-shoot scene directory used in filming the orientation tape.

***Step climbing.*** A step-climbing platform was constructed specifically for use in Experiments 4 and 5. This apparatus consisted of a rectangular wooden platform with a target landing area measuring 94cm in width by 80cm in depth by 16cm in height. The painted platform had 93cm high security railings on the two parallel short sides. The platform was braced to prevent movement.

***Stop watch.*** A Micronta, hand held LCD quartz stop watch was used in timing events for the instructional audio tape and in scoring pain behaviour.

***Test room.*** A quiet test room was used for all laboratory experiments. The room measured 6.25 meters in length, by 3 meters in width, and 2.45 meters in height, was well lit by fluorescent fixtures, and had light grey coloured wall to wall carpeting.

***Thermometer.*** A *Fisher Scientific, NBS Specification Monograph 150,* individually re-tested thermometer (catalogue number 14-985B), with a range of -20 to 110 degrees Celsius and 1 degree Celsius tolerance, was used to determine water temperature during the cold pressor experiments.

***Video.*** Two cameras were used to film the orientation tape and subjects' behaviour during the laboratory experiments. One camera was wall mounted (*Panasonic Digital 5000 Heavy Duty System Camera with an 8X TV zoom lens* manufactured by Matshushita Communication Industrial Company Limited) and was remote controlled by a *Panasonic Camera Remote Controller* (model number WV-CR12) via a *Panasonic Remote Operation Pan/Tilt Head* (model number WV PH-10). This wall-mounted camera provided total body film of subjects' behaviour throughout the laboratory experiments. The second camera (*Panasonic Variable High Speed Shutter SVHS Reporter Movie Camera Recording and Playback* model number AG-450 with *Piezo* auto-focus and auto-white balance) was floor mounted on a tripod (*Manfrotto Professional Tripod* model number 128) and, although auto-focused, was aimed manually prior to the start of each experiment. This floor mounted camera was used to provide close-up film of subjects' facial expressions throughout the laboratory experiments. Video tapes were recorded and played on a *Panasonic Pro-line SVHS HiFi MTS Broadcast Stereo Multiplex Video Cassette Recorder* (model number AG-1960) and viewed on *a Panasonic Colour Video Monitor* (model number CT-1030MC). A *Panasonic Professional/Industrial Video Pro-line*

*SVHS HiFi* video cassette recorder (model number AG-500R) with four rotary heads and helical scanning system was used to make duplicate copies of the video tapes.

### *General Procedures*

***Informed consent.*** In accordance with the Canadian Psychological Association's (1991), "Canadian Code of Ethics for Psychologists", Dalhousie University's, Victoria General Hospital's, and Nova Scotia Rehabilitation Centre's ethics and research review committee guidelines, informed consent was obtained from individual subjects prior to their participation in the study. Informed consent included the conveyance of information regarding the composition of the research team, the purpose of the study, the exact procedures employed, the benefits and risks involved in participation, the voluntary nature of participation, confidentiality of data, rights to refuse or withdraw at any time, and subjects' rights for clarification at any time. Subjects were given the opportunity to question the investigators regarding the above, and signed agreement to participate was obtained prior to commencement of the research. Appendix K presents copies of the individual consent forms employed at each of the four settings as described below.

***Setting and duration.*** The setting used in this research varied. Pain patients completed Experiment 1 at the clinic where they had been receiving treatment. Control subjects completed Experiment 1 at Dalhousie University.

Experiment 1 did not require more than one hour to complete. All other studies were conducted at the laboratories of Dr. Patrick McGrath of the Department of Psychology, Dalhousie University and did not require more than two hours to complete.

***Monitoring water temperature***. Water temperature was measured on two occasions: while subjects were viewing the orientation video, immediately prior to the start of Experiment 2 and; immediately following Experiment 3.

***Debriefing***. Following Experiment 1 and the completion of the research, rationale for procedures and general feedback about the subject's performance were given and subjects were given an opportunity to question the investigator.

***Remuneration***. All subjects received a forty dollar honorarium. This honorarium covered expenses which may have been incurred by subjects over the course of the study (e.g., transportation, parking, babysitting, long distance telephone charges).

### *Data analyses*

Between and within group differences from each experiment were tested using repeated measures univariate and multivariate analysis of variance with planned contrasts. The suitability of the data for these types of statistical analyses was determined prior to inferential testing.

***Generalizability***. Pain group subjects were selected sequentially from new and on-going cases at each of the participating clinics. Apart from the

initial pre-selection (cf., Procedures section of Experiment 1), no systematic bias occurred in subject selection. Control group subjects appeared reasonably representative of pain group's age, education and socio-economic cohort.

***Normality***. Univariate normality was assessed by visual inspection of each dependent variable's frequency distribution, measures of skewness and kurtosis, and stem-leaf plots (Thorndike, 1978).

***Homogeneity***. Bartlett's Test of Sphericity and Box's M Test statistic were used to evaluate univariate and multivariate homoscedasticity of variance for the each variable's individual and combined distributions.

***Linearity***. Scatterplots were visually inspected for linearity of residuals.

Also, to reduce the risk of Type I error from multiple tests of significance with several dependent variables and to protect against any possible redundancy and suppression between the dependent variables, multivariate analyses of variances were, where appropriate, performed first. Significant multivariate effects were followed-up with univariate analyses and planned contrasts to locate the source of the effects.

***Probability tests and levels of significance***. Unless otherwise indicated, two-tailed tests of significance are reported in the results. Results were considered significant when the obtained alpha levels were no higher than five percent. Although trends are reported when the obtained alpha levels were greater than five percent but less than eight percent, trends were not considered sufficient evidence to support hypotheses.

## EXPERIMENT 1: DEMOGRAPHIC AND PSYCHOMETRIC ASSESSMENT

Experiment 1 was conducted to establish the homogeneity of the samples, the representativeness of the samples relative to other studies, and to provide an opportunity for identifying and pre-screening patients for participation in Studies 3 to 5, should the need have arisen.

### *Hypotheses*

***1. Handicap.*** It was expected that pain patients would a) report experiencing higher levels of handicap and, b) be rated by others as displaying higher levels of handicap than would control subjects.

***2. Perceived control.*** It was expected that pain patients would report a lower sense of control over pain than would control subjects.

***3. Pain behaviour.*** It was expected that pain patients would report higher levels of pain behaviour than would control subjects.

***4. Depression.*** It was expected that pain patients would report higher levels of depressive symptomatology than would control subjects.

***5. Anxiety.*** It was expected that pain patients would report higher levels of trait anxiety than would control subjects.

## *Method*

### *Procedures*

***Training clinicians.*** Patient case managers were trained in the use of the Subject Selection Form and the WHO Handicap Scale prior to subject recruitment.

***Rater reliability.*** All clinician ratings were subjected to reliability checks by the author during a post-subject selection interview. These interviews served to standardize interpretation of the rating manuals. Thus, raters made consistent subjective interpretations in the use of the two instruments.

***Subject selection.*** The principal investigator in conjunction with clinical staff at each of the clinics identified potential candidates for inclusion in the study from current cases.

***Consent of treating physician.*** Verbal consent was obtained from the identified patient's family physician or treating physician at the private clinics.

***Subject recruitment.*** Patients who satisfied the selection criteria were asked to participate in this research by their treating physician at the Victoria General Hospital's Pain Clinic, and by their treating physiotherapist at the independent physiotherapy clinics. Prior to being asked to consent, all potential subjects received a description of the research procedures as well as a copy of the consent form (see Appendix K).

***Informed consent.*** According to the procedures described above,

informed consent was obtained from all subjects prior to commencement of the research.

***Self-report measures***. Subjects were asked to complete the battery of paper and pencil questionnaires described above. The entire battery did not require more than one hour to complete.

***Control group subject recruitment***. Pain subjects were requested to ask a same sex friend to participate in the research.

***Debriefing***. Subjects were debriefed as to the procedures completed, given an opportunity to question the researchers and an appointment for further testing at Dalhousie University.

## *Results*

Table 5 presents group data on total scores for the WHO Handicap Scale, the Self-report Disability and Handicap Scale, the Pain Behaviour Check List, the two Coping Strategies Questionnaire perceived control items, the Beck Depression Inventory, and the Trait sub-test of the Spielberger State-Trait Anxiety Inventory.

Table 5

Descriptive statistics on total scores for Experiment 1 measures

| | Group | |
|---|---|---|
| | Pain | Control |
| Measure | Mean (S.D.) | Mean (S.D.) |
| WHO[a] | 8.95 ( 3.90) | 0.15 (0.40)* |
| Handicap[b] | 27.16 (10.61) | 1.60 (2.33)* |
| CSQ 43[c] | 2.55 ( 1.79) | 4.25 (1.11)* |
| CSQ 44[c] | 2.25 ( 0.97) | 3.75 (1.25)* |
| Pain behaviour[d] | 60.00 (14.63) | 24.90 (9.78)* |
| Depression[e] | 13.90 ( 8.03) | 5.25 (8.30)* |
| Anxiety[f] | 47.90 (11.64) | 34.65 (8.60)* |

Note. $N = 40$.
*$p < .001$.
[a] WHO Handicap Scale. [b] Self-report Disability and Handicap Scale. [c] CSQ perceived control items. These two items were combined into one perceived control item in later analyses. [d] Pain Behaviour Check List. [e] Beck Depression Inventory. [f] Trait sub-test, State-Trait Anxiety Inventory.

***Hypotheses 1a and 1b: Handicap***. There were significant differences between pain and control groups' mean scores on measures of observer rated handicap using the WHO Handicap Scale ($t = 10.05$, 38 *df*, $p < .001$) and self-reported disability and handicap ($t = 10.96$, 38 *df*, $p < .001$) (see Table 5). Pain patients consistently displayed and reported significantly higher levels of

handicap as a result of pain than did control group subjects.

***Hypothesis 2: Perceived control.*** There were significant differences between pain and control groups' mean scores on measures of perceived control over pain. Pain group mean scores on items 43 and 44 of the Coping Strategies Questionnaire were significantly lower than control group mean scores ($t$ = -3.64, 38 *df*, $p < .001$; $t$ = -4.24, 38 *df*, $p < .001$ respectively) (see Table 5). Pain patients consistently reported significantly lower perceived control over pain than did control group subjects.

***Hypothesis 3: Pain behaviour.*** There were significant differences between pain and control groups' mean total scores on the Pain Behaviour Check List. Pain patients consistently reported displaying significantly higher levels of pain behaviour in response to pain than did control group subjects ($t$ = 8.98, 38 *df*, $p < .001$) (see Table 5).

***Hypothesis 4: Depression.*** There were significant differences between pain and control groups' mean total scores on the Beck Depression Inventory ($t$ = 3.35, 38 *df*, $p < .001$) (see Table 5). Pain patients reported significantly higher levels of depressive symptomatology than did control group subjects.

***Hypothesis 5: Anxiety.*** There were significant differences between pain and control groups' mean total scores on the Trait sub-test of the State-Trait Anxiety Inventory ($t$ = 4.09, 38 *df*, $p < .001$) (see Table 5). Pain patients reported more anxious symptomatology than did control group subjects.

### *Experiment 1: Conclusions and discussion*

Results supported the predictions. Pain group subjects displayed and reported more handicap, more depressive and anxious symptomatology, and less perceived control over pain than did the control group subjects. This pattern of results is well established in the literature and indicated that the samples were appropriately drawn and distributed, and that results from this research would generalize adequately to other similar samples.

## EXPERIMENT 2: PREDICTING EXPERIMENTAL PAIN AND BASELINE PAIN PERCEPTION MEASURES

This experiment was conducted to: 1) attempt to replicate Rachman and Lopatka's (1988) findings that chronic pain patients are accurate in their predictions of impending pain, thus, a repeated exposure design was employed; 2) to provide baseline data on pain predictions by establishing subjects' tendencies to either over or under predict pain; 3) to provide reliable baseline data on pain thresholds and; 4) to serve as pre-exposure training for Experiment 3 (because during Experiment 2 subjects would be given three short exposures to the same stimuli used in Experiment 3 and were required to make predictions about future pain, report pain thresholds and intensity levels).

### *Hypotheses*

The reader will note below that it was hypothesized that pain patients would display lower pain thresholds and report higher levels of pain than would control subjects. At first glance it may seem that these predictions were incompatible with predictions made regarding subjects' initial expectancies and some of the published research. It is not clear whether chronic pain patients have higher or lower pain thresholds than pain-free subjects (Peters & Schmidt, 1992). Some research would suggest that chronic pain patients have higher pain thresholds and other research would suggest that chronic pain patients

have lower pain thresholds than healthy controls (Lipman, Blumenkopf, & Parris, 1987; Malow, Grimm, & Olson, 1980). Regardless, it would not be appropriate to make any conclusions about all chronic pain patients based on studies of one clinical syndrome. Responses to acute pain appear to differ as a function of the clinical syndrome which is studied (Peters & Schmidt, 1992). Some research with chronic low back pain patients suggested that these patients had higher pain thresholds than did pain-free subjects (e.g., Cohen, Naliboff, Schandler, Heinrich, 1983; Naliboff, Cohen, Schandler, Heinrich, 1981). However, both these papers reported on a study where control subjects were not well matched with patients' age or medication use. These factors alone could have accounted for the pain groups' increased latency to detect painful sensations.

Hypotheses for Experiment 2 were made on the basis of evidence presented in the Introduction, because research has shown, albeit not reliably, that anxiety (e.g., Bronzo, & Powers, 1967; Cornwall & Donderi, 1988; Martinez-Urrutia, 1975; Miron, Duncan, & Bushnell, 1989; Weisenberg, 1980), depression (e.g., Zelman, Howland, Nichols, & Cleeland, 1991), and even ongoing pain (e.g., Naliboff & Cohen, 1989) tend to increase sensitivity to pain; it has long been recognized that chronic pain patients typically report and display higher levels of anxious and depressive symptomatology than do pain free subjects (Crisson, Keefe, Wilkins, Cook, & Muhlbaier, 1986; Craig, 1984; Turner, & Romano, 1984), and there was compelling theory that predicted that

chronic low back pain patients would display increased sensitivity to pain (Lethem, Slade, Troup, & Bentley, 1983; Philips, 1987).

***6. Predicting pain.*** It was predicted that there would be no significant differences between groups on predictions of the intensity of future experimental pain from cold water immersion.

***7. Predicting pain: accuracy.*** It was predicted that there would be no significant difference between groups on the accuracy of predictions about the intensity of future experimental pain from cold water immersions.

***8. Predicting pain: accuracy over time.*** It was predicted that there would be no significant differences between groups on improvements, over trials, in accuracy of predictions about the intensity of future experimental pain from cold water immersions.

***9. Pain thresholds.*** It was predicted that there would be significant differences between groups on mean pain thresholds during cold pressor pain: pain patients would display lower pain thresholds than would control subjects.

***10. Sensitization/habituation.*** There were insufficient data to formulate hypotheses regarding changes in pain perception as a function of repeated exposure to a painful stimulus. Thus, no explicit predictions were made regarding sensitization or habituation to pain during the cold pressor trials of Experiment 2.

## *Method*

### *Procedure*

***Step 1: Familiarization.*** Subjects were familiarized with the experimental apparatus and procedures; seated next to the room temperature water tank; reminded that, though the instructional audio tape would guide them through the activity, they would be monitored via the camera and could ask questions at any time; and left alone in the test room.

***Step 2: Room temperature immersion.*** Subjects performed one 60 second immersion in the room temperature tank to standardize surface skin temperature between subjects.

***Step 3: Predicting pain.*** Subjects moved to the cold water tank and were asked to report the peak level of pain they expected to experience during the cold pressor immersion task using the 11 point pain intensity scale.

***Step 4: Cold pressor immersion and pain thresholds.*** Subjects performed the cold pressor immersion task with the knowledge that the total immersion duration would be 30 seconds. Subjects were requested to report the precise moment that the experimental stimulus began to feel painful.

***Step 5: Reporting actual pain experienced.*** Immediately following completion of the task subjects were asked to report the peak level of pain actually experienced during the task.

***Step 6: Inter-trial rest period.*** Subjects were given a 180 second inter-trial

rest period.

***Steps 7-14: Repeated trials.*** Steps 2 to 6 were repeated on two more trials for a total of three predicted and reported pain scores for each subject.

## *Results*

Repeated measures analyses of variance were used to test Hypotheses 6, 7, 8 and 9.

***Hypothesis 6: predicting pain.*** Table 6 presents mean pain predictions by trial for Experiment 2.

Table 6

Mean pain predictions by trial

| | Group | | | |
|---|---|---|---|---|
| | Pain | | Control | |
| Trial | Mean | SD | Mean | SD |
| 1 | 4.50 | 2.24 | 4.95 | 2.56 |
| 2 | 5.20 | 2.01 | 5.65 | 2.93 |
| 3 | 5.65 | 2.39 | 6.50 | 1.99 |

Note. $N = 40$.

There were no significant differences between groups in predictions of pain across trials ($F_{(1, 38)} = 0.70$, $p = .41$). However, there was a significant main effect for Trials. As illustrated in Figure 3, both groups' pain predictions increased across trials ($F_{(2, 76)} = 14.27$, $p < .001$).

---

Insert Figure 3 about here

---

***Hypotheses 7 and 8: accuracy in predicting pain.*** Table 7 presents, by trial, average accuracy; that is, tendency to over or under-predict pain. Accuracy was computed as predicted pain minus actual reported pain immediately following the immersion. Because all subjects underpredicted pain in each of the three trials, mean accuracy is reported. Negative accuracy values indicate under-predictions.

Table 7

Mean accuracy by trial

| | Group | | | |
|---|---|---|---|---|
| | Pain | | Control | |
| Trial | Mean | SD | Mean | SD |
| 1 | -1.95 | 2.21 | -1.1 | 1.37 |
| 2 | -1.15 | 1.90 | -0.95 | 1.88 |
| 3 | -1.45 | 1.91 | -0.05 | 1.37 |

Note. Accuracy was computed as predicted minus reported pain. $N = 40$.

There were no significant differences between groups in mean accuracies in predicting pain across the three trials ($F_{(1, 38)} = 3.38$, $p = .07$), and there was no significant group by trial interaction ($F_{(2, 76)} = 1.91$, $p = .15$). However, there were significant changes in accuracy across the three trials ($F_{(2, 76)} = 3.24$, $p < .05$). Figure 4 illustrates these changes. The control group improved their accuracy with each new trial (i.e., approached "0"), while the pain group, albeit also displaying a general improvement in accuracy across trials (and thus no significant effects), seemed to display more variability in accuracy.

Insert Figure 4 about here

***Hypothesis 9: pain thresholds.*** Table 8 presents average pain thresholds for each group by trial.

Table 8

Mean cold pressor pain thresholds by trial

| | Group | | | |
|---|---|---|---|---|
| | Pain | | Control | |
| Trial | Mean | SD | Mean | SD |
| 1 | 17.16 | 9.97 | 22.67 | 9.20 |
| 2 | 16.11 | 9.34 | 22.01 | 20.25 |
| 3 | 15.86 | 8.96 | 17.67 | 7.97 |

Note. Threshold values are reported in seconds. $N$ = 40.

There were no significant differences between groups in pain thresholds across the three trials in Experiment 2 ($F_{(1, 38)} = 2.44$, $p = .13$), no significant changes in thresholds across the three trials ($F_{(2, 76)} = 1.22$, $p = .30$), or any

group by trial interaction ($F_{(2, 76)} = 0.59$, $p = .56$) (see Figure 5).

---

Insert Figure 5 here

---

### *Experiment 2: Conclusions and discussion*

***Predicting pain.*** There was good support for Hypothesis 6. There were no significant differences between pain and control subjects in their predictions of impending pain. Pain patients did not over or under predict pain compared to control subjects.

These data follow well from Rachman and Lopatka's (1988) data. They found that chronic pain patients predicted pain more accurately than fear patients predicted fear, despite the fact that pain patients typically reported high levels of fear related to their own pain. Rachman and Lopatka (1988) suggested that this may have been because pain patients have more experience with their pain than fear patients have with their fear, and thus they have had more experience predicting pain. Their reasoning would not account for why in Experiment 2 pain-free subjects predicted pain as well as pain subjects predicted pain. Whether or not Rachman's and Lopatka's conclusion was valid is not crucial to this discussion. What was interesting from their experiment (Rachman, & Lopatka, 1988), and from other research on pain

predictions (cf., Rachman & Arntz, 1991), was that there may exist a general pattern of predicting pain, and that this pattern has been reliably observed with both clinical and normal control subjects under a variety of aversive clinical stimuli. Experiment 2 provided an opportunity to explore, in part, the generalizability of this pattern to experimental pain situations.

***Predicting pain: accuracy and accuracy over time***. Hypotheses 7 and 8 were also supported. There were no significant differences between groups in their accuracy of predictions. Pain patients did not over or under predict impending pain any more or less than did the control subjects. Further, there were no differences between groups in their accuracy of prediction over time. Both groups' predictions of pain increased across trials and this was consistent with the general pattern of predicting pain which was referred to previously.

It is often reported that people (i.e., pain and pain-free subjects alike) tend to overpredict aversive events, and overpredict pain in particular (cf., Rachman & Arntz, 1991). Figure 3 illustrates that the pain and control groups actually underpredicted pain in Experiment 2. This apparent discrepancy may be because studies which showed that chronic pain patients tended to overpredict pain were not based on samples of chronic low back pain patients. These studies were based on data from samples of, for example, chronic rheumatoid arthritis sufferers (Rachman & Lopatka, 1988) and dental patients (Wardle, 1984). There may be differences as a function of clinical disorder or diagnosis.

Although Rachman and Arntz (1991, p.352) stated that they believe some chronic low back pain patients may overpredict their pain and that this may be related to excessive "suffering"; their own research (e.g., Arntz & Peters, 1989 cited in Rachman & Arntz, 1991) indicated that, consistent with results from Experiment 2, chronic low back pain patients tend to underpredict pain. Whether chronic low back pain patients over or underpredict pain is an important issue from the point of view of therapeutic intervention and this issue needs to be investigated further. Experiment 3 will provide another opportunity to examine between group differences in pain prediction.

***Pain thresholds, sensitization and habituation to pain.*** Hypothesis 9 was not supported. Pain patients' pain thresholds were indistinguishable from control subjects' pain thresholds.

The absence of any between group differences in pain thresholds during Experiment 2 may be understood in the context of stimulus salience. In order to make valid comparisons between groups, stimuli must have equal meaning to all subjects. Results from Experiment 2 indicated that the cold water immersion was equally painful for pain and control subjects. (Both groups predicted and, in fact, reported moderate levels of pain.) Hypothesis 9 was based primarily on laboratory accounts which reported that induced and clinical anxiety have been associated with heightened pain sensitivity (i.e., lower thresholds). However, many of these studies did not incorporate appropriate control groups. Experiment 2 employed well matched control groups and

exposed all subjects to an equally salient stimulus. Recent, better controlled experiments have reported findings similar to those obtained in Experiment 2. For example, in a well controlled investigation of suppressor agents (i.e., noxious counterirritants) in dental pain, Sigurdsson and Maixner (1994) found no differences in pain thresholds between groups of pain and pain-free subjects.

Also, despite reviews which continue to endorse conventional thought on the relation between anxiety and pain (e.g., Gracely, 1994), reports also began appearing in the literature, during the completion of this research, which asserted that this relation was more complex than originally believed. These reports (e.g., Al Absi & Rokke, 1991), suggested that generalized anxiety has little impact on pain perception but that *stimulus-related* anxiety increases pain sensitivity. In fact, in a recent study which examined the effects of attentional focus, stimulus-relevant anxiety and stimulus-irrelevant anxiety on pain perception, Arntz, Dreesen and De Jong (1994), showed that attentional focus, and the stimulus focusing effects of stimulus-relevant anxiety, heighten pain sensitivity more than any stimuli-related anxiety per se.

Whether attentional focus or stimulus-specific anxiety heightens pain sensitivity, neither was explicitly quantified in Experiment 2. However, both groups were subjected to the same experimental conditions, and this, combined with the fact that the cold pressor task was novel to all subjects, indicates that any inadvertent manipulation of attentional focus or stimulus-relevant anxiety

during the experiment would have been experienced equally by both groups. These methodological controls may have precluded the inadvertent manufacturing of group differences in pain thresholds.

Contrary to other findings (c.f, Brands, & Schmidt, 1987), visual inspection of Figure 5 did not indicate any increased sensitivity or habituation to pain, for either group, as a function of repeated exposure to the pain stimuli. Because other habituation research has typically employed many more trials (e.g., 8), it well may have been the case that there were insufficient trials in Experiment 2 to make any reliable conclusions about the presence or absence of between group differences in habituation to pain. Regardless, for the purposes of these experiments, it was useful to know that there were no between group, baseline differences in rate of habituation to pain, at least over a small number of trials.

As the reader proceeds to Experiment 3, it also may be useful to bear in mind that there were no baseline differences between groups in pain predictions or thresholds during cold water immersion.

## EXPERIMENT 3: THE EFFECTS OF PREDICTABILITY OF COLD PRESSOR PAIN ON PAIN PREDICTION, PAIN PERCEPTION AND PAIN BEHAVIOUR

This experiment extended the study of between group differences in pain prediction and pain responsivity, and examined the effects of stimulus predictability on these variables. As in Experiment 2, subjects were requested to predict the peak level of pain they expected to experience during the cold pressor task. However, prior to making these predictions, subjects were told the duration of the immersions and the type of signals that would be available to them. The specificity of this information was altered between conditions. These differences in the pre-immersion briefing altered the stimulus' predictability; that is, the availability of information about the aversive event. Under the low predictability condition, subjects were not given any information about either the duration of the aversive event, or any signals about stimulus offset (i.e., the end of the aversive stimulus). Under the high predictability condition, subjects were given reliable (i.e., probability equal to 1.0) information about the duration of the aversive event and a visual signal about time remaining in the trial to stimulus offset (see Appendix I for transcribed pre-immersion instructions).

### *Hypotheses*

The hypotheses were based on two assumptions. Firs , it was believed

that on initial presentation, cold water immersion would be equally salient to pain and control subjects; and second, as discussed in Experiment 2, it was believed that pain subjects' experience of pain during Experiment 3 (i.e., pain thresholds and reports) possibly would be mediated by their elevated baseline levels of anxiety and depression.

***11. Effects of stimulus predictability on pain predictions prior to cold pressor pain.*** a) As in Experiment 2, it was again predicted that on initial presentation, there would be no significant differences between groups on predictions of the intensity of future experimental pain from cold water immersion and, b) it was predicted that subjects would make higher predictions under conditions of low versus high predictability.

***12. Effects of stimulus predictability on pain thresholds during cold pressor task.*** a) For the reasons summarized above and in Experiment 2, it was predicted that there would be significant differences between groups; that is, pain subjects would have lower pain thresholds than would control subjects. b) It was predicted that both groups would show significant differences in pain thresholds as a function of level of stimulus predictability. That is, both groups would have lower thresholds under conditions of low versus high stimulus predictability.

***13. Effects of low and high stimulus predictability on reported pain after cold pressor task.*** a) It was predicted that there would be significant differences between groups; that is, pain subjects would report having experienced higher

levels of pain than would control subjects. b) It was predicted that both groups would show significant differences in reported pain as a function of level of stimulus predictability. That is, both groups would report more pain under conditions of low versus high stimulus predictability.

***14. Effects of low and high stimulus predictability on pain behaviour during and immediately following cold pressor task*** a) It was predicted that there would be significant differences between groups; that is, pain subjects would display more pain behaviour than would control subjects. b) It was predicted that both groups would show significant differences in pain behaviour as a function of level of stimulus predictability. That is, all groups would display more pain behaviour under conditions of low versus high stimulus predictability.

## *Method*

### *Procedure*

***Step 1: Counterbalancing.*** Half the subjects in each group were randomly assigned to receive the low predictability trial first. The remaining subjects in each group received the high predictability trial first.

***Step 2: Verbal instructions and visual signals.*** During the low predictability trial, subjects received little information about the duration of the immersion procedure. Conversely, during the high predictability trial, subjects were provided with maximum verbal and visual information regarding the

duration of the immersion. Pre-recorded instruction provided subjects with information on the total duration of the trial prior to the actual immersion, and subjects were told they would be provided with visual information on the length of time remaining to stimulus offset. The latter was achieved during the trial with a count-down timer. Appendix I presents the instructions which subjects heard prior to the low and high predictability conditions.

***Step 3: Predicting pain.*** Subjects were asked to report the peak level of pain they expected to experience during the cold pressor task using the eleven point pain intensity scale.

***Step 4: Cold water immersions and pain thresholds.*** Subjects performed the cold pressor task. Total immersion duration was sixty seconds. Subjects were requested to report the precise moment that the experimental stimulus began to feel painful.

***Step 5: Reporting actual pain experienced.*** Immediately following completion of the task, subjects were asked to report the peak level of pain experienced during the task.

***Step 6: Inter-trial rest period.*** Subjects were given a 180 second inter-trial rest period.

***Steps 7-14: Repeated trial.*** Steps 2 to 6 were repeated once more, in the counterbalanced order, to complete the block. There were no further trials in Experiment 3.

## *Results*

Multivariate analyses of variance indicated that there were significant between-subjects multivariate main effects for order ($F_{(1,36)} = 5.56$, $p < .05$) but not group ($F_{(1,36)} = 1.36$, $p = .25$). There was no group by order multivariate interaction ($F_{(1,36)} = .50$, $p = .49$). There was a significant within-subjects main effect for condition (i.e., level of stimulus predictability) ($F_{(5,180)} = 31.47$, $p < .001$). There was a significant multivariate interaction between order and condition ($F_{(5,180)} = 6.63$, $p < .001$) but no group by condition ($F_{(5,180)} = 1.20$, $p = .31$), or group by order by condition interaction ($F_{(5,180)} = .42$, $p = .83$).

Overall, there were significant differences in mean pain predictions, thresholds and reports as a function of the level of stimulus predictability. There were also significant order effects and what appeared to be differential carry-over effects (i.e., order by condition interaction). As planned, univariate analyses and contrasts were conducted to locate the sources of these effects.

***Hypothesis 11: Effects of stimulus predictability on pain predictions prior to cold pressor pain.*** Table 9 presents mean pain predictions as a function of condition (i.e., level of stimulus predictability), group and order.

Table 9

Mean predictions of cold pressor pain by condition, group and order

| | Condition | | | |
|---|---|---|---|---|
| | Low Predictability | | High Predictability | |
| | Pain | Control | Pain | Control |
| Position[a] | Group | Group | Group | Group |
| 1 | 7.33 | 7.90 | 6.16 | 7.00 |
| | (1.94) | (1.79) | (2.60) | (1.83) |
| 2 | 7.36 | 7.60 | 8.56 | 8.60 |
| | (2.34) | (1.84) | (1.59) | (1.66) |

Note. Standard deviations in parentheses. There were 10 subjects per cell.
[a] Test position.

Table 10 presents a summary table for the mixed factorial analysis of variance on pain predictions. There were no significant between-subjects main effects for group ($F_{(1,36)} = .51$, $p = .48$) or order ($F_{(1,36)} = 3.31$, $p = .07$); and there was no group by order interaction ($F_{(1,36)} = .04$, $p = .85$). There was also no significant within-subjects main effect for condition ($F_{(1,36)} = .02$, $p = .88$); and there were no significant group by condition ($F_{(1,36)} = .00$, $p = .95$), or, group by order by condition interactions ($F_{(1,36)} = 1.27$, $p = .27$). However, there was a

significant order by condition interaction ($F_{(1,35)} = 14.34$, $p < .001$). Figure 6 illustrates this carry-over effect as a function of test position.

---

Insert Figure 6 about here

---

Table 10

Analysis of variance summary table: Group by order by condition on pain predictions prior to cold pressor task

| Source | *df* | Mean Square | *F* |
|---|---|---|---|
| Group | 1 | 3.45 | .51 |
| Order | 1 | 22.40 | 3.31$^{\cdot}$ |
| Condition | 1 | .02 | .02 |
| Group by order | 1 | .24 | .04 |
| Group by condition | 1 | .00 | .00 |
| Order by condition | 1 | 17.06 | 14.34$^{\cdot\cdot}$ |
| 3-way interaction | 1 | 1.52 | 1.27 |
| Between error | 36 | 6.76 | |
| Within error | 36 | 1.19 | |

$^{\cdot}$ $p = .07$.
$^{\cdot\cdot}$ $p < .001$.

Because the order by condition interaction precluded any definitive conclusions about the main effects of stimulus predictability on pain predictions, all planned contrasts were performed only using cells which were comprised of data from the first test position for each condition. These cells constituted a 2 X 2 completely randomized between-subjects factorial component (nested

within the overall 2 X 2 X 2 mixed factorial design) and were appropriate for estimating the effects of stimulus predictability on pain predictions. Data from these cells were not confounded by order or carry-over effects. Figure 7 illustrates the effects of predictability on pain predictions when responses are not confounded by order and carry-over effects ($F_{(1,36)} = 14.34$, $p < .001$).

---

Insert Figure 7 about here

---

Whereas controlling for order and interaction effects revealed significant treatment effects (see Figure 7), contrast analyses did not reveal any significant differences between groups on pain predictions under either condition (see Table 11).

Table 11

Contrasts on pain predictions: independent group means and standard deviations for first test position data

| | Group | | |
|---|---|---|---|
| Contrast | Pain | Control | *t*-value[a] |
| Low predictability | 7.33 (1.94) | 7.90 (1.79) | -0.66[ns] |
| High predictability | 6.18 (2.60) | 7.00 (1.83) | -0.83[ns] |

Note. $n$ = 20. 18 *df*'s for each test. Standard deviations in parentheses.
[a] One-tailed test.
[ns] ns.

***Hypothesis 12: Effects of stimulus predictability on pain thresholds during cold water immersion.*** Table 12 presents mean pain thresholds as a function of condition (i.e., level of stimulus predictability), group and order.

Table 12

Mean cold pressor pain thresholds by condition, group and order

| | Condition | | | |
|---|---|---|---|---|
| | Low Predictability | | High Predictability | |
| Position[a] | Pain Group | Control Group | Pain Group | Control Group |
| 1 | 10.29 ( 6.92) | 17.57 ( 6.84) | 28.52 (20.13) | 30.38 (19.15) |
| 2 | 27.60 (20.62) | 21.93 (16.67) | 14.14 (11.16) | 24.59 (12.80) |

Note. Standard deviations in parentheses, $N$ = 40.
[a] Test position.

Table 13 presents a summary table for the mixed factorial analysis of variance on pain thresholds. There was no significant between-subjects main effect for group ($F_{(1,36)}$ = 1.32, $p$ > .10) but there was a significant main effect for order ($F_{(1,36)}$ = 6.62, $p$ < .01). There was no group by order interaction ($F_{(1,36)}$ = .44, $p$ > .10). There was a significant within-subjects main effect for condition ($F_{(1,36)}$ = 5.00, $p$ < .05); but there were no significant group by condition ($F_{(1,36)}$ = .17, $p$ > .10), or, group by order by condition interactions ($F_{(1,36)}$ = .66, $p$ > .10).

Figure 8 illustrates the effects, by group, of stimulus predictability collapsed across order.

Insert Figure 8 about here

Table 13

Analysis of variance summary table: Group by order by condition on pain thresholds during cold pressor immersion

| Source | *df* | Mean Square | *F* |
|---|---|---|---|
| Group | 1 | 630.55 | 1.32 |
| Order | 1 | 3161.73 | 6.62** |
| Condition | 1 | 168.98 | 5.00** |
| Group by order | 1 | 208.51 | .44 |
| Group by condition | 1 | 5.59 | .17 |
| Order by condition | 1 | 126.34 | 3.74* |
| 3-way interaction | 1 | 22.33 | .66 |
| Between error | 36 | 477.91 | |
| Within error | 36 | 33.82 | |

* $p = .06$.
** $p < .05$.

Interestingly, here again there was a trend towards significance for the

order by condition interaction ($F_{(1,36)} = 3.74$, $p = .06$).

Figure 9 illustrates this trend as a function of test position. It is intriguing that, here again, the effects of stimulus predictability may have been mediated by subject's previous experience.

---

Insert Figure 9 about here

---

Figure 10 illustrates the effects of predictability on pain thresholds when responses were not confounded by order effects.

---

Insert Figure 10 about here

---

In addition to significant treatment effects when order and carry-over effects were controlled for, there were also significant differences between groups on pain thresholds under conditions of low but not high stimulus predictability (see Table 14). Pain patients displayed significantly lower thresholds under conditions of low predictability than did control subjects (see Figure 10).

Table 14

Contrasts on pain thresholds: independent group means and standard deviations for first test position data

| | Group | | |
|---|---|---|---|
| Contrast | Pain | Control | *t*-value[a] |
| Low predictability | 10.29 ( 6.92) | 17.57 ( 6.84) | -2.30* |
| High predictability | 28.52 (20.13) | 30.38 (19.15) | -0.22 |

Note. $n$ = 20. 18 *df*s for each test. Standard deviations in parentheses.
[a] One-tailed test.
* $p < .05$.

***Hypothesis 13: Effects of stimulus predictability on pain ratings following cold pressor pain.*** Table 15 presents mean pain intensity ratings as a function of condition (i.e., level of stimulus predictability), group and order.

Table 15

Mean pain intensity ratings of cold pressor pain by condition, group and order

| | Condition | | | |
|---|---|---|---|---|
| | Low Predictability | | High Predictability | |
| Position[a] | Pain Group | Control Group | Pain Group | Control Group |
| 1 | 9.00 (1.32) | 8.30 (1.49) | 8.27 (1.85) | 7.00 (1.87) |
| 2 | 7.64 (2.50) | 7.20 (2.44) | 8.78 (1.30) | 7.90 (1.50) |

Note. Standard deviations in parentheses, $N = 40$.
[a] Test position.

Table 16 presents a summary table for the mixed factorial analysis of variance on pain ratings. Apart from a trend towards significance for order ($F_{(1,36)} = 3.27$, $p = .08$), there were no significant effects of stimulus predictability on subjects pain ratings following the cold pressor task.

Table 16

Analysis of variance summary table: Group by order by condition on pain ratings following cold pressor immersion

| Source | *df* | Mean Square | *F* |
|---|---|---|---|
| Group | 1 | 13.44 | 2.36 |
| Order | 1 | 18.61 | 3.27* |
| Condition | 1 | .04 | .03 |
| Group by order | 1 | 02 | .00 |
| Group by condition | 1 | 1.28 | 1.00 |
| Order by condition | 1 | 1.39 | 1.09 |
| 3-way interaction | 1 | .54 | .42 |
| Between error | 36 | 5.69 | |
| Within error | 36 | 1.28 | |

Note. $N = 40$.
* $p = .08$.

Not surprisingly given the absence of significant effects, contrast analyses revealed no significant differences between pain and control groups' reported levels of pain at either level of stimulus predictability (see Table 17).

Table 17

Contrasts on pain ratings: independent group means and standard deviations for first test position data

| | Group | | |
|---|---|---|---|
| Contrast | Pain | Control | *t*-value[a] |
| Low predictability | 9.00 (1.32) | 8.30 (1.49) | -0.97[ns] |
| High predictability | 8.27 (1.85) | 7.00 (1.89) | -1.56[ns] |

Note. $N = 20$. Standard deviations in parentheses. 18 *df*s for each test.
[a] One-tailed test.
ns.

***Hypothesis 14: Effects of low and high stimulus predictability on pain behaviour during and immediately following cold pressor task.*** Table 18 presents mean pain behaviour scores as a function of condition, group and order.

Table 18

Mean pain behaviour scores by group, condition and order

| | Condition | | | |
|---|---|---|---|---|
| | Low predictability | | High predictability | |
| Position[a] | Pain Group | Control Group | Pain Group | Control Group |
| First | 129.67 ( 80.26) | 63.60 (40.56) | 125.64 ( 92.22) | 79.40 (107.75) |
| Second | 142.64 ( 72.19) | 76.60 (86.24) | 122.11 ( 63.26) | 76.90 ( 44.37) |

Note. $N$ = 40. Standard deviations in parentheses.
[a] Test position.

Table 19 presents a summary table for the mixed factorial analysis of variance. Pain patients displayed significantly more pain behaviour than control subjects in both conditions (see Figure 11). However, there was no effect of predictability on total pain behaviour scores; nor were there any order or interaction effects.

Table 19

Analysis of variance summary table: Group by order by condition on time engaged in pain behaviour during cold pressor task

| Source | *df* | Mean Square | *F* |
|---|---|---|---|
| Group | 1 | 62154.62 | 7.92* |
| Order | 1 | 1273.17 | .16 |
| Group by order | 1 | 1.23 | .00 |
| Condition | 1 | 88.92 | .02 |
| Group by condition | 1 | 2055.71 | .52 |
| Order by condition | 1 | 494.73 | .13 |
| Three way | 1 | 1.39 | .00 |
| Between error | 36 | 7849.11 | |
| Within error | 36 | 3946.67 | |

* $p < .01$.

Insert Figure 11 about here

### *Experiment 3: conclusions and discussion*

Table 20 provides an "at-a-glance", dichotomous listing of major effects obtained in Experiment 3 and, for simplicity, will be referred to throughout this discussion.

Table 20

Experiment 3: Presence or absence of effects from variations of stimulus predictability during cold water immersion

| ***Source of Effect*** | ***Variable*** | | | |
|---|---|---|---|---|
| | **Pain Prediction** | **Pain Threshold** | **Pain Report** | **Pain Behaviour** |
| Group | No | Yes[c] | No | Yes |
| Condition | Yes | Yes | No | No |
| Contrast 1 [a] | No | Yes | No | Yes |
| Contrast 2 [b] | No | No | No | Yes |

[a] Contrast 1 = Pain group versus control group under condition of low stimulus predictability.
[b] Contrast 2 = Pain group versus control group under condition of high stimulus predictability.
[c] There was an effect under conditions of low but not high predictability.

***Pain predictions.*** Hypothesis 11a was supported (see Table 20). Pain groups' pain predictions were no lower or higher than were control groups' pain

predictions. This finding was consistent with results from Experiment 2 and indicates good reliability and robustness for this finding. Even under more aversive conditions than those of Experiment 2 (the reader will recall that Experiment 3 involved conditions of low stimulus predictability and longer exposure duration), no between group differences in pain predictions were observed.

Hypothesis 11b also was supported (see Table 20). Both pain and control group subjects who received the low predictability treatment predicted significantly more pain than subjects who received the high predictability treatment (although in the counterbalanced cells the effects of stimulus predictability on pain predictions were mediated by subject's previous experience).

The latter finding supported the arguments made in the Introduction that the availability of information about impending pain can affect predictions. Under conditions of low availability of information, expectancies (i.e., predictions), for both groups, were more pessimistic than under conditions of high availability of information about impending pain.

***Pain thresholds.*** Hypothesis 12a was partially supported (see Table 20). There were significant differences between groups on pain thresholds under conditions of low but not high stimulus predictability. Pain patients displayed significantly lower thresholds under conditions of low predictability than did control subjects (see Figure 10).

This finding was intriguing because it indicated that pain subjects may have an increased vulnerability, relative to pain-free subjects, to conditions of low predictability. This idea will be pursued further in later sections. Briefly, the reader will recall that pain subjects believed they had little control over pain prior to this experiment (as indicated in Experiment 1). If, as discussed previously, conditions of high stimulus predicability increase perceived control, perhaps pain subjects were able to benefit from the information provided in the high predicability condition, such that their perceptions of pain were not significantly different than those of pain-free control subjects. However, if pain subjects perceive painful situations as more hopeless than others (because of their self-reported low perceived control pain in general), they may perceive conditions of low predictability as especially hopeless. If one were to perceive a situation as especially hopeless, one may feel more anxiety in that situation than would others who do not perceive the situation as hopeless.

The discussion from Experiment 2 (e.g., Cornwall & Donderi, 1988; Miron, Duncan, Bushnell, 1989), provided an empirically based, theoretical mechanism for this selective vulnerability to conditions of low stimulus predictability. Increased levels of anxiety may heighten one's alertness to pain, which may serve to focus one's attention (i.e., allocation of attention) on the changes in sensation attributable to the cold water, which may result in earlier detection and perception of pain and subsequently, lower pain thresholds.

By the same reasoning it may be argued that the treatment effects

produced in Experiment 3 were an artifact of the procedures employed. That is, in the high predictability condition, subjects were provided a visual stimulus (i.e., the count-down timer) which may have functioned to assist subjects to divert their attention away from the nociceptive stimulus. While allocating attention away from pain has been shown to produce higher pain tolerance (Brewer, & Karoly, 1989), and this may have had a role in producing some of the effects observed; this effect is difficult to achieve, it requires explicit training, and pain tolerance is a qualitatively different measure from pain thresholds. Aversive events have primacy in the allocation of attention. Further, in the low predictability condition, subjects were provided with the same visual stimuli. Rather than flashing sequentially descending digits, the timer flashed a static display of digits (in the low predictability condition) which would have provided a comparable visual distractor to the stimulus provided in the high predictability condition. Finally, the fact that the experimental manipulation produced effects on predictions provided evidence that the effects on pain thresholds were not experimental artifact.

Nevertheless, this is an interesting issue and future research could examine concurrently the effects of variations in the allocation of attention and variations in stimulus predictability, with the addition of a further control group to test for the presence of attentional distracters.

Hypothesis 12b was supported. Both groups displayed lower pain thresholds under conditions of low predictability than under conditions of high

predictability.

That the extent of availability of information about impending pain had an impact on subjects' pain thresholds is dramatic and this finding will also be explored in detail in later sections. For the moment, it appears reasonable to conclude that, as theorized, variations in stimulus predictability not only affect expectancies (i.e., pain predictions), but also affect pain perception.

***Reported pain.*** Hypothesis 13a was not supported. There were no significant differences between pain subjects' or control subjects' reports of pain following cold water immersion.

This finding was intriguing because it suggested that despite the fact that pain subjects had an increased sensitivity in detecting pain under conditions of low stimulus predictability, this sensitivity did not manifest itself in any increases in pain ratings relative to pain-free controls.

Although some may argue that, for whatever reason (e.g., by virtue of their experience with pain or the health care system) pain subjects are less stoical about pain and simply report pain earlier than pain-free subjects, this does not explain why the effect was observed only under conditions of low predictability. This interaction was perplexing and further research is required before any definitive conclusions may be made regarding either the psychological origins or mechanisms for this effect.

There was only weak support for Hypothesis 13b. There was a trend for subjects in the low predictability groups to report higher levels of pain following

cold water immersion than subjects in the high predictability groups. The absence of any clear effects of stimulus predictability on pain reports raises the possibility that predictability exerts its strongest effects on expectancies and behaviour during events rather than on thoughts and behaviours subsequent to events. It would be interesting in future research to contrast subjects' reports of pain *during*, rather than *after* exposure to pain.

***Pain behaviour.*** Hypothesis 14a was supported. Pain subjects displayed more pain behaviour than did control subjects during exposure to pain from cold water immersion. This finding exemplifies the previously discussed non-linearity between pain perception and pain behaviour (because there were no differences between groups on predictions or thresholds and yet there was a difference between groups in behaviour) and raises a question as to why between group differences were observed on this variable and not on the other, more elementary, responses to pain.

Hypothesis 14b was not supported. There was no effect of stimulus predictability on subjects' displays of pain during exposure to pain from cold water immersion.

This finding raises the possibility that either the effects of stimulus predictability are limited to basic (possibly early) components of pain perception (e.g., pain thresholds) or that the experimental manipulation was not sufficient to produce effects on more complex motor and social behaviours (i.e., pain behaviours).

Unfortunately, the data do not offer an explanation for why pain subjects should differ from pain-free subjects in levels of pain behaviour displayed during exposure to an event which is novel to members of both groups. Pain patients might be expected to display increased baseline levels of pain behaviour, but more research is required in order to understand the factors which control the apparent variability in responses to pain from different sources.

***Manipulation check***. The efficacy of the experimental manipulation was confirmed by the fact that, for both groups, pain predictions were higher in Experiment 3 than they were in Experiment 2, and by the fact that there were treatment effects.

***General commentary***. Striking treatment effects were observed from a simple experimental manipulation of the availability of information about the duration of exposure to a painful stimulus (cold water). A perplexing pattern of between group differences was also observed. The question remains whether these results are peculiar to the novel experimental stimulus employed in Experiment 3, or whether these represent more general results that may be reproduced under other, more familiar painful events. Experiments 4 and 5 will shed further light on this query.

## EXPERIMENT 4: THE EFFECTS OF PREDICTABILITY OF STEP-CLIMBING PAIN ON PAIN PREDICTIONS, PAIN PERCEPTION AND PAIN BEHAVIOUR

Experiment 4 was designed to determine whether the effects of stimulus predictability on pain predictions, thresholds, reports and behaviour remained constant across pain from different sources.

Because there were few experiments which had studied factors which affect the perception of pain across different modalities (Janal, Glusman, Kuhl, Clark, 1994; Peters & Schmidt, 1992) and none which had examined these effects from acute laboratory pain to clinically relevant pain, it remained unclear whether factors which affected the perception of pain from one source generalized to pain from other sources. Because few studies had examined within subjects responses to pain from different sources (Janal, Glusman, Kuhl, Clark, 1994; Peters & Schmidt, 1992), and none had examined responses across cold pressor and more clinically relevant pain, it also remained unclear whether subjects' responses to pain would be consistent across pain from different sources (Chapman, 1983; Peters & Schmidt, 1992).

Thus, this experiment employed a step climbing paradigm rather than the cold pressor task to produce pain. The research questions remained the same as those posed in Experiment 3 but it was expected that the procedures employed in Experiment 4 would produce different effects than the effects produced by Experiment 3 procedures. Step-climbing produces a more natural

and clinically relevant experimental pain stimulus for chronic low back pain patients than does cold water immersion.

Group differences in pain prediction were hypothesized in Experiment 4 because it was thought that step-climbing would likely elicit ecologically relevant pain memories in pain group subjects. Similarly, treatment effects on pain thresholds, reports and behaviour were predicted only for the pain group because the step-up task was not expected to be an especially salient pain stimulus for control group subjects.

### *Hypotheses*

***15. Effects of stimulus predictability on pain predictions prior to step-ups.*** a) It was predicted that pain subjects would make higher pain predictions than would control subjects and, b) it was predicted that all subjects would make higher predictions under conditions of low versus high predictability.

***16. Effects of stimulus predictability on pain thresholds during step-ups.*** a) It was predicted that pain subjects would have lower pain thresholds than would control subjects and, b) would have lower pain thresholds under conditions of low versus high predictability.

***17. Effects of stimulus predictability on reported pain following step-ups.*** a) It was predicted that pain subjects would report higher levels of pain following step-ups than would control subjects and, b) would report more pain following conditions of low versus high predictability.

***18. Effects of low and high stimulus predictability on pain behaviour during and immediately following step-ups.*** a) It was predicted that pain subjects would display more pain behaviour during and following step-ups than would control subjects and, b) would display more pain behaviour following conditions of low versus high predictability.

## *Method*

### *Procedures*

Procedures followed in Experiment 4 were identical to those followed in Experiment 3 and, apart from the following, will not be described again.

***Familiarization.*** Subjects were familiarized with the step-climbing apparatus and procedures.

***Predicting pain.*** Subjects were asked to report the peak level of pain they expected to experience during a 60-second step-up trial using the pain intensity scale.

***Step climbing and pain thresholds.*** Total climbing duration was 180 seconds for each of the two predictability conditions. Subjects were asked to try their best to complete the task, but they were also told that they could step-up at their own pace. Subjects reported the precise point in time that they began to feel pain.

***Reporting actual pain experienced.*** Subjects reported the peak level of

pain actually experienced during the task immediately following completion of each condition.

## *Results*

Multivariate analyses of variance indicated that there were significant between-subjects main effects for group (Pillais = .70, $df$ = 3, 34, p < .001) but not order (Pillais = .07, $df$ = 3, 34, $p$ > .05). There was no significant group by order interaction (Pillais = .07, $df$ = 3, 34, $p$ > .05). There was no significant within-subjects main effect for condition (i.e., level of stimulus predictability) (Pillais = .12, $df$ = 3, 34, $p$ > .05). There were no significant multivariate interactions between group and condition (Pillais = .09, $df$ = 3, 34, $p$ > .05), but there were significant interactions between order and condition (Pillais = .32, $df$ = 3, 34, $p$ < .01), and group, order and condition (Pillais = .33, $df$ = 3, 34, $p$ < .01).

Thus, there were significant differences between pain patients and controls in mean pain predictions, thresholds and reports from step-up pain. There were also significant differential treatment effects. As planned, univariate analyses and contrasts were conducted to locate the sources of these effects.

***Hypothesis 15: Effects of stimulus predictability on pain predictions prior to step-ups.*** Table 21 presents mean pain predictions as a function of condition (i.e., level of predictability), group and order (i.e., position at which subjects

received each of the two conditions).

Table 21

Mean predictions of step-up pain by condition, group and order

| | Condition | | | |
|---|---|---|---|---|
| | Low predictability | | High predictability | |
| | Pain | Control | Pain | Control |
| Position[a] | Group | Group | Group | Group |
| First | 5.22 (2.17) | 0.33 (0.68) | 3.36 (2.34) | 0.40 (0.97) |
| Second | 4.36 (2.29) | 0.40 (0.70) | 5.78 (1.92) | 0.40 (0.70) |

[a] Test position.

Pain patients' mean predictions were significantly higher than control subjects' predictions ($F_{(1,38)} = 66.35$, $p < .001$). However, because control subjects' predictions did not depart significantly from zero (i.e., there were significant floor effects with control subjects' scores, and thus limited variance), all further analyses of pain predictions prior to step-ups did not include control group data. Table 22 presents a summary table for the 2 X 2 (order by condition) mixed factorial analysis of variance on pain groups' pain predictions. There were no significant main effects for order or condition (i.e., level of

stimulus predictability). However, there was a significant within-subjects interaction effect between order and condition.

Table 22

Analysis of variance summary table: Order by condition on pain predictions prior to step-ups

| Source | *df* | Mean Square | *F* |
|---|---|---|---|
| Order | 1 | 26.51 | 3.02 |
| Condition | 1 | .49 | .55 |
| Order by condition | 1 | 5.99 | 6.69* |
| Between error | 18 | 8.78 | |
| Within error | 18 | .90 | |

* $p < .01$.

Figure 12 illustrates the order by condition interaction as a function of test position. The effects of stimulus predictability were strongly mediated by pain subjects' previous experience.

Insert Figure 12 about here

Because of the order by condition interaction, contrast analysis were performed using data from cells in the first test position. These analyses revealed significant effects of predictability on pain predictions ($t$ = 3.02, 18 $df$, $p < .01$). Pain subjects who received the low predictability treatment predicted significantly more pain than their counterparts who received the high predictability treatment (see Figure 13).

Insert Figure 13 about here

***Hypothesis 16: Effects of stimulus predictability on pain thresholds during step-ups.*** Table 23 presents mean pain thresholds as a function of condition (i.e., level of predictability), group and the order (i.e., position at which subjects received each of the two conditions).

Table 23

Mean step-up pain thresholds by condition, group and order

| | Condition | | | |
|---|---|---|---|---|
| | Low predictability | | High predictability | |
| Position[a] | Pain Group | Control Group | Pain Group | Control Group |
| First | 26.57 (20.65) | 169.00 ( 37.95) | 76.32 (73.21) | 170.27 ( 33.93) |
| Second | 71.43 (79.78) | 151.65 ( 62.04) | 31.69 (22.29) | 169.00 ( 37.95) |

[a] Test position.

There was a significant difference between pain group's and control group's mean thresholds during step-ups ($F_{(1,36)} = 74.68$, $p < .001$). Pain patients' mean thresholds were significantly lower than control subjects' thresholds. However, control group's data were skewed negatively, with a majority of cases achieving threshold ceilings. Thus, further analyses of thresholds values did not include control group scores.

Table 24 presents a summary table for the 2 X 2 (order by condition) mixed factorial analysis of variance on pain thresholds. There was no effect of order. There was a trend towards significance for the within-subjects effect of condition, but there was no significant order by condition interaction.

Table 24

Analysis of variance summary table: Order by condition on pain thresholds prior to step-ups

| Source | *df* | Mean Square | *F* |
|---|---|---|---|
| Order | 1 | 19849.09 | 2.89 |
| Condition | 1 | 251.31 | 3.98[•] |
| Order by condition | 1 | .07 | .00 |
| Between error | 18 | 6861.10 | |
| Within error | 18 | 63.13 | |

[•] $p = .06$.

Figure 14 illustrates the nearly significant effects of stimulus predictability on the pain group's mean thresholds collapsed across order of presentation.

Insert Figure 14 about here

Figure 15 illustrates these effects using cells in the first test position only (responses are not confounded by previous experience).

Both presentations indicate that pain subjects who received the low predictability treatment displayed lower pain thresholds during step-ups than their cohorts who received the high predictability treatment.

---

Insert Figure 15 about here

---

***Hypothesis 17: Effects of stimulus predictability on reported pain following step-ups.*** Table 25 presents mean peak pain ratings as a function of condition (i.e., level of predictability), group and the order (i.e., position at which subjects received each of the two conditions).

Table 25

Mean ratings of peak step-up pain by condition, group and order

| | Condition | | | |
|---|---|---|---|---|
| | Low predictability | | High predictability | |
| Position[a] | Pain Group | Control Group | Pain Group | Control Group |
| First | 6.11 (2.14) | 0.20 (0.42) | 4.36 (2.98) | 0.20 (0.42) |
| Second | 4.73 (3.23) | 0.30 (0.48) | 6.89 (2.09) | 0.20 (0.42) |

[a] Test position.

Pain patients' mean peak pain ratings were significantly higher than control subjects' ratings ($F_{(1,36)} = 75.65$, $p < .001$). However, because control subjects' mean ratings did not depart significantly from zero (i.e., there were significant floor effects with control subjects' scores, and thus limited variance), all further analyses of reported pain following step-ups did not include control group data. Table 26 presents a summary table for the 2 X 2 (order by condition) mixed factorial analysis of variance on pain groups' pain ratings. There were no significant main effects for order or condition (i.e., level of stimulus predictability). However, there was a significant within-subjects interaction effect between order and condition.

Table 26

Analysis of variance summary table: Order by condition on pain ratings following step-ups

| Source | *df* | Mean Square | *F* |
|---|---|---|---|
| Order | 1 | 37.82 | 2.62 |
| Condition | 1 | .42 | 1.51 |
| Order by condition | 1 | 3.22 | 11.49* |
| Between error | 18 | 14.41 | |
| Within error | 18 | .28 | |

* $p < .001$.

Figure 16 illustrates the order by condition interaction as a function of test position. The effects of stimulus predictability were strongly mediated by pain subjects' previous experience.

Insert Figure 16 about here

Contrast analysis between cells in the first test position (responses are

not confounded by the order by condition interaction) revealed significant effects of predictability on pain reports ($t$ = 3.28, 18 $df$, $p$ < .01). Pain subjects who received the low predictability treatment reported experiencing significantly more pain than their colleagues who received the high predictability treatment (see Figure 17).

---

Insert Figure 17 about here

---

***Hypothesis 18: Effects of low and high stimulus predictability on pain behaviour during and immediately following step-ups.*** Table 27 presents mean pain behaviour scores as a function of condition, group and order.

Table 27

Mean pain behaviour scores by group, condition and order

| | Condition | | | |
|---|---|---|---|---|
| | Low predictability | | High predictability | |
| Position[a] | Pain Group | Control Group | Pain Group | Control Group |
| First | 165.33 (147.31) | 73.60 ( 27.13) | 188.45 (112.77) | 76.20 ( 58.45) |
| Second | 231.82 (138.70) | 199.90 (138.51) | 235.89 (155.22) | 122.10 ( 64.35) |

Note. $N$ = 40. Standard deviations in parentheses.
[a] Test position.

Table 28 presents a summary table for the mixed factorial analysis of variance. There was a main effect for group. Pain patients displayed significantly more pain behaviour than control subjects in both conditions (see Figure 18). There was also a significant order by condition interaction. Planned contrasts, using only cells from the first test position, did not reveal any significant effects of predictability on pain behaviour for either group (see Table 29).

Table 28

Analysis of variance summary table: Group by order by condition on pain behaviour scores during step-ups

| Source | *df* | Mean Square | *F* |
|---|---|---|---|
| Group | 1 | 152090.07 | 7.29* |
| Order | 1 | 12300.88 | .59 |
| Group by order | 1 | 4681.06 | .22 |
| Condition | 1 | 2866.49 | .57 |
| Group by condition | 1 | 13039.28 | 2.57 |
| Order by condition | 1 | 101816.02 | 20.09** |
| Three way | 1 | 4224.48 | .83 |
| Between error | 36 | 20853.63 | |
| Within error | 36 | 5068.80 | |

* $p < .01$.
** $p < .001$.

Insert Figure 18 about here

Table 29

Contrasts on pain behaviour: independent means and standard deviations for first test position data

| | Condition | | |
|---|---|---|---|
| Group | Low | High | *t*-value |
| Pain | 165.33 (147.31) | 188.45 (112.78) | $1.03^{ns}$ |
| Control | 73.60 ( 27.14) | 76.20 ( 58.45) | $.48^{ns}$ |

Note. 18 *df* for each contrast. Standard deviations in parentheses.

***Experiment 4: conclusions and discussion***

Table 30 provides an "at-a-glance", dichotomous listing of major effects obtained in Experiment 4 and, for simplicity, will be referred to throughout this discussion.

Table 30

Experiment 4: Presence or absence of effects from variations of stimulus predictability during step-ups

| ***Source of Effect*** | ***Variable*** | | | |
|---|---|---|---|---|
| | **Pain Prediction** | **Pain Threshold** | **Pain Report** | **Pain Behaviour** |
| Group | Yes | Yes | Yes | Yes |
| Condition [a] | Yes | Trend | Yes | No |

[a] Pain group only, $n$ = 20.

***Pain predictions.*** Hypothesis 15a was supported (see Table 30). Pain groups' pain predictions were significantly higher than were control groups' pain predictions. This finding was not consistent with findings from Experiments 2 and 3 (i.e., no between group differences in pain predictions) and raises the question; why should there be group differences during exposure to pain from a different source? Two issues are pertinent to this discussion.

As mentioned in Experiment 3, in order for between group comparisons to be valid, the aversive stimuli must be equally salient to all groups. Cold water immersion appeared to have been equally painful for pain and control subjects and no group differences in pain predictions were found in Experiment 2 or 3 using this stimulus. However, pain from step-ups would have been

qualitatively different for the two groups. Step-ups are often painful for chronic low-back pain sufferers and pain group subjects' prediction may have been influenced by negative past experiences with this activity. Conversely, pain-free subjects were unlikely to have had painful past experiences with step climbing. Negative past experiences with pain adversely influences expectancies (Erskine, Morley, Pearce, 1990), and perhaps for this reason between group differences in pain predictions were obtained in this experiment and not in Experiment 2 or 3. This reasoning is consistent with recent research which indicates that, contrary to past beliefs, responses to pain vary widely as a function of the source of the pain (e.g., Janal, Glusman, Kuhl, & Clark, 1994). If this is truly the case, it would not be surprising to find different patterns of results with different pain modalities.

Hypothesis 11b also was supported. Pain subjects who received the low predictability treatment predicted significantly more pain than subjects who received the high predictability treatment. This again suggested that the experimental manipulation was efficacious and also suggests that the effects of stimulus predictability on pain predictions were not limited to pain from cold water immersion, but also generalized to the more clinically relevant pain from step climbing.

***Pain thresholds***. Hypothesis 16 was supported. Not surprisingly, pain group displayed significantly lower pain thresholds than control subjects during step-ups.

Hypothesis 16b was also supported. Pain group subjects displayed significantly lower pain thresholds under conditions of low predictability than under conditions of high predictability. That the extent of availability of information about impending pain had an impact on subjects' pain thresholds is once again dramatic. That this effect should generalize from cold pressor pain to step-up pain, in a within subjects design, indicates considerable robustness for this effect.

***Reported pain.*** Hypothesis 17a was supported. Pain groups' pain ratings were significantly higher than were control groups' pain ratings. This finding also was not surprising given the aforementioned discussion on between group differences in the salience of step-ups as an aversive stimulus modality.

There was support for Hypothesis 17b. Pain subjects in the low predictability group reported higher levels of pain following step-ups than subjects in the high predictability group.

It was unclear why there was a treatment effect on pain ratings with step-up pain and not with cold pressor pain. Brief visual examination of pain groups' pain ratings from each experiment indicated that pain subjects found the cold water immersion more painful than step-ups. In fact, pain ratings for the cold water immersion were much higher than pain ratings for step climbing (cf., Table 15 & 25). It may have been the case that either there were ceiling effects with the use of the 11 point rating scale for the cold water immersion (i.e., that the cold water stimulus was too strong and obfuscated any treatment

effects that may have been present), or that there simply were no treatment effects on pain ratings during cold water immersion. Regardless, in Experiment 4, pain subjects perceived *less pain* when provided with information, in advance, about the impending event.

***Pain behaviour.*** Hypothesis 18a was supported. Pain subjects displayed more pain behaviour than did control subjects during exposure to pain from step-climbing. This finding was consistent with the clinical literature which is replete with reports that pain patients display more pain behaviour than do control subjects (cf., Introduction).

In this experiment at least, there was some consistency between subjects' reported levels of pain and observed pain behaviour. The pain group reported more pain than did the control group and the pain group displayed more pain behaviour than did the control group.

Last, Hypothesis 18b was not supported. There was no effect of stimulus predictability on subjects' displays of pain during exposure to pain from step-ups. The absence of any clear treatment effects on pain behaviour may have been because there was considerable variability in this distribution. Although not appropriate for this study, further research might begin with closer inspection of individual subject's scores.

***Final note***. At this point the reader will have observed that some of the effects obtained in Experiment 3 and 4 were buffered by differential carry-over effects in the counter-balanced, repeated measures trial. The pattern of these

effects raises the possibility that they represented more than random, experimental noise. Because these effects were relevant to Experiments 3, 4 and possibly 5, closer examination of their nature will be reserved for the general discussion.

# EXPERIMENT 5: THE EFFECTS OF PREDICTABILITY OF PAIN FROM STATIONARY STANDING ON PAIN PREDICTIONS, PAIN PERCEPTION AND PAIN BEHAVIOUR

Like Experiment 4, Experiment 5 was also designed to determine whether the effects of predictability on pain predictions, thresholds, reports and behaviour remained constant across pain from different stimuli. However, this experiment employed a stationary standing task rather than the cold pressor or step-climbing task to produce pain. Stationary standing, like step-climbing, produces a more natural and clinically relevant experimental pain stimulus than does cold water immersion and provided an opportunity to determine whether effects observed during Experiment 4 were specific to step-climbing or whether they were general responses to clinically relevant pain. Thus, the research questions and with one exception, the hypotheses in Experiment 5 remained the same as those in Experiment 4. It was believed that standing would not be perceived as aversive by pain-free subjects, and for this reason, no treatment effects were predicted for the control group on any of the dependent variables under study.

## *Hypotheses*

***19. Effects of stimulus predictability on pain predictions prior to stationary standing.*** a) It was predicted that pain subjects would make higher pain

predictions than would control subjects and, b) it was predicted that pain patients would make higher predictions under conditions of low versus high predictability.

***20. Effects of stimulus predictability on pain thresholds during stationary standing.*** a) It was predicted that pain subjects would report lower pain thresholds than would control subjects and, b) would report lower pain thresholds under conditions of low versus high stimulus predictability.

***21. Effects of stimulus predictability on reported pain following stationary standing.*** a) It was predicted that pain subjects would report higher levels of pain following stationary standing than would control subjects and, b) would report more pain following conditions of low versus high predictability.

***22. Effects of low and high stimulus predictability on pain behaviour during and immediately following stationary standing.*** a) It was predicted that pain subjects would display more pain behaviour during and following stationary standing than would control subjects and, b) would display more pain behaviour following conditions of low versus high stimulus predictability.

## *Method*

### *Procedures*

Procedures followed in Experiment 5 were identical to those followed in Experiment 4 and, apart from the following, will not be described again.

***Familiarization.*** Subjects were familiarized with the stationary-standing apparatus and procedures.

***Predicting pain.*** Subjects were asked to report the peak level of pain they expected to experience during a 60-second stationary standing trial using the pain intensity scale.

***Stationary standing and pain thresholds.*** Total standing duration was 180 seconds for each of the two predictability trials. Subjects reported the precise point in time that they began to feel pain.

***Reporting actual pain experienced.*** Subjects reported the peak level of pain experienced during the task immediately following completion of each trial.

## *Results*

Multivariate analyses of variance indicated that there were significant between-subjects main effects for group (Pillais = .63, $df$ = 3, 34, $p < .001$) but not order (Pillais = .11, $df$ = 3, 34, $p > .05$). There was no significant group by order interaction (Pillais = .10, $df$ = 3, 34, $p > .05$). There was no significant within-subjects main effect for condition (i.e., level of stimulus predictability) (Pillais = .14, $df$ = 3, 34, $p > .05$). There were no significant multivariate interactions between group and condition (Pillais = .14, $df$ = 3, 34, $p > .05$), or between group, order and condition (Pillais = .15, $df$ = 3, 34, $p > .05$). There were significant interactions between order and condition (Pillais = .36, $df$ = 3,

34, $p < .01$).

Thus, there were significant differences between groups in mean pain predictions, thresholds and reports from step-up pain. There were also significant differential treatment effects. As planned, univariate analyses and contrasts were conducted to locate the sources of these effects.

***Hypothesis 19: Effects of stimulus predictability on pain predictions prior to stationary standing.*** Table 31 presents mean pain predictions as a function of condition (i.e., level of predictability), group and the order (i.e., position at which subjects received each of the two conditions).

Table 31

Mean predictions of standing pain by condition, group and order

| | Condition | | | |
|---|---|---|---|---|
| | Low predictability | | High predictability | |
| | Pain | Control | Pain | Control |
| Position[a] | Group | Group | Group | Group |
| First | 5.11 (2.76) | 0.30 (0.48) | 3.36 (2.46) | 0.20 (0.42) |
| Second | 3.46 (2.34) | 0.40 (0.70) | 6.00 (2.45) | 0.60 (0.84) |

[a] Test position.

Pain patients' mean predictions were significantly higher than control subjects' predictions ($F_{(1,36)} = 52.11$, $p < .001$). However, because control subjects' predictions did not depart significantly from zero (i.e., there were significant floor effects with control subjects' scores, and thus limited variance), all further analyses of pain predictions prior to step-ups did not include control group data. Table 32 presents a summary table for the 2 X 2 (order by condition) mixed factorial analysis of variance on pain groups' pain predictions. There was a significant between subjects main effect for condition (i.e., level of stimulus predictability) but not order and there was a significant within-subjects interaction effect between order and condition.

Table 32

Analysis of variance summary table: Order by condition on pain predictions prior to stationary standing

| Source | *df* | Mean Square | *F* |
|---|---|---|---|
| Order | 1 | 45.61 | 3.74* |
| Condition | 1 | 1.58 | 5.79** |
| Order by condition | 1 | 2.38 | 8.73** |
| Between error | 18 | 12.18 | |
| Within error | 18 | .27 | |

Note. $n = 20$.
* $p = .07$.
** $p < .01$.

Although there were significant effects of predictability on pain predictions prior to stationary standing, these effects were mediated by subjects' previous experience. Contrast analysis between cells in the first test position (responses are not confounded by the order by condition interaction) revealed significant effects of predictability on pain predictions ($t = 5.12$, 18 *df*, $p < .001$). Pain subjects who received the low predictability treatment predicted significantly more pain than their cohorts who received the high predictability treatment (see Figure 19).

Insert Figure 19 about here

***Hypothesis 20: Effects of stimulus predictability on pain thresholds during stationary standing.*** Table 33 presents mean pain thresholds as a function of condition (i.e., level of predictability), group and the order (i.e., position at which subjects received each of the two conditions).

Table 33

Mean standing pain thresholds by condition, group and order

| | Condition | | | |
|---|---|---|---|---|
| | Low predictability | | High predictability | |
| Position[a] | Pain Group | Control Group | Pain Group | Control Group |
| First | 33.73 (28.02) | 171.86 ( 28.89) | 87.02 (75.85) | 163.39 ( 55.69) |
| Second | 82.52 (78.42) | 162.84 ( 50.48) | 34.58 (28.60) | 169.89 ( 28.88) |

Note. Thresholds are reported in seconds.
[a] Test position.

There was a significant difference between pain group's and control group's mean thresholds during stationary standing ($F_{(1,36)} = 42.52$, $p < .001$).

Pain patients mean thresholds were significantly lower than control subjects' thresholds. However, control groups' data were skewed negatively, with a majority of cases achieving threshold ceilings. Thus, further analyses of threshold values did not include control group scores.

Table 34 presents a summary table for the 2 X 2 (order by condition) mixed factorial analysis of variance on pain thresholds. Although there was a trend towards a significant order effect, there were no other significant or near significant effects.

Table 34

Analysis of variance summary table: Order by condition on pain thresholds during stationary standing

| Source | *df* | Mean Square | *F* |
|---|---|---|---|
| Order | 1 | 5360.22 | 3.53$^{\cdot}$ |
| Condition | 1 | 70.69 | .54 |
| Order by condition | 1 | 33.07 | .25 |
| Between error | 18 | 7193.43 | |
| Within error | 18 | 131.88 | |

$^{\cdot}.08 > p < .05$.

***Hypothesis 21: Effects of stimulus predictability on reported pain following stationary standing.*** Table 35 presents mean peak pain ratings as a function of condition (i.e., level of predictability), group and the order (i.e., position at which subjects received each of the two conditions).

Table 35

Mean ratings of peak standing pain by condition, group and order

| | Condition | | | |
|---|---|---|---|---|
| | Low predictability | | High predictability | |
| Position[a] | Pain Group | Control Group | Pain Group | Control Group |
| First | 6.44 (2.79) | 0.50 (0.97) | 3.90 (2.80) | 0.30 (0.48) |
| Second | 4.18 (3.06) | 0.40 (0.70) | 6.89 (2.47) | 0.40 (0.70) |

[a] Test position.

Pain patients' mean peak pain ratings were significantly higher than control subjects' ratings ($F_{(1,36)} = 59.06$, $p < .001$). However, because control subjects' mean ratings did not depart significantly from zero (i.e., there were significant floor effects with control subjects' scores, and thus limited variance), all further analyses of reported pain following standing did not include control group data. Table 36 presents a summary table for the 2 X 2 (order by

condition) mixed factorial analysis of variance on pain groups' pain ratings. There was no significant main effect of condition (i.e., level of stimulus predictability). However, there were significant order effects, and there was a significant order by condition interaction.

Table 36

Analysis of variance summary table: Order by condition on pain ratings following stationary standing

| Source | *df* | Mean Square | *F* |
|---|---|---|---|
| Order | 1 | 68.02 | 4.35* |
| Condition | 1 | .07 | .60 |
| Order by condition | 1 | 1.27 | 10.41** |
| Between error | 18 | 15.64 | |
| Within error | 18 | .12 | |

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

Figure 20 illustrates the order by condition interaction as a function of test position. The effects of stimulus predictability were strongly mediated by pain subjects' previous experience.

---

Insert Figure 20 about here

---

Contrast analysis between cells in the first test position (responses are not confounded by the order by condition interaction) revealed significant effects of predictability on pain reports ($t$ = 3.73, 18 $df$, $p < .01$). Pain subjects who received the low predictability treatment reported experiencing significantly more pain than their cohorts who received the high predictability treatment (see Figure 21).

---

Insert Figure 21 about here

---

***Hypothesis 22: Effects of low and high stimulus predictability on pain behaviour during and immediately following stationary standing.*** Table 37 presents mean pain behaviour scores as a function of condition, group and

order.

Table 37

Mean pain behaviour scores by group, condition and order

| | Condition | | | |
|---|---|---|---|---|
| | Low predictability | | High predictability | |
| Position[a] | Pain Group | Control Group | Pain Group | Control Group |
| First | 161.37 (123.80) | 155.10 (117.43) | 223.36 (145.02) | 125.00 (130.24) |
| Second | 134.64 ( 96.10) | 85.89 (101.95) | 110.75 (124.89) | 131.10 (109.70) |

Note. $N$ = 40. Standard deviations are given in parentheses.
[a] Test position.

Table 38 presents a summary table for the mixed factorial analysis of variance. There were no main effects for group or condition. However, there was a significant order by condition interaction.

Table 38

Analysis of variance summary table: Group by order by condition on pain behaviour scores during stationary standing

| Source | *df* | Mean Square | *F* |
|---|---|---|---|
| Group | 1 | 20723.38 | .88 |
| Order | 1 | 130.67 | .01 |
| Group by order | 1 | 30421.23 | 1.29 |
| Condition | 1 | 3315.61 | .67 |
| Group by condition | 1 | 618.93 | .13 |
| Order by condition | 1 | 47997.05 | 9.77* |
| Three way | 1 | 6806.14 | 1.39 |
| Between error | 36 | 23628.90 | |
| Within error | 36 | 4912.13 | |

* $p < .001$.

Planned contrasts, using only cells from the first test position, revealed a significant effect of predictability on pain behaviour for the pain group (see Table 39 and Figure 22).

Table 39

Contrasts on pain behaviour: independent means and standard deviations for first test position data

| | Condition | | |
|---|---|---|---|
| Group | Low | High | *t*-value |
| Pain | 161.37 (123.80) | 223.36 (145.07) | 6.23* |
| Control | 155.10 (117.43) | 125.00 (130.24) | .54ns |

Note. 18 *df* for each contrast.
* $p < .01$.

Insert Figure 22 about here

Thus, contrary to the hypothesis, pain patients, in response to stationary standing, displayed more pain behaviour under conditions of high predictability than under conditions of low predictability.

### *Experiment 5: conclusions and discussion*

Table 40 provides an "at-a-glance", dichotomous listing of major effects obtained in Experiment 5 and, for simplicity, will be referred to throughout this discussion.

Table 40

Experiment 5: Presence or absence of effects from variations of stimulus predictability during stationary standing

| ***Source of Effect*** | ***Variable*** | | | |
|---|---|---|---|---|
| | **Pain Prediction** | **Pain Threshold** | **Pain Report** | **Pain Behaviour** |
| Group | Yes | Yes | Yes | No |
| Condition [a] | Yes | No | Yes | Yes[b] |

[a] Pain group only, $n$ = 20, using data from cells in first test position.
[b] Not in predicted direction though.

***Between group differences.*** Hypotheses 19a, 20a, and 21a were supported. As expected, pain groups' pain predictions were significantly higher than were control groups' pain predictions (see Table 40). Control group subjects did not expect that the standing task would be aversive (see Table 31). Further, pain groups' pain thresholds were significantly lower than were control

groups' pain thresholds, and pain subjects reported significantly more pain from standing than did control group subjects. However, Hypothesis 22a was not supported. Pain subjects displayed no more or less pain behaviour during standing than did control subjects.

This finding was interesting for a number of reasons. First, it could indicate a problem with the validity of the measurement tool. It was possible that pain-free control subjects were engaging in behaviour that was being rated as indicating pain, where no pain existed. This is an empirical question and it is best addressed in future research, although this argument does not seem probable given the apparent utility of the instrument during Experiments 3 and 4.

Second, it was possible that although control group ratings of pain were not high, their behaviour indicated some degree of *discomfort* while performing the stationary standing task. Further validity studies of the pain behaviour rating system might include a closer inspection of the pain behaviour subscale scores to reveal which pain behaviours were accounting for the absence of between group differences during Experiment 5. Keefe, Bradley and Crisson (1990) presented data which suggested that more fine-grained, subscale analyses can differentiate subgroups of pain patients. Perhaps similar analyses could indicate whether specific pain behaviours are more indicative of acute pain and others are more indicative of chronic pain. If this were the case, follow-up investigation of pain behaviour subscales, analyzing behaviour during

exposure to each of the three pain modalities might prove to be interesting.

***Treatment effects.*** Hypothesis 19b was supported. Pain subjects who received the low predictability treatment predicted significantly more pain from stationary standing than subjects who received the high predictability treatment (see Table 40).

Hypothesis 20b was not supported. There was only a trend for pain group subjects to display lower pain thresholds under conditions of low predictability than under conditions of high predictability.

Hypothesis 21b was supported. Pain subjects in the low predictability group reported significantly higher levels of pain following stationary standing than subjects in the high predictability group.

These three findings were generally consistent with those obtained in Experiments 3 and 4. Despite the fact that subjects did not perceive the standing task as aversively as they perceived cold water immersion and step climbing, there was good generalization of effects across all three pain modalities.

Last, Hypothesis 22b was not supported. Although there was an effect of stimulus predictability on subjects' displays of pain during standing, the effect was not in the predicted direction. Subjects displayed *more* pain behaviour in the high predictability condition than they did during the low predictability condition. Given the other findings obtained, this remains a theoretical enigma.

***A final note.*** Again during Experiment 5 there were carry-over effects.

These effects were in the same direction as the effects obtained in Experiments 3 and 4. It seems reasonable to conclude, at this point, that these effects represented more than simply random sources of variance. The nature and possible ramifications of these effects will be explored in the Discussion.

## *RELATIONSHIP BETWEEN VARIABLES*

The reader will recall that the Introduction explored theoretical arguments and survey based evidence for an association between subjects' perceptions of control over pain and their responses to clinical pain. Experiment 2 provided an opportunity to examine associations between subjects' self-reported perceived control over pain and their responses to experimentally induced pain, and post hoc, to examine the relationship between pain perception and pain behaviour.

### *Hypotheses*

***23. Relationship between perceived control and pain predictions.*** It was predicted that there would be negative covariation between subject's perceived control scores and the prediction of pain in Experiment 2; that is, low perceived control would be associated with high pain predictions.

***24. Relationship between perceived control and pain thresholds.*** It was predicted that there would be positive covariation between subject's perceived control over pain scores and pain thresholds reported in Experiment 2; that is, high perceived control would be associated with high pain thresholds.

***25. Relationship between perceived control and pain behaviour.*** It was predicted that there would be negative covariation between subject's perceived control over pain scores and the extent of pain behaviour displayed in Experiment 2; that is, low perceived control would be associated with high pain behaviour.

***26. Relationship between studies: perceived control and pain.*** It was

predicted that there would be negative covariation between subject's perceived control over pain scores and reported pain scores in Experiment 2; that is, low perceived control would be associated with high reports of pain.

## *Results*

### *Perceived control and pain predictions*

Hypothesis 23 predicted that there would be negative covariation between subject's perceived control scores and the prediction of pain in Experiment 2; that is, low perceived control would be associated with high pain predictions.

Because of moderately high correlations between CSQ item 43 and 44 (.68 for pain group [$p < .01$, $n = 20$] & .64 for control group [$p < .01$, $n = 20$]), scores on these two items were summed to produce one global, perceived control score.

***Results and conclusions***. Results did not support the hypothesis. There were consistent, moderate order positive correlations between perceived control scores and pain predictions in Experiment 2 for both pain and control subjects. The more subjects perceived they had control over pain, the higher were their predictions of impending pain. Table 41 presents a table of correlations between predictions for each trial and subjects' perceived control scores.

Table 41

Pearson Product Moment correlation coefficients between perceived control scores and Experiment 2 pain predictions, by trial, for pain and control subjects

| | **Perceived Control Scores** | |
|---|---|---|
| | ***Group*** | |
| ***Pain Predictions*** | ***Pain*** | ***Control*** |
| Trial 1 | .37 | .29 |
| Trial 2 | .25 | .37 |
| Trial 3 | .39* | .25 |

* one-tailed $p < .05$, $n = 20$ per group.

***Perceived control and pain thresholds***

Hypothesis 24 predicted that there would be positive covariation between subject's perceived control over pain scores and pain thresholds reported in Experiment 2; that is, high perceived control would be associated with high pain thresholds.

***Results and conclusions***. Results did not support the hypothesis for the pain group, but did support the hypothesis for the control group. There was no association between perceived control scores and pain thresholds in Experiment 2 for pain patients. There was a moderately strong association between perceived control scores and pain thresholds for control subjects. The

more control subjects perceived they had control over pain in general, the higher were their pain thresholds. Table 42 presents a table of correlations between pain thresholds for each trial and subjects' perceived control scores.

Table 42

Pearson Product Moment correlation coefficients between perceived control scores and Experiment 2 pain thresholds, by trial, for pain and control subjects

| | **Perceived Control Scores** | |
|---|---|---|
| | ***Group*** | |
| ***Pain Thresholds*** | ***Pain*** | ***Control*** |
| Trial 1 | -.08 | -.11 |
| Trial 2 | .02 | .52* |
| Trial 3 | .02 | .42* |

* one-tailed $p < .05$, $n = 20$ per group.

***Perceived control and pain behaviour***

Hypothesis 25 predicted that there would be negative covariation between subject's perceived control over pain scores and the extent of pain behaviour displayed in Experiment 2; that is, low perceived control would be associated with high pain behaviour.

***Results and conclusions.*** Results did not support the hypothesis. There

were no strong associations between perceived control and pain behaviour in Experiment 2 for either pain or control subjects. Table 43 presents a table of correlations between displayed pain behaviour during each trial and subjects' perceived control scores.

Table 43

Pearson Product Moment correlation coefficients between perceived control scores and Experiment 2 displayed pain behaviour, by trial, for pain and control subjects

| | ***Perceived control scores*** | |
|---|---|---|
| | ***Group*** | |
| ***Pain Behaviour*** | ***Pain*** | ***Control*** |
| Trial 1 | -.20 | -.13 |
| Trial 2 | -.14 | .06 |
| Trial 3 | -.26 | -.01 |

Note. $n$ = 20 per group.

***Perceived control and pain***

Hypothesis 26 predicted that there would be negative covariation between subject's perceived control over pain scores and reported pain scores in Experiment 2; that is, low perceived control would be associated with high

reports of pain.

***Results and conclusions***. Results did not support the hypothesis. There were no strong associations between perceived control scores and pain reports in Experiment 2 for either pain or control subjects. Table 44 presents a table of correlations between pain reports for each trial, and subjects' perceived control scores.

Table 44

Pearson Product Moment correlation coefficients between Experiment 2 perceived control scores and pain reports by trial for pain and control subjects

| | **Perceived Control Scores** | |
|---|---|---|
| | ***Group*** | |
| ***Pain Reports*** | ***Pain*** | ***Control*** |
| Trial 1 | .31 | .22 |
| Trial 2 | .12 | .12 |
| Trial 3 | .19 | -.07 |

Note. $n$ = 20 per group.

### *Relationship between pain perception and pain behaviour during cold water immersion*

Experiment 2 provided an opportunity to examine between group differences in the relationship between subjects' perceptions of pain and their displays of pain behaviour during repeated exposure to an acute laboratory pain stimuli.

***Results***. Table 45 presents Pearson correlation coefficients, by group, for subjects' pain thresholds and reports and their pain behaviour scores for each of the three cold water trials in Experiment 2.

Table 45

Pearson correlations between pain perception and pain behaviour scores for pain and control groups during Experiment 2 ($N$ = 40)

| **Pain Perception** | | **Pain Behaviour** | | |
|---|---|---|---|---|
| | **Group** | **Trial 1** | **Trial 2** | **Trial 3** |
| **Thresholds** | Pain | -.50* | -.11 | -.43* |
| | Control | .11 | .48* | .16 |
| **Reports** | Pain | .53* | .30 | .37* |
| | Control | -.06 | .08 | .11 |

* $p < .05$.

***Conclusions and discussion.*** Despite the facts that both groups had an adequate range of scores on measures used in this analysis, and that there were no significant differences between groups in pain perception (see Experiment 2), there were clear differences between groups in the pattern and valence of correlations between measures of pain perception and pain behaviour (see Table 45). There was only one non-zero order correlation between pain perception and pain behaviour for the control group. There were several moderate order correlations between pain perception and pain

behaviour for the pain group. For the pain group, there was an inverse relationship between pain thresholds and displays of pain behaviour, and a positive linear relationship between reports of pain and displays of pain behaviour. For the control group, the only significant correlation indicated that there was a positive linear relationship between pain thresholds and pain behaviour.

The pattern of correlations for the pain group were not consistent with the clinical literature described in the Introduction which reported weak relationships between questionnaire measures of pain intensity and pain behaviour with chronic pain patients. However, the correlations presented above were based on measures obtained during and after exposure to an acute experimental pain stimulus, and not on responses to questions about chronic pain. Because these observation have implications for results from several sections, discussion of this discrepancy will be taken up in the Discussion.

Nevertheless, it may be useful to reiterate here that the only significant relationships between a questionnaire measure of perceived control and pain were with early components of pain perception (i.e., pain thresholds, see last section). There were no significant correlations between perceived control and either pain ratings or pain behaviour. The pattern of results was similar for both pain and control groups alike. Thus, relationships between perceived control over pain, pain perception and pain behaviour, were not peculiar to one group or another, and, *a priori* perceptions of control over pain likely had little

influence in producing between group differences in pain behaviour previously reported or the differential pattern of correlations reported here.

### *Relationship between pain groups' perceptions of pain and displays of pain behaviour during Experiments 4 and 5*

Experiments 4 and 5 provided opportunities to examine the relationship between pain group subjects' perceptions of pain and their displays of pain behaviour during step climbing and standing.

***Results***. Table 46 presents Pearson correlation coefficients for subjects' pain thresholds and reports and their total pain behaviour scores for Experiments 4 and 5.

Table 46

Pearson correlations between pain perception and pain behaviour scores for the pain group during Experiments 4 and 5 ($N$ = 20)

| Measure | Total Pain Behaviour Scores | | | |
|---|---|---|---|---|
| | Step Climbing | | Standing | |
| | Low[a] | High[b] | Low[a] | High[b] |
| Thresholds | -.08 | .06 | .42 | .36 |
| Reports | .16 | .15 | -.52 | -.36 |

[a] Correlation with the pain behaviour scores under the low predictability condition.
[b] Correlation with pain behaviour scores under the high predictability condition.

***Conclusions and discussion.*** There were no significant relationships between measures of pain perception and pain behaviour during step-climbing. These results were consistent with what is frequently reported in the clinical literature and supports the notion that, for chronic low back pain patients, step-climbing is a more ecologically valid pain stimulus than is cold water immersion. Conversely, correlations between pain perception and pain behaviour were of a greater magnitude during standing. These data were paradoxical, given what has been reported in earlier sections, and no reasonable explanation could be offered except that pain behaviour scores during Experiment 5 were, in fact, irregular (see Experiment 5). Although paradoxical correlations can often be attributed to measurement variance, this was apparently not the case for the

measures of pain perception. For example, there were strong correlations, in the expected direction, between Experiment 5 pain thresholds and pain reports during conditions of low and high stimulus predictability (-.79, $p < .001$ & -.84, $p < .001$ respectively). Whether or not these unexpected results can be attributed to pain behaviour measurement error is an empirical question which is best resolved through further psychometric investigation of the observational rating system.

# *DISCUSSION*

## *Summary of research*

The aims of this dissertation were to investigate the effects of stimulus predictability on pain perception and pain behaviour; to investigate whether these effects remained constant across pain from different sources; and to investigate the relationship between perceived control, pain perception and pain behaviour.

A series of experiments was conducted on the same two groups of subjects to examine differences in responses to these effects between chronic low back pain patients and pain-free controls. There was good, although at times qualified, support for many of the hypotheses. However, several of the findings were unexpected. In Experiment 2, in which cold pressor pain was used, there were no differences between chronic low back pain patients and matched, pain-free controls in predictions of impending pain, in patterns of predicting pain during repeated exposures to a painful stimulus, or in pain thresholds, even after repeated exposure to the painful stimulus. Experiment 3 confirmed, under longer exposure durations, that there were no differences between groups in pain predictions. During Experiment 3, chronic low back pain patients displayed an increased sensitivity to pain under conditions of low stimulus predictability compared to control subjects. Subjects in both groups predicted significantly more pain and displayed significantly lower pain

thresholds under conditions of low versus high stimulus predictability. Experiments 4 and 5 produced similar effects and demonstrated (with qualifiers discussed below) good generalization of these findings to different, more clinically relevant, pain stimuli.

Pain subjects displayed more pain behaviour than did control subjects in all experiments. However, neither group's displays of pain behaviour were significantly affected by variations in stimulus predictability.

Significant relationships were found between perceived control over pain, pain predictions and pain thresholds but not between perceived control and pain reports or behaviour during acute pain stimulation. This pattern of relationships was the same for both groups. Conversely, there were significant correlations between pain subjects', but not control subjects', perceptions of pain and their displays of pain behaviour during cold water immersion, but not during step climbing or standing. Discussion ensues of the empirical and theoretical ramifications of these results.

***On the effects of predictability***

Table 47 summarizes the effects of stimulus predictability on pain predictions and pain perception during exposure to pain from cold water immersion, step-climbing and stationary standing. As predicted, under conditions of low stimulus predictability, both pain and pain-free subjects tended to make higher pain predictions, report lower pain thresholds and report higher

levels of pain than they did under conditions of high stimulus predictability.

Table 47

Presence or absence of effects of stimulus predictability on pain predictions, pain perception and pain behaviour during Experiments 3, 4 and 5

| | *Source of Pain* | | |
|---|---|---|---|
| ***Variable*** | ***Cold pressor*** | ***Step-ups*** | ***Standing*** |
| Predictions | Yes [a] | Yes [b] | Yes [b] |
| Thresholds | Yes [a] | Trend [b] | No |
| Reports | No | Yes [b] | Yes [b] |
| Behaviour | No | No | Yes [c] |

[a] There was an effect for both pain and control groups.
[b] There was an effect for pain group only.
[c] This effect was not in the predicted direction.

These effects were contingent on the saliency of the stimulus modality. Although a similar pattern of effects was observed across three different sources of pain for the pain group, no effects were observed for the control group during step-climbing or standing. This was probably because, for the control group, these activities were neither anticipated nor perceived to be painful.

Thus, there was good evidence that pain predictions and pain perception

can be altered by variations in external control parameters. This research showed, for the first time, that pain predictions and pain perceptions can vary as a function of the availability of information about the duration and offset of an impending painful stimulus. These effects were not specific to pain from one stimulus, but rather, were demonstrated prior to conditions of acute experimentally induced pain and prior to more ecologically relevant experimentally induced acute pain such as the pain from step-climbing and standing, when the event was *a priori* perceived to be painful.

Explicit variation in stimulus predictability did not produce the predicted effect on subjects' displays of pain behaviour (see Table 47). The persistent absence of significant effects on pain behaviour, given the strong effects on pain perceptions, provided further indication of the dissociation between pain perception and pain behaviour. This was consistent with the questionnaire based research reviewed in the Introduction, which indicated that there was a weak and inconsistent relationship between pain perception and pain behaviour in chronic low back pain research. This research provides the first experimental data with chronic low back pain patients and healthy pain-free controls that examine this relationship.

***On differences between chronic low back pain patients and pain-free controls***

Chronic low back pain subjects displayed increased sensitivity to conditions of low stimulus predictability compared to controls. They reported a

greater impact from exposure to painful stimuli when they were not provided with information about the duration of a potentially painful upcoming event. Under conditions of high predictability (when the stimulus was novel and equitably aversive to all subjects), there were no differences in pain predictions, pain threshold or pain reports between chronic low back pain patients and healthy pain-free subjects.

Chronic low back pain patients displayed more pain behaviour than did pain-free controls even under conditions which were anticipated and perceived to be equally painful to both groups (i.e., cold water immersion).

### *Unresolved issues*

Several questions were only partially addressed in previous sections or left unanswered. Why did the pain group display more pain behaviour than did the control group? Why were there no significant effects of predictability on pain behaviour? Why did the pain group display increased sensitivity to pain under conditions of low predictability? Could the between group differences in pain behaviour observed throughout this research and the varying pattern of correlations between pain perception and pain behaviour reported in the last section be related? Next, behavioral, social communication, and cognitive perspectives will be introduced in an attempt to reconcile these results.

### *Why the pain group displayed more pain behaviour than did the control group*

The behavioral principle of stimulus generalization (Schmidt & Arntz, 1987) suggests that a particular response that is initially linked only to one stimulus will, over time, generalize to other stimuli which resemble the original stimulus. From this principle, one might predict that chronic pain patients should react with chronic pain behaviour not only to situations which elicit chronic pain, but also to acute pain situations, because of the sensory similarities between chronic and acute pain. Although this model may explain the between group differences in pain behaviour observed in this research, it does not adequately account for the often reported persistence of these behaviours in the absence of reinforcement.

Linton, Melon, & Götesdam (1985), presented a Pavlovian or classical conditioning model to counter allegations that learning models (i.e., instrumental models such as Fordyce, 1976) could not explain why pain behaviours persist in the absence of secondary reinforcers. This model also could be used to explain the between group differences in pain behaviour and the differential pattern of correlations observed in Experiment 2. A Pavlovian account of pain behaviour would postulate that during repeated exposure to acute trauma, pain could become an interoceptive conditioned stimulus for tissue damage. (It is frequently implied that only external signals can become conditioned stimuli, e.g., Keefe & Lefebvre, 1994.) The unconditioned response to the trauma would include: avoidance (cf., guarding), withdrawal, isolation or rubbing of the affected part (cf., bracing), and grimacing. These are behaviours which, in

clinical research, would be labelled pain behaviours. This model would suggest that pain patients' greater displays of pain behaviour relative to control subjects, during novel acute experimental pain stimulation represent, in part, conditioned responses. Control group subjects did not display the same frequency or magnitude of pain behaviours or the same relationship between pain and pain behaviour because they have had little past experience with repeated exposure to pain. Similarly, it may have been the case that, for the pain group, the initiation of, or thought of, step climbing and standing may have precipitated a conditioned pain behaviour response. Hence, this response did not need to be associated with the perception of pain to be elicited.

The fact that control subjects displayed pain behaviours in many of the situations where pain subjects displayed pain behaviours suggests that these responses reflect normal and possibly adaptive responses to acute pain. The conditioning model provides an explanation for why pain groups' responses were more frequent and greater in magnitude than were control groups'.

Interestingly, pain subjects, unlike controls, acknowledged displaying more pain behaviour in response to pain in general (see Experiment 1). It may be that pain subjects have become aware of this conditioned response or, for whatever reasons, are less stoical about pain than control subjects. Unfortunately, to the present, there has been little experimental research on respondent conditioning with chronic low back pain patients.

***Why pain behaviours may have been immune to the effects of variations in stimulus predictability***

In this research, pain perceptions were more directly related to the sensory/discriminative qualities of the nociceptive stimulus than were pain behaviours. Subjects in both groups predicted and perceived more pain during the long immersions of Experiment 3 than during the shorter immersions of Experiment 2. But, as previously mentioned, pain behaviours did not show this relationship with the sensory / discriminative or expected qualities of the stimulus. Others have reported that, unlike the data on pain perceptions (cf., discussion presented in Experiment 4), certain types of pain behaviour can be stable across pains with very different sensory qualities (Prkachin, 1992), and this is consistent with a conditioning model of pain behaviour.

But the motivation for individuals to communicate to the world that they are in pain appears rooted in a genetic reflex (Craig, 1994). Sending the pain message to the world through overt motoric behaviours stems from infancy, where these behaviours are readily influenced by the infant's external social environment (Craig, 1994). Influences from external social environments continue to exert strong effects on pain behaviour through to maturity, and it is recognized that many factors in an individual's social communication network can influence the display and persistence of pain behaviours: Examples include spousal behaviour (Flor, Kerns, & Turk, 1987) and experimenter gender (Levine & Simone, 1991).

Although pain behaviours represent the overt expression or communication of the sensory qualities of pain to others, as discussed in the Introduction, they also reflect many other aspects of an individual's experience with pain (Craig, Prkachin, Grunau, 1992; Turk & Flor, 1987), and may even represent a means of coping (Keefe & Dunsmore, 1992a). Whether or not pain behaviours reflect conditioned responses, they also can be understood as communications to the world about an individuals past, present and expected future relationship with pain (Philips, 1987; Rachman & Arntz, 1991) and, as such, represent complex cognitive, affective and psychosocial events. A social communications perspective can explain the saliency of these behaviours for both sender and receiver, and emphasizes that pain behaviours occur within a broad context of social interactions. For those with little past experience with pain, there may be little to communicate during exposure to a novel, acute experimental pain situation. In the case of chronic pain, these communications may represent more complex signals which, for example, may reflect a rich history of social interactions focused on pain.

Although pain perceptions also involve complex psychological events including emotional arousal, motivational drives and cognitions, perceptions, to a large extent, represent transient responses to immediate sensory events (Gracely, 1994). It is not surprising that an external event, such as stimulus predictability, might have mediated this response because stimulus predictability provided important information about the nature and severity of those events. If

it is the case that pain behaviours represent not only responses to pain per se, but cognitive and affective processes and environmental influences as well, then it could be argued that the pain behaviour response may have been less influenced by an transient and novel event such as the predictability of a brief external stimulus.[1] Perhaps displays of pain behaviour were more influenced by these historical and environmental factors than by the experimental manipulation. By this reasoning, pain behaviours should reflect these influences. It remains unclear to what extent external environmental variables, apart from predictability, influenced the display of pain behaviour.

It should be mentioned that the social communications perspective is not incompatible with the behavioral perspective on pain behaviours. The social communication model identifies which experiences and interactions influence pain behaviour. The classical conditioning model provides a mechanism to explain how these social experiences may come to influence the display of pain behaviours.

***Why did chronic low back pain patients display increased sensitivity to conditions of low predictability relative to the control group?***

The discussion at the end of Experiment 3 implicated cognitive factors as

---

[1] That is not to say that pain behaviours were not influenced by predictability. In many instances, there were trends towards significance for the treatment effect. But, experimental treatment effects on pain behaviour were either too small to reach significance, or mediated by other influences, or just not present.

a possible source of the pain groups' increased sensitivity to pain under conditions of low predictability. In fact, altered cognitive appraisals can produce selective deficits in information processing which can result in specific deficits in coping with highly stressful events (Peacock, Wong, & Reker, 1993), including pain (Main & Waddell, 1991).

For example, Williams and Keefe (1991), found that chronic low back pain patients who believed their pain was mysterious and unpredictable (i.e., patients displaying evidence of altered appraisals) were less likely to use coping strategies to manage pain.

In a well executed path analytic model of pain perception, Geisser, Robinson, Keefe, and Weiner (1994) found that altered cognitive appraisals (labelled catastrophising in their study) in chronic pain patients mediated the evaluative and affective but not the sensory aspects of pain. (This finding was consistent with the fact, in this research, there were few differences between groups on measures of pain perception, but there were differences in pain behaviour.) It may be that sensory responses to pain (reflected more in an individual's perceptions of pain) are less vulnerable to mediation by possibly respondently conditioned individual cognitive and affective responses, but that pain behaviours are more controlled by these responses.

Crook, Tunks, Kalaher, & Roberts (1988) presented data which indicated that handicapped chronic low back pain patients' cognitive appraisals may have been altered by chronic pain and handicap.

Several others researchers have reported differences in cognitive styles of appraisal between chronic low back pain patients and healthy pain-free controls (Jensen, Turner, Romano, & Lawler, 1994; Turk, & Rudy, 1988) and have shown that these differences can be associated with greater reports of pain or greater displays of pain behaviour (Anderson, Keefe, Bradley, McDaniel, Young, Turner, Agudelo, Semble, & Pisko, 1988; Reesor & Craig, 1988).

In their research with 50 healthy male subjects, Weisenberg, Wolf, Mittwoch, and Mikulincer (1990), found that only subjects rated low in learned resourcefulness were especially vulnerable to the impact of an aversive stimulus presented under conditions of no onset predictability. Although learned resourcefulness may encompass a broader range of cognitive events than do cognitive appraisals, both terms refer to internal mental processes. Relevant to this discussion was the interaction they reported between a cognitive process and the experimental manipulation of stimulus predictability.

Altered cognitive appraisals under stressful conditions may have produced the increased sensitivity to pain displayed by the pain group under conditions of low stimulus predictability.

Under conditions of low stimulus predictability, an individual is forced to rely on internal appraisal processes, as little information is forthcoming from external sources. If the individual has altered or deficient cognitive appraisals, they may not have the internal resources to cope with the situation. They may generate more fear or anxiety provoking thoughts than would others in the

same situation and this may result in increased sensitivity to this event.

Although the etiology of these changes in cognition is interesting and important for theory and practice, lengthy discussion would be beyond the scope of this dissertation and would be presumptuous because no such changes were measured in this sample.

However, for the handicapped, chronic low back pain subjects, an on-going perception of little control over pain (see Experiment 1), and the likely absence of actual control over their pain, may have resulted in cognitive and behavioral deficits similar to those associated with the learned helplessness phenomenon discussed earlier. This helpless state might be characterized by dysfunctional cognitive appraisals about information coming from the internal and external environments (e.g., catastrophising). In this state, the individual would no longer generate adaptive appraisals during stressful or aversive situations. Over time, these altered cognitions may have been reinforced through an instrumental fear-avoidance cycle (Lethem, Slade, Troup et al, 1983; Philips, 1987) or even conditioned to interoceptive stress and pain signals. Ultimately, the individuals are left vulnerable to situations of high stress and for example, they would display increased sensitivity to pain during conditions of low stimulus predictability.

The fact that there were no significant differences between groups during conditions of high stimulus predictability indicated that pain patients, like controls, were able to effectively use the information provided to them. Perhaps

in chronic low back pain, altered cognitive appraisals are only a liability when these patients have no external referent.

The fact that between group differences were frequently negated when the pain group was provided with previous exposure to the pain under conditions of high predictability suggested that this group of chronic low back pain patients had the ability to use newly available information to modify their perceptions. This suggested that if there are alterations in cognitive appraisals, they are not as debilitating as those observed in learned helplessness studies. Helpless subjects do not use new information or experiences to alter their perceptions and behaviour in aversive situations.

These arguments are speculative. Whether or not these processes can account for the pattern of results presented here remains to be determined.

But if these arguments are correct, the persistence of pain and pain behaviour in chronic low back pain, rather than reflecting a, "gross exaggeration of pain ... or a design fault (Wall, 1994)", reflect normal responses to events which, over time, may have simply ceased to be adaptive.

Much remains to be understood about the extent to which and how pain perception and pain behaviours are influenced or altered by psychological events. The behavioral, social communications and cognitive perspectives reviewed here provide direction and plausible mechanisms for understanding which specific aspects of the acute pain experience may be important for predicting, preventing and minimizing the impact of pain on chronic low back

pain patients' levels of physical and emotional functioning.

Since Melzack's and Wall's Gate Control Theory (Melzack & Wall, 1965), models of pain have partitioned the pain experience into a number of components including, for example, sensory, affective/motivational, cognitive and behavioral aspects. Most older models failed to provide much specificity and did not account for the behavioral dimensions of chronic pain, especially the persistent displays of pain behaviours (Philips, 1987).

Although many new models offer more specificity, most continue in the linear or unitary philosophy and few, if any, have attempted to explain by what mechanisms, psychological or otherwise, the components of the model interact (e.g., Lethem, Slade, Troup and Bentley, 1983; Waddell, Newton, Henderson, Somerville,, & Main, 1993; Wade, Dougherty, Hart, Raffi, Price, 1992; Wall, 1994).

This discussion presents tentative hypotheses about processes which can mediate the pain experience and plausible mechanisms for how specific psychological, historical and environmental factors might control the perception of pain and the display of pain behaviour.

### *Limitations of this research*

***The experimental design.*** A major purpose of this research was to investigate the effects of variations in the predictability of stimulus duration and offset on pain perception and pain behaviour. Although statements and

conclusions have been made regarding the effects of "predictability", these statements are limited to the dimensions of predictability tested and to the stimuli employed in these experiments. Recent evidence suggests that variations in other dimensions of predictability, such as information about the sensory quality of the stimulus or about stimulus onset, may have different effects on pain responses than those reported here (e.g., Crombez, Baeyens, & Eelen, 1994), and as previously discussed, both pain and healthy control subjects' pain responses vary as a function of the stimulus employed (e.g., Janal, Glusman, Kuhl, Clark, 1994).

***The sample.*** Conclusions from these experiments were based on results obtained from homogeneous groups of handicapped, male, chronic low back pain patients and healthy pain-free controls. It would be inappropriate to generalize these data to females, non-handicapped chronic low back pain patients, to patients with non-mechanical chronic low back pain or to any other specific group of chronic pain patients. Similarly, this sample of chronic low back pain patients was not severely depressed (see Experiment 1). Although the data have yet to be replicated, there is recent evidence to suggest that depressed, chronic low back patients cope, or respond, differently to pain than do matched groups of non-depressed chronic low back pain patients (Weickgenant, Slater, Patterson, Atkinson, Grant, & Garfin, 1993). If this data is accurate, generalizations to depressed chronic low back patients also would be limited.

***Carry-over effects***. There were significant differential carry-over effects observed in Experiments 3, 4 and 5 which did not discriminate between groups. These effects could be summarized by the two statements. When subjects' first exposure to a novel and acute, experimental pain stimulus occurred under conditions of low predictability of stimulus duration and offset, future exposure to the same stimulus was perceived to be more aversive. However, when subjects' first exposure to a novel and acute, experimental pain stimulus occurred under conditions of high stimulus predictability, future exposure to that same stimulus, under conditions of low predictability, were perceived to be less aversive than if subjects had not received previous exposure to the stimulus. Thus, initial exposure to the pain stimulus, under conditions of high predictability, seemed to buffer the negative effects of future exposure to that stimulus.

Although there is no precedent for this interaction in the chronic low back pain literature, this effect may be worthy of study in its own right. There are similar proactive effects reported in the animal literature. For example, in their research with rats, Maier and Warren (1988) reported that pre-exposure to inescapable shock with a safety signal (an animal research analogue to stimulus onset predictability, that is, providing information about stimulus onset) completely blocked the development of the escape deficit associated with learned helplessness. In their research (just as in this research) pre-treatment exposure to the aversive stimulus under conditions of high predictability

buffered the impact of future exposure to the same stimulus. However, the "buffering" effect was time limited; it only operated when pre-exposure occurred during the same session as test exposure. In Maier's and Warren's (1988) research, pre-exposure with a safety signal was not effective in buffering exposure during subsequent sessions.

In this research, the occurrence of these effects resulted in decreased sample size for the analysis of treatment effects and decreased power to detect these effects. If it was the case that the effects of predictability on pain behaviour were small, the small sample that remained for the study of treatment effects (i.e., $n$ = 10 per experimental cell) may have produced a Type II statistical error (Keppel, 1982).

### *Future research*

This research has demonstrated the viability and utility of laboratory experimentation with chronic low back pain patients in an area where such research was sorely lacking (Chapman, 1983; Schmidt, & Arntz, 1987), and established that a simple experimental manipulation of external parameters can produce significant effects on subjects' experiences of pain.

Future research needs to establish the parametric properties of this effect. For example, what is the duration of the effect? What is the rate of extinction? How robust is the effect? What are the minimum or maximum amounts of stimulus information necessary to produce the effect? And can the

effect be demonstrated with variations in other aspects of predictability such as stimulus onset and sensory qualities?

Other questions are: What is it about conditions of low predictability that produce these effects? How do conditions of low predictability affect subjects? What happens to subjects under conditions of low predictability? How does previous exposure to a painful stimulus, under conditions of high predictability, buffer future exposure to that stimulus? Clearly, cognitive processes of appraisal and expectancies must be involved. But, for example, do subjects perceive greater control during conditions of high predictability?

Philips (1987, p.276), predicted that cognitions such as expectations of increasing pain and memories of past painful experiences were of great importance in determining pain behaviour. It would be interesting to determine the extent to which these variables are involved in mediating the effects of stimulus predictability on pain behaviour. Future research could, for example, employ think aloud (Heyneman, Fremoun, Gana, Kirkland, & Heiden, 1990) or debriefing strategies (Spanos, Brown, Jones, & Horner, 1981) to elucidate the extent to which these processes mediate experimental effects. Through the use of procedures such as these, subjects' cognitive and affective responses (i.e., what subjects are thinking and feeling) may be determined before, during and after exposure to the stimulus, under each experimental condition.

With the exception of Flor and Birbaumer's (1994) recent research with healthy subjects, there appears to have been very little interest in the

application of respondent models to the phenomena of chronic pain. Learning theory, in general, still has much to contribute to the theory and practice of pain management and clinical psychology in general (Eifert & Plaud, 1993). Future research would benefit from closer collaboration with basic behavioral theorists.

***A final word on predictability.*** Although this research was not designed to investigate therapeutic gains, two findings in particular have clinical relevance. First, the finding that variations in stimulus predictability can influence pain perceptions implies that it may be useful for treatment programmes to provide to patients as much clear and specific information about their pain as possible: for example, when and under what circumstances are patients likely to experience changes in bodily sensations, how long the sensations may be expected to last, what the sensations mean, which signals indicate recovery and which do not. Second, the carry-over effect indicated that it may be crucial to intervene early in the disability process (likely during the acute phase) if a prophylactic buffer is to be created. This way, when pain is experienced, it is experienced under conditions of high rather than low temporal predictability. A randomized clinical trial could determine whether providing such intervention would result in a decreased incidence of handicapped chronic pain syndromes.

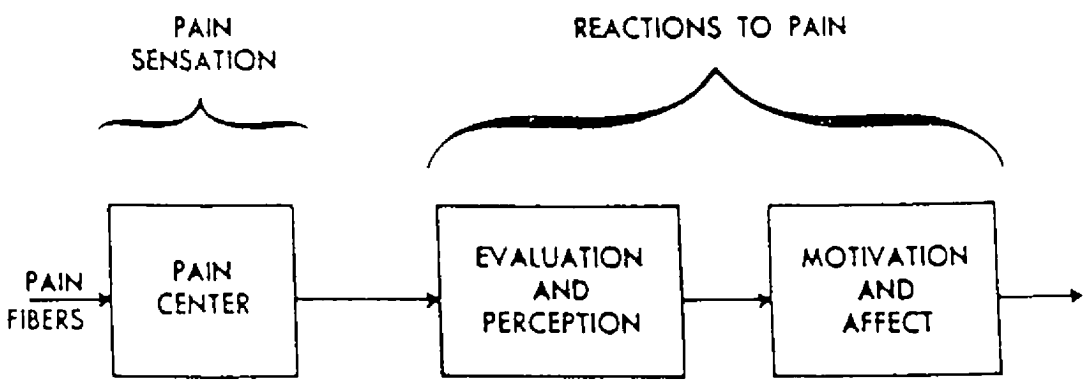



*Figure 1*. Traditional linear temporal sequence model of pain (Melzack, 1983).

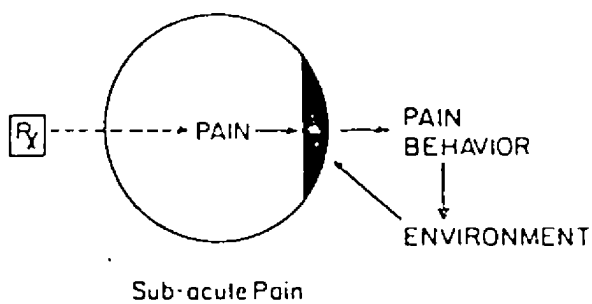



*Figure 2*. Linear model of pain behaviour (Fordyce, 1978).

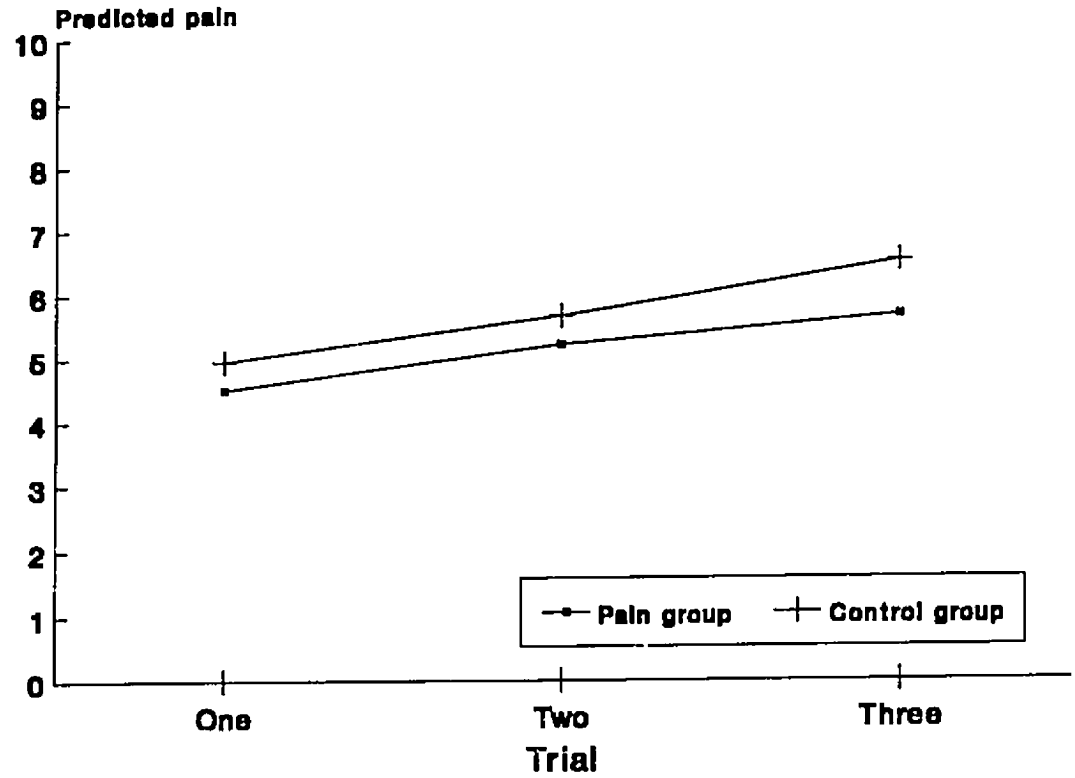



*Figure 3*. Pain predictions across trials in Experiment 2.

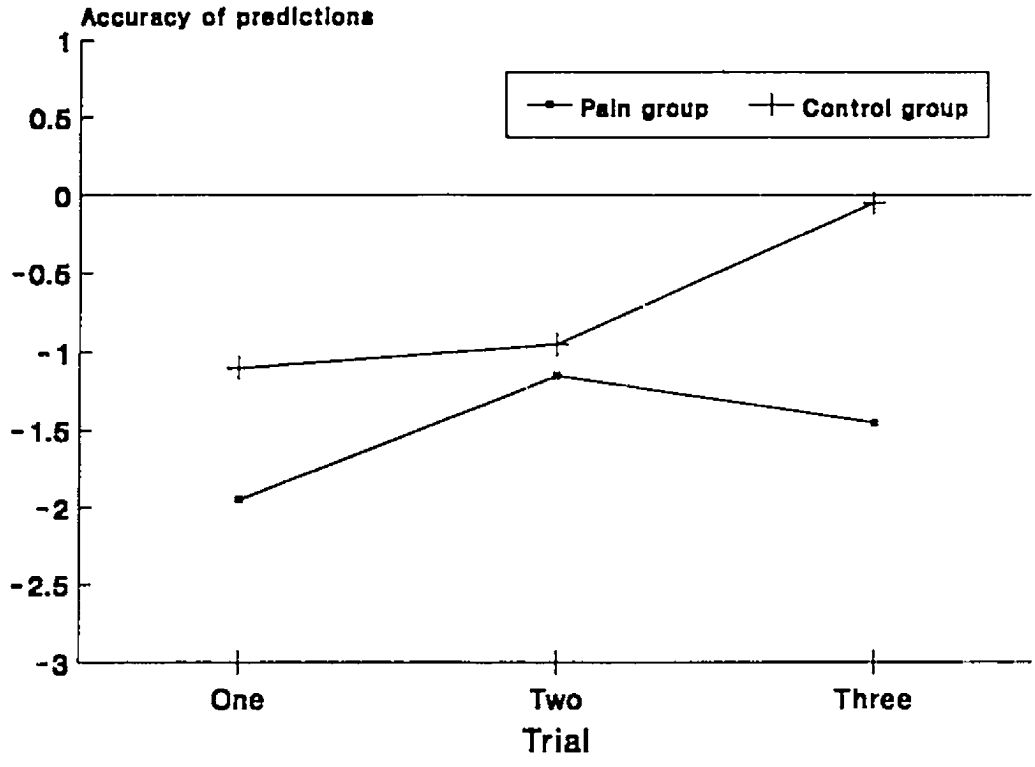



*Figure 4*. Accuracy in predicting pain across trials in Experiment 2.

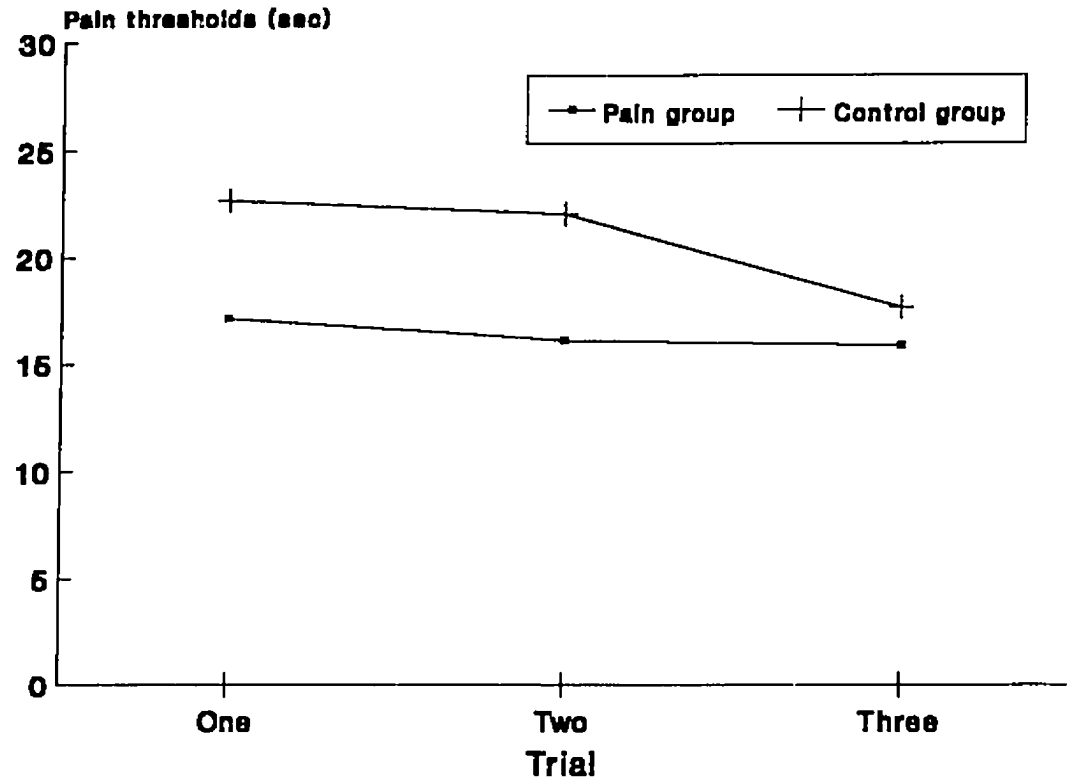



*Figure 5*. Pain thresholds across trials in Experiment 2.

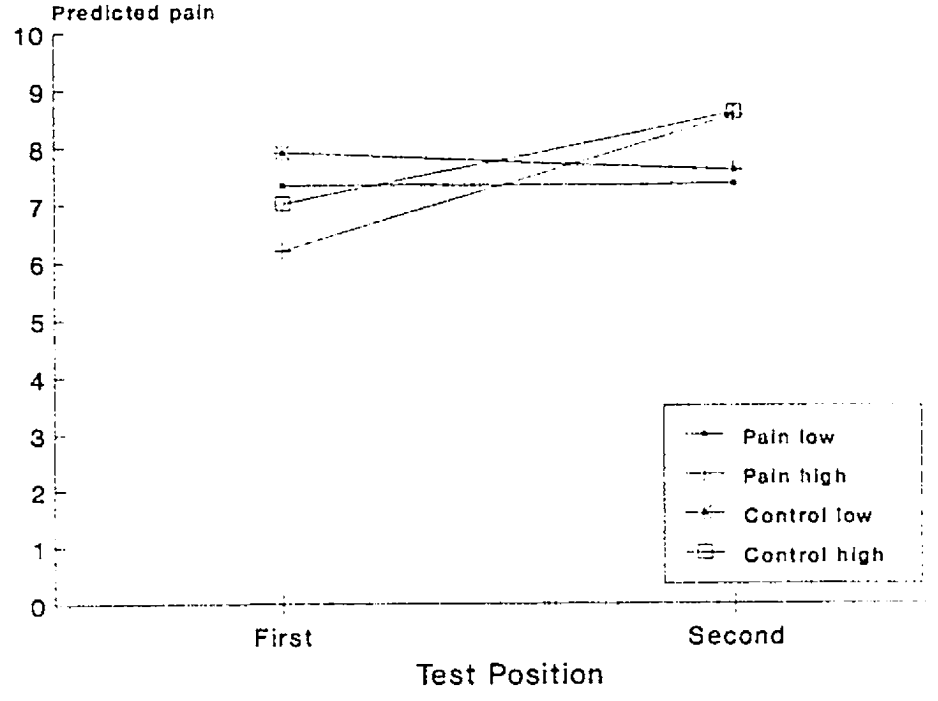



***Figure 6***. Carry-over effects on pain predictions prior to cold pressor task.

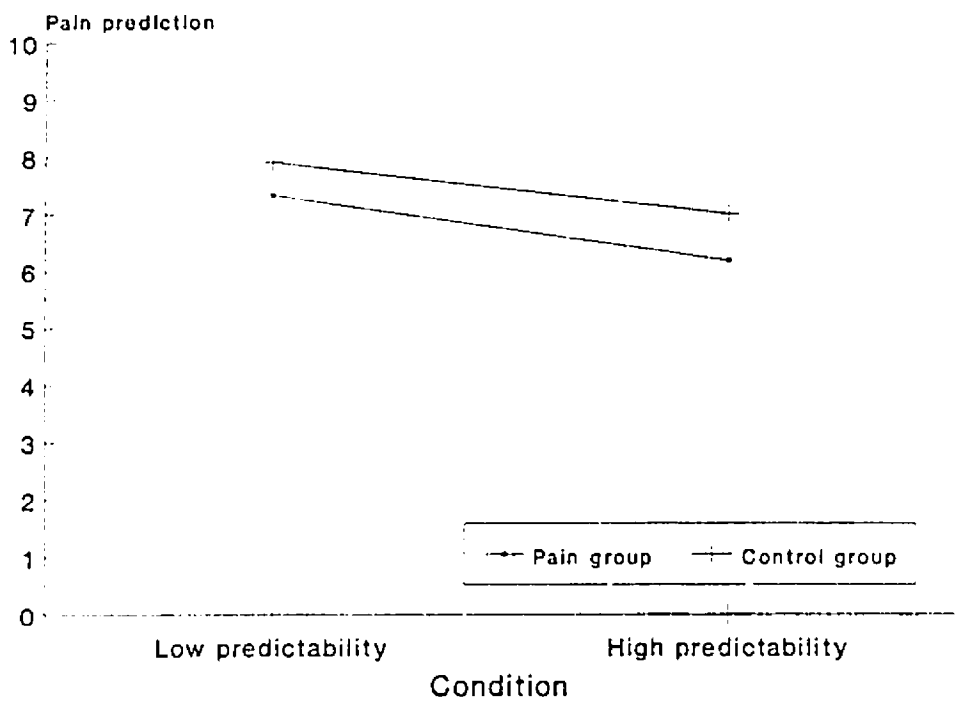



*Figure 7*. Pain predictions as a function of group and predictability condition for non-repeated measures.

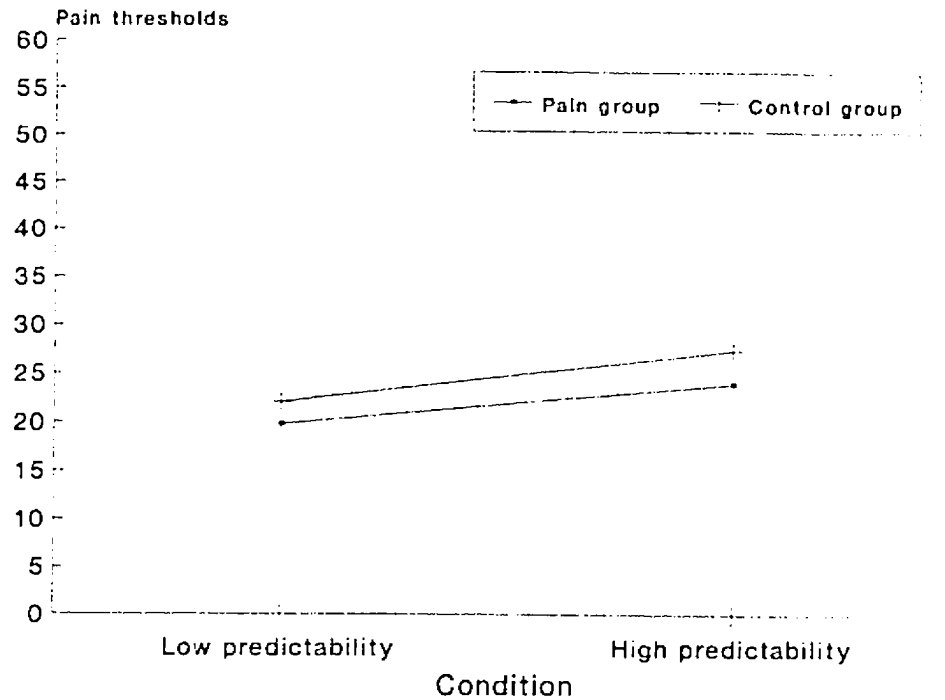



***Figure 8***. Effects of predictability on pain thresholds by group during cold pressor task.

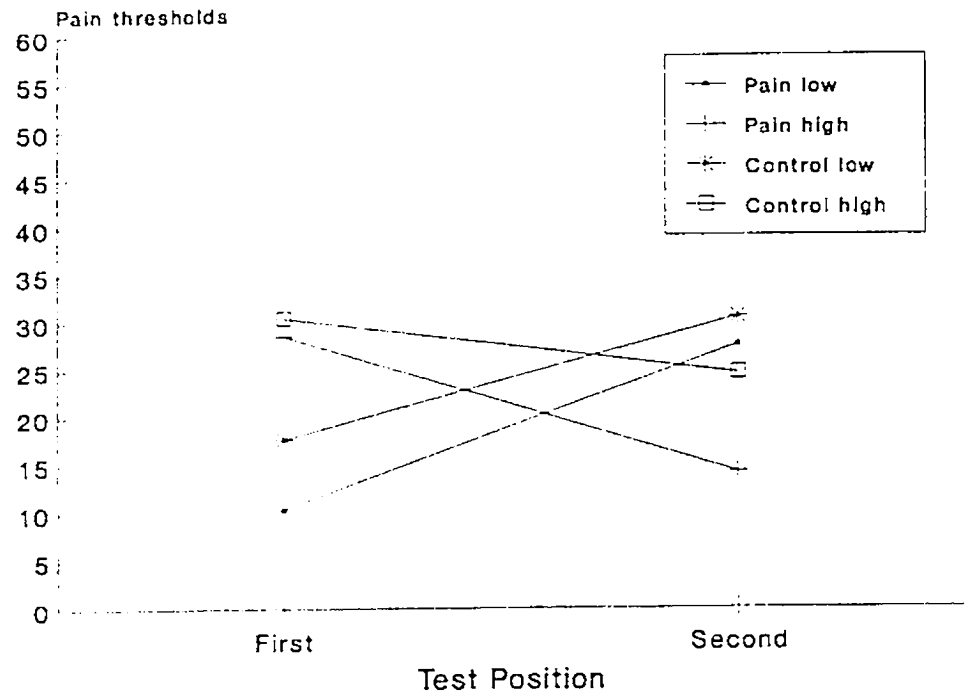



***Figure 9***. Mean pain thresholds during cold pressor task as a function of test position.

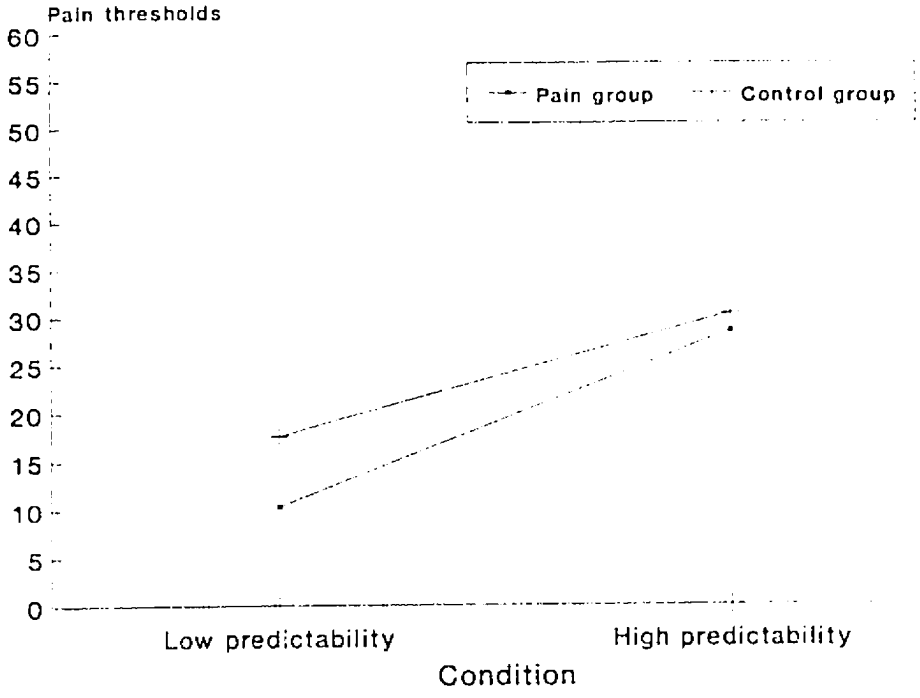



***Figure 10***. Effects of predictability on pain thresholds for cells in the first test position.

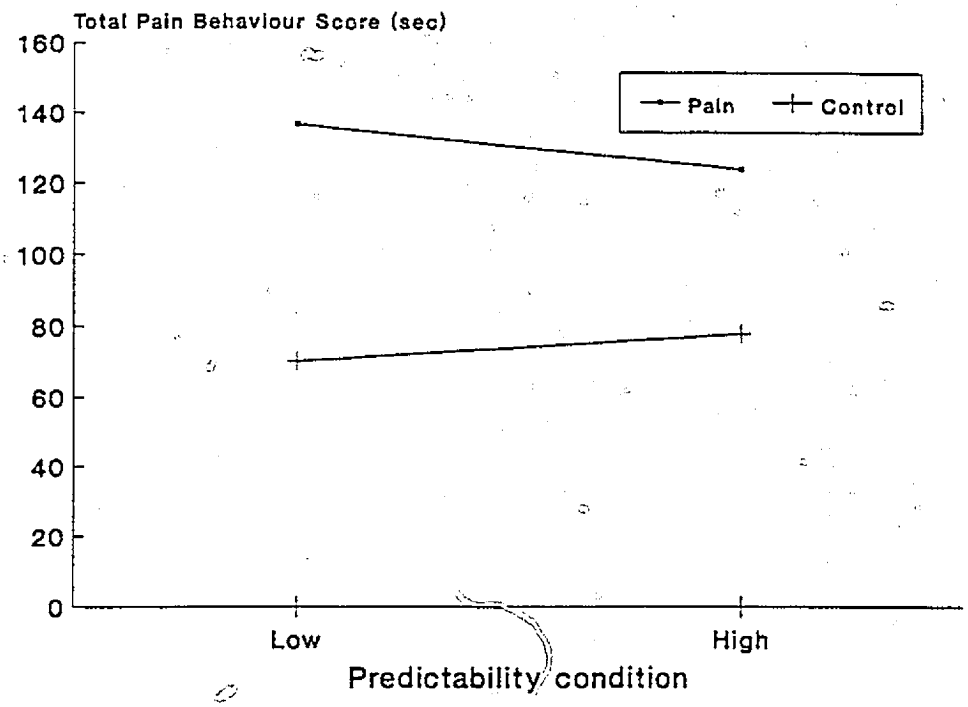



***Figure 11.*** Mean pain behaviour scores during conditions of low and high stimulus predictability.

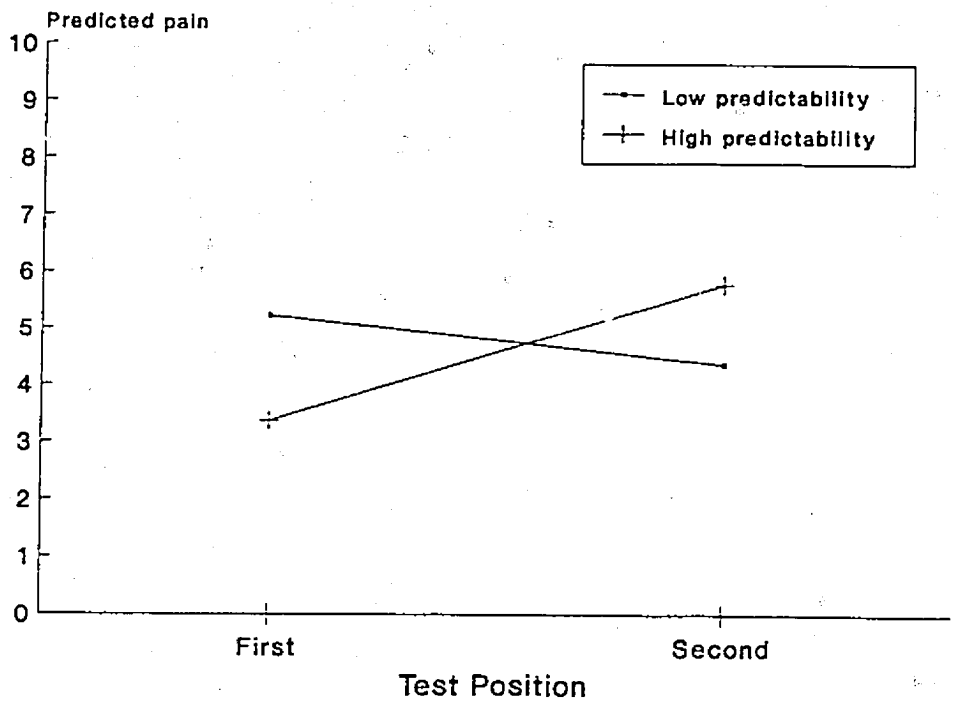



***Figure 12***. Order by condition interaction on pain groups' pain predictions prior to step-ups ($n$ = 20).

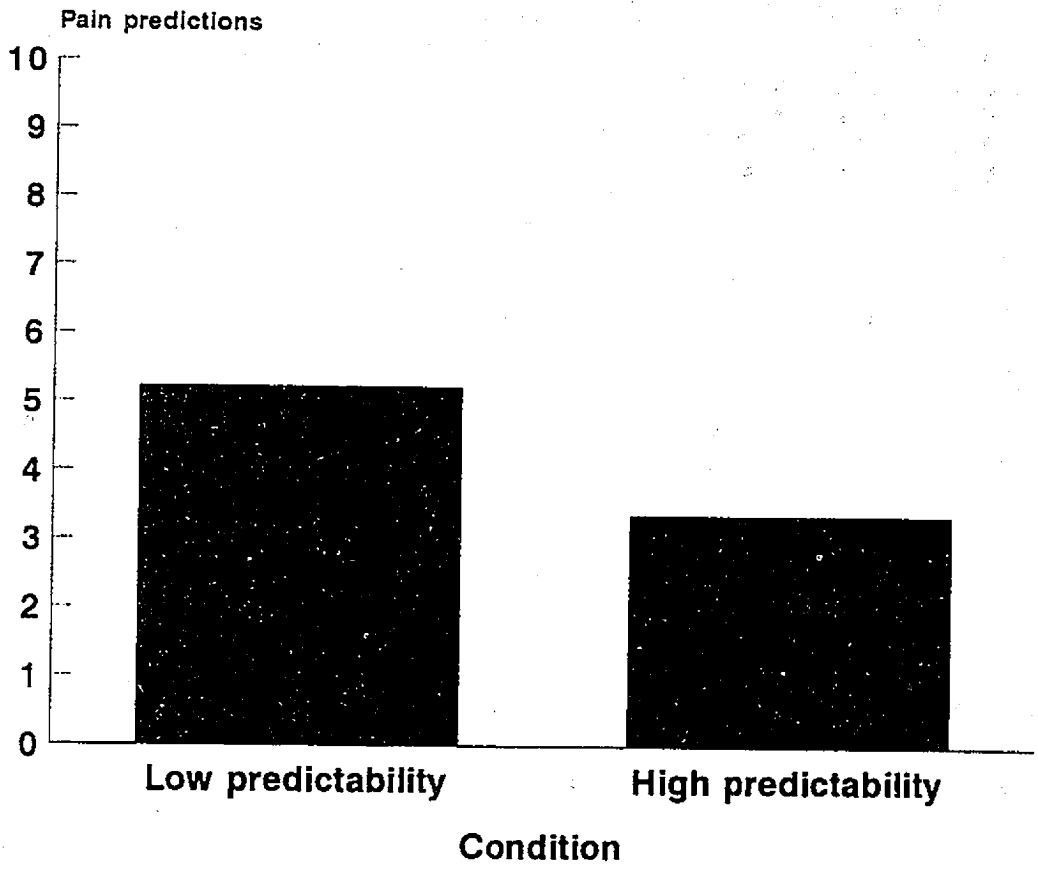



***Figure 13***. Effects of low versus high predictability on pain groups' pain predictions prior to step-ups for cells in the first test position.

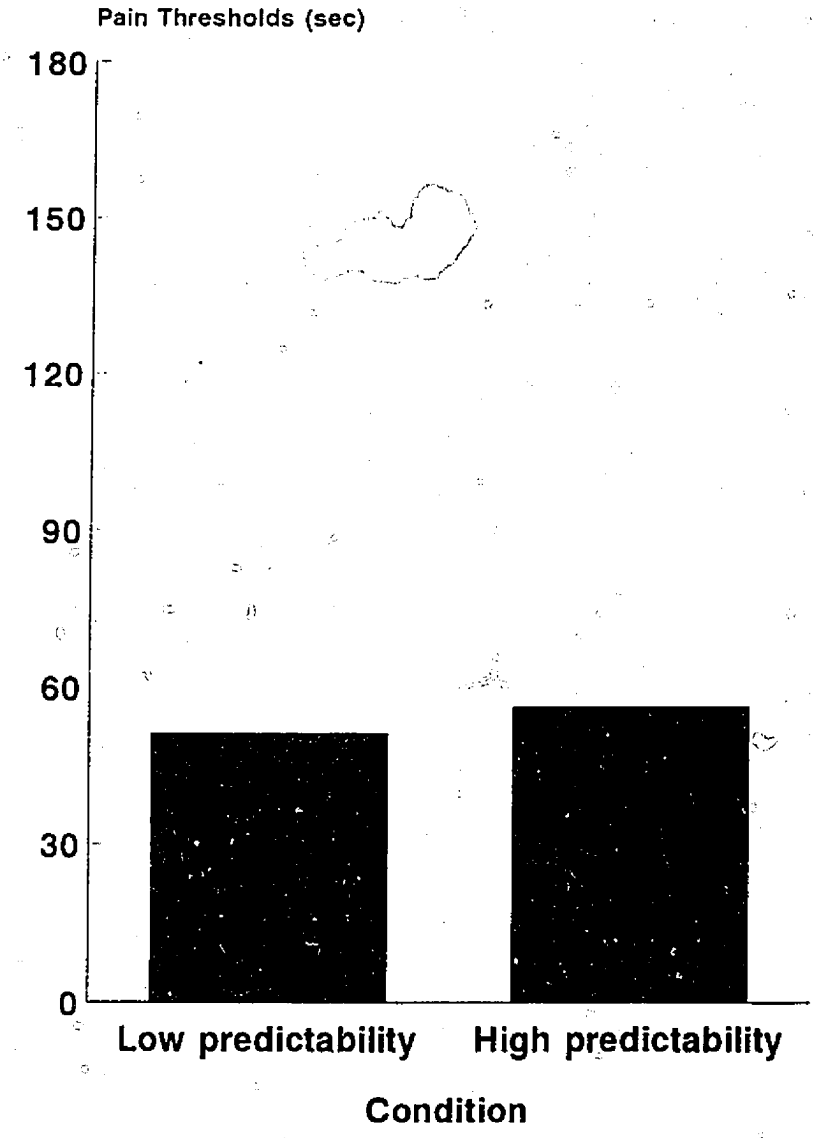



***Figure 14***. Effects of predictability on pain groups' step-up thresholds.

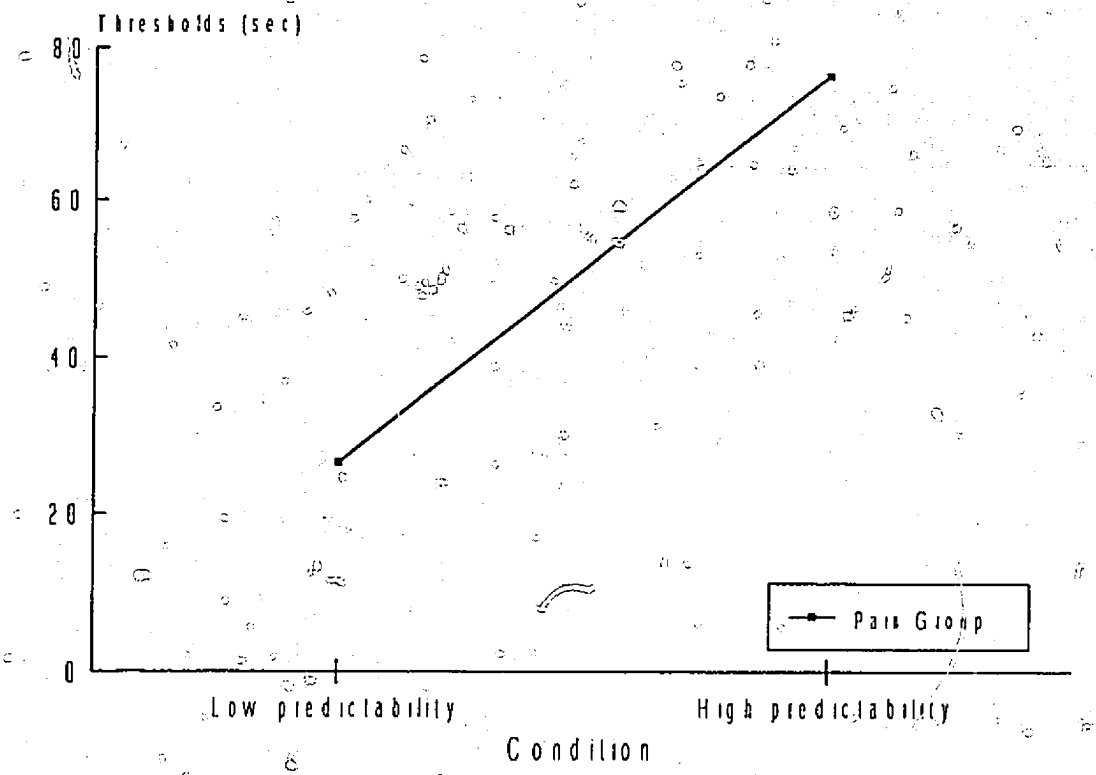



***Figure 15***. Effects of predictability on pain groups' step-up thresholds using cells from the first test position only.

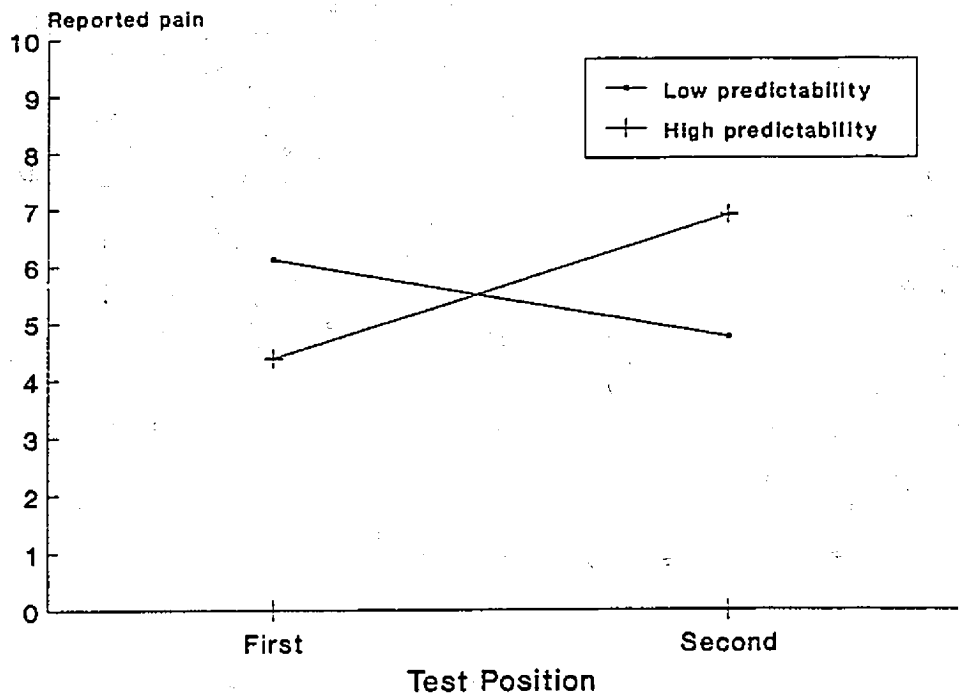



***Figure 16***. Order by condition interaction on pain group pain ratings following step-ups.

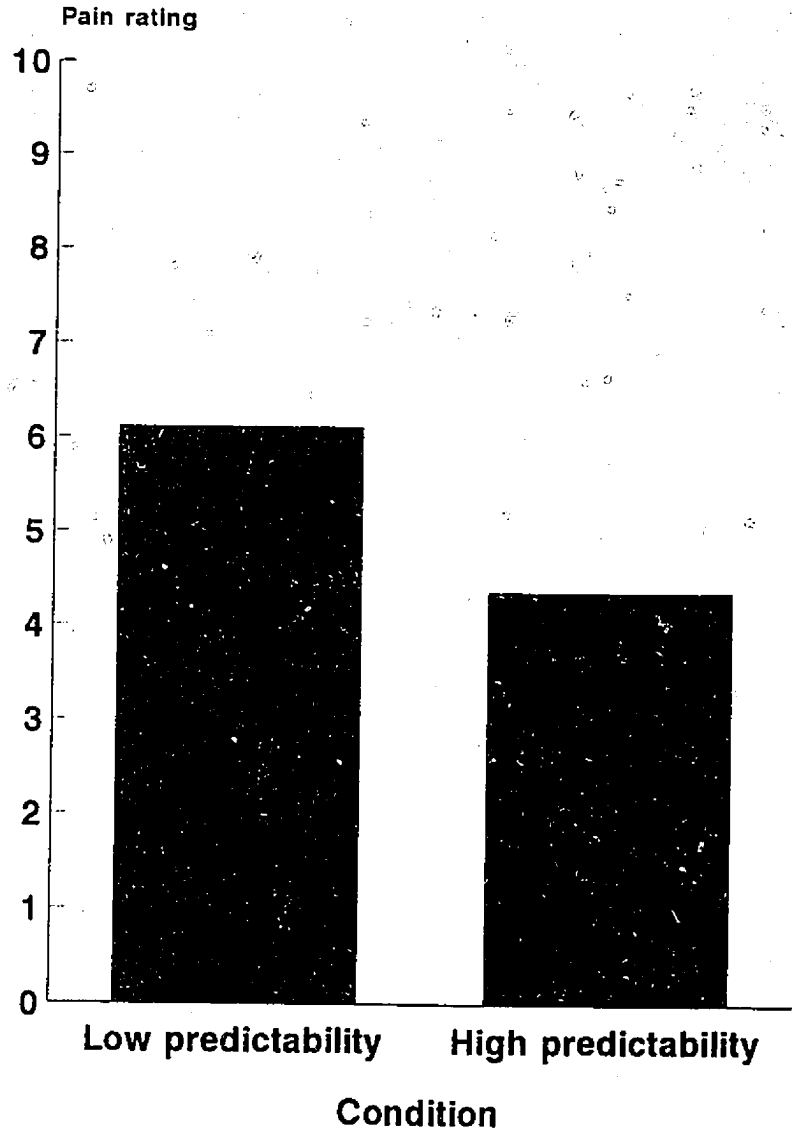



***Figure 17***. Effects of predictability on pain reports following step-ups for pain group data from cells in the first test position.

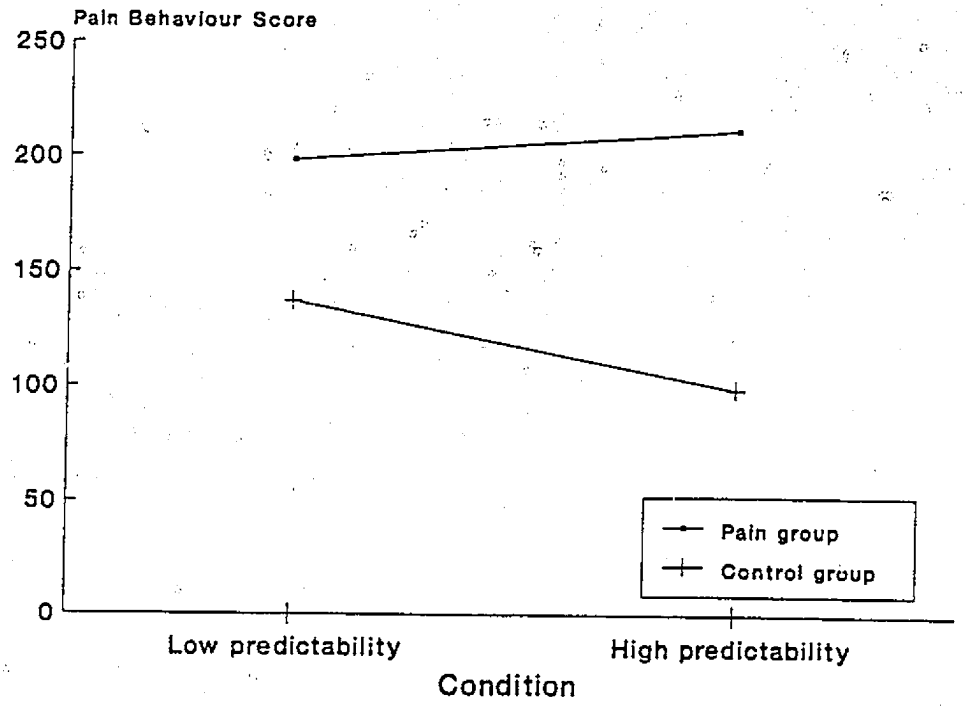



***Figure 18***. Effects of predictability on pain behaviour during step-ups for pain and control group data.

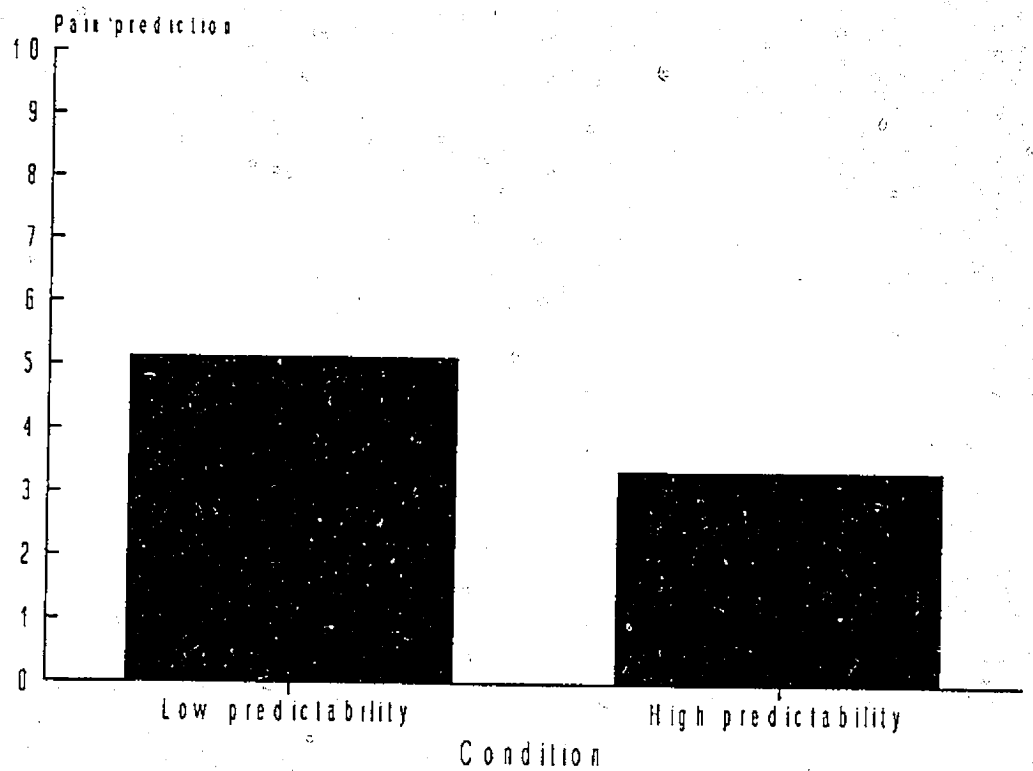



***Figure 19***. Effects of predictability on pain subjects' pain prediction prior to stationary standing using data from cells in the first test position.

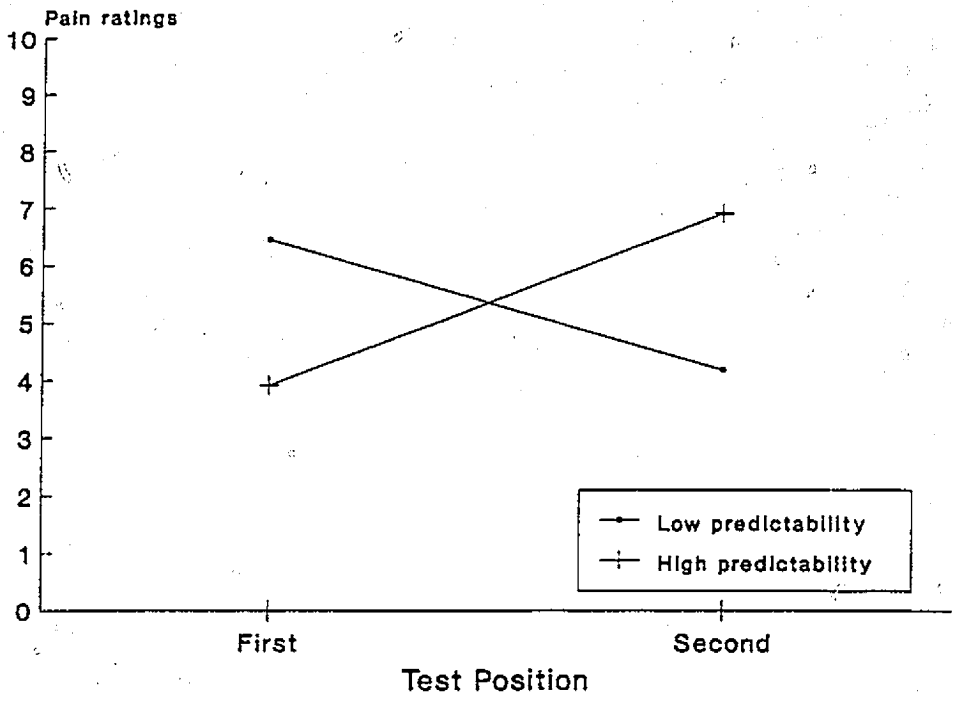



***Figure 20***. Order by condition interaction on pain groups' pain ratings following standing ($n$ = 20).

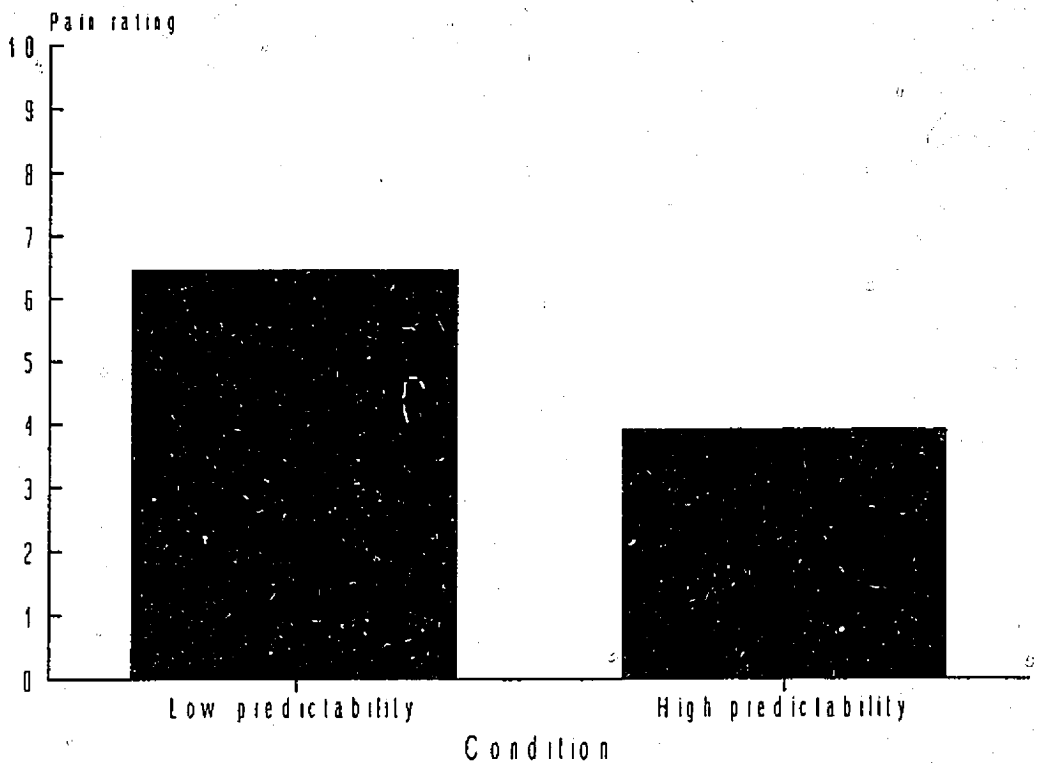



***Figure 21***. Effects of predictability on pain group pain reports following standing using data from the first test position.

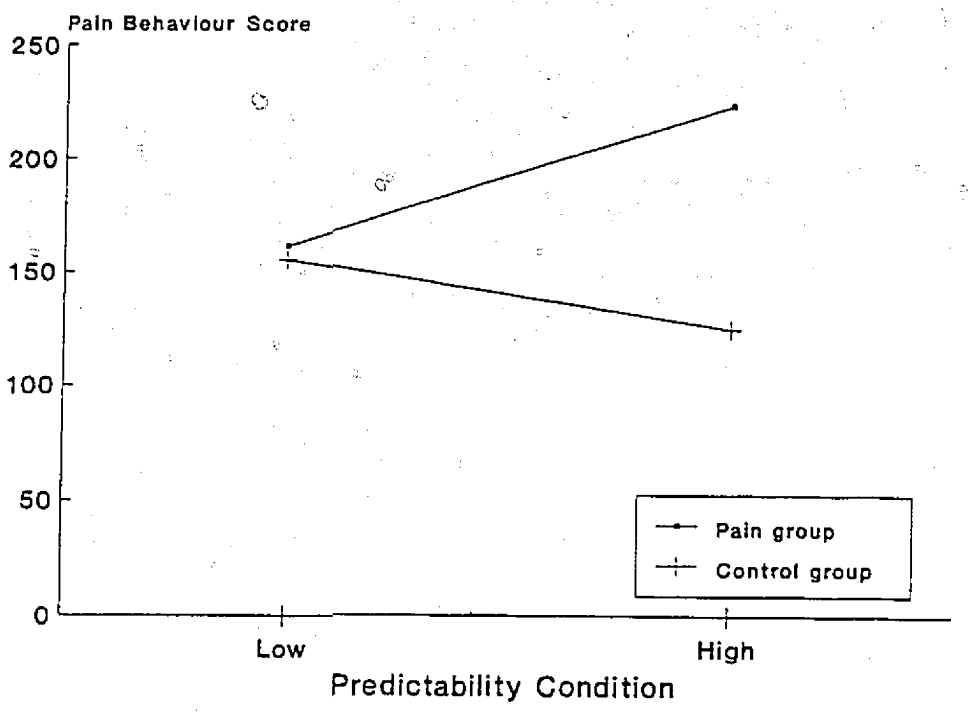



***Figure 22.*** Effects of stimulus predictability on pain and control group pain behaviour during standing ($N$ = 40).

## REFERENCES

Abbott, B.B., Schoen, L.S., & Badia, P. (1984). Predictable and unpredictable shock: behavioral measures of aversion and physiological measures of stress. Psychological Bulletin, 96(1), 45-71.

Abramson, L.Y., Garber, J., & Seligman, M.E.P. (1980). Learned helplessness in humans: An attributional analysis. In J. Garber & M.E.P. Seligman (Eds.), Human Helplessness. New York: Academic Press.

Abramson, L.Y., Seligman, M.E.P., & Teasdale, J.D. (1978). Learned helplessness in humans: Critique and reformulation. Journal of Abnormal Psychology, 87, 49-74.

Al Absi, M., & Rokke, P.D. (1991). Can anxiety help us tolerate pain? Pain, 46, 43-51.

American Psychiatric Association. (1994). Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition. Washington, D.C.: Author.

Anderson, K.O., Bradley, L.A., McDaniel, L.K., Young, L.D., Turner, R.A., Agudelo, C.A., Keefe, F.J., Pisko, E.J., Snyder, R.M., & Semble, E.L. (1987). The assessment of pain in rheumatoid arthritis. Arthritis and Rheumatism, 30(1), 36-43.

Anderson, K.O., Keefe, F.J., Bradley, L.A., McDaniel, L.K., Young, L.D., Turner, R.A., Agudelo, C.A., Semble, E.L., & Pisko, E.J. (1988). Prediction of pain behaviour and functional status of rheumatoid arthritis patients using medical status and psychological variables. Pain, 33(1), 25-32.

Appelbaum, K.A., Radnitz, C.L., Blanchard, E.B., & Prins, A. (1988). The Pain Behavior Questionnaire (PBQ): A global report of pain behavior in chronic headache. Headache, 22(1), 53-58.

Arntz, A., Dreesen, L., & De Jong, P. (1994). The influence of anxiety on pain: attentional and attributional mediators. Pain, 56, 307-314.

Arntz, A., & Schmidt, A.J.M. (1989). Perceived control and the experience of pain. In A. Steptoe & A. Appels (Eds.), Stress, Personal Control and Health. Chichester: Wiley, 131-162.

Arthur, A.Z. (1986). Stress of predictable and unpredictable shock. Psychological Bulletin, 100(3), 379-383.

Averill, J.R. (1973). Personal control over aversive stimuli and its relationship to stress. Psychological Bulletin, 80, 286-303.

Balleine, B., & Job, R.F.S. (1991). Reconsideration of the role of competing responses in demonstrations of the interference effect (learned helplessness). Journal of Experimental Psychology: Animal Behavior Processes, 17(3), 270-280.

Beck, A.T., & Steer, R.A. (1988). Psychometric properties of the Beck Depression Inventory: Twenty-five years of evaluation. Clinical Psychology Review, 8, 77-100.

Beck, A.T., Ward, C.H., Mendelson, M., Mock, J., & Erbaugh, J. (1961). An inventory for measuring depression. Archives of General Psychiatry, 4, 561-571.

Boureau, F., Luu, M., & Doubrere, J.F. (1991). Study of experimental pain measures and nociceptive reflex in chronic pain patients and normal subjects. Pain, 44(2), 131-138.

Braha, R.E.D., Goodman, J., McGrath, P.J. (1993). Rating overt pain behavior in experimentally induced pain conditions: Preliminary validation of modifications to existing techniques. ABSTRACTS: 7th World Congress on Pain, August 22-27, 1993, Paris, France. International Association for the Study of Pain: Seattle, WA, 552.

Brands, A.E.F., & Schmidt, A.J.M. (1987). Learning processes in the persistence behavior of chronic low back pain patients with repeated acute pain stimulation. Pain, 30, 329-337.

Brewer, B.W., & Karoly, P. (1989). Effects of attentional focusing on pain perception. Motivation and Emotion, 13(3), 193-203.

Bronzo, A., & Powers, G. (1967). Relationship of anxiety with pain thresholds. Journal of Psychology, 66, 181-83.

Campbell, I.G., Carstens, E., & Watkins, L.R. (1991). Comparison of human pain sensation and flexion withdrawal evoked by noxious radiant heat. Pain, 45(3), 259-268.

Canadian Psychological Association. (1991). Canadian Code of Ethics for Psychologists. Old Chelsea, Quebec:Author.

Chapman, C.R. (1983). On the relationship of human laboratory and clinical pain research. In R. Melzack (Ed.), Pain measurement and assessment. New York: Raven Press.

Cohen, M.J., Naliboff, B.D., Schandler, S.L., Heinrich, R.L. (1983). Signal detection and threshold measures to loud tones and radiant heat in chronic low back pain patients and cohort controls. Pain, 16, 245-252.

Connally, G.H., & Sanders, S.H. (1991). Predicting low back pain patients' response to lumbar sympathetic nerve blocks and interdisciplinary rehabilitation: the role of pretreatment overt pain behavior and cognitive coping strategies. Pain, 44(2), 139-146.

Cornwall, A., & Donderi, D.C. (1988). The effects of experimentally induced anxiety on the experience of pressure pain. Pain, 35, 105-113.

Craig, K.D. (1984). Psychology of pain. Postgraduate Medical Journal, 60, 835-840.

Craig, K.D. (1992). Echoes of pain. American Pain Society Journal, 1(2), 105-108.

Craig, K.D. (1994). Emotional aspects of pain. In P.D. Wall and R. Melzack (Eds.), Textbook of Pain. Third Edition. London: Churchill Livingstone, 261-274.

Craig, K.D., & Patrick, C.J. (1985). Facial expression during induced pain. Journal of Personality and Social Psychology, 48, 1080-1091.

Craig, K.D., & Prkachin, K.M. (1983). Nonverbal measures of pain. In R. Melzack (Ed.), Pain measurement and assessment. New York: Raven Press.

Craig, K.D., Prkachin, K.M., & Grunau, R.V.E. (1992). The facial expression of pain. In D.C. Turk and R. Melzack (Eds.), Handbook of Pain Assessment. London: The Guilford Press.

Crisson, J.E., & Keefe, F.J. (1988). The relationship of locus of control to pain coping strategies and psychological distress in chronic pain patients. Pain, 35, 147-154.

Crisson, J., Keefe, F.J., Wilkins, R.H., Cook, W.A., & Muhlbaier, L.H. (1986). Self-report of depressive symptoms in low back pain patients. Journal of Clinical psychology, 42(3), 424-430.

Crombez, G., Baeyens, F., & Eelen, P. (1994). Sensory and temporal information about impending pain: the influence of predictability in pain. Behavior Research and Therapy, 32(6), 611-622.

Crook, J., Tunks, E., Kalaher, S., & Roberts, J. (1988). Coping with persistent pain: a comparison of persistent pain sufferers in a specialty pain clinic and in a family practice clinic. Pain, 34(2), 175-184.

Dunn-Geier, B.J., McGrath, P.J., Rourke, B.P., Latter, J., & D'Astous, J. (1986). Adolescent chronic pain: The ability to cope. Pain, 26, 23-32.

Eich, E., Reeves, O.L, Jaeger, B., & Graf-Redford, S.B. (1985). Memory for pain: Relation between past and present intensity. Pain, 23, 375-379.

Eifert, G.H., & Plaud, J.J. (1993). From behavior theory to behavior therapy: The contribution of behavioral theories and research to the advancement of behavior therapy. Journal of Behavior Therapy and Experimental Psychiatry, 24(2), 101-105.

Efran, J.S., Charney, R.L., Ascher, L.M., & Lukens, M.D. (1989). Coping styles, paradox, and the cold pressor task. Journal of Behavioral Medicine, 12(1), 91-103.

Erskine, A., Morley, S., & Pearce, S. (1990). Memory for pain: a review. Pain, 41, 255-265.

Flor, H., & Birbaumer, N. (1994). Psychophysiological methods in the assessment and treatment of chronic pain. In J. Carlson and R. Seifert (Eds.), Biobehavioral Self-Regulation and Health, Volume 2. New York: Plenum Press, 171-184.

Flor, H., Kerns, R.D., & Turk, D.C. (1987). The role of spouse reinforcement, perceived pain, and activity levels of chronic pain patients. Journal of Psychosomatic Research, 31(2), 251-259.

Follette, V.M., & Jacobson, N.S. (1987). Importance of attributions as a predictor of how people cope with failure. Journal of Personality and Social psychology, 52, 1205-1211.

Fordyce, W.E. (1976). Behavioral methods for chronic pain and illness. Saint Louis: The C.V. Mosby Company.

Fordyce, W.E. (1983). The validity of pain behaviour measurement. In R. Melzack (Ed.), Pain measurement and assessment. New York: Raven Press.

Fordyce, W.E., Fowler, R.S., & DeLateur, B. (1968). An application of behaviour modification technique to a problem of chronic pain. Behaviour Research and Therapy, 6, 105-107.

Fox, I. (1991). The relationship between overt pain behaviour and reported pain intensity. Unpublished undergraduate research project. Department of Psychology, Dalhousie University, Halifax, Nova Scotia.

Gamsa, A. (1994). The role of psychological factors in chronic pain. II. A critical appraisal. Pain, 57(1), 17-29.

Geisser, M.E., Robinson, M.E., Keefe, F.J., & Weiner, M.L. (1994). Catastrophizing, depression and the sensory, affective and evaluative aspects of pain. Pain, 59(1), 79-84.

Gil, K.M., Keefe, F.J., Crisson, J.E., & Van Dalfsen, P.J. (1987). Social support and pain behaviour. Pain, 29, 209-217.

Gracely, R.H. (1994). Studies of pain in normal man. In P. Wall & R. Melzack (Eds.), Textbook of Pain. Third Edition. Edinburough: Churchill Livingston, 315-336.

Heyneman, N.E., Fremoun, W.J., Gana, D., Kirkland, F., & Heiden, L. (1990). Individual differences and the effectiveness of different coping strategies for pain. Cognitive Therapy and Research, 14, 63-77.

Jahanshahi, M., & Philips, C. (1986). Validating a new technique for the assessment of pain behaviour. Behavior Research and Therapy, 24(1), 35-42.

Janal, M.N., Glusman, M., Kuhl, J.P., & Clark, W.C. (1994). On the absence of correlation between responses to noxious heat, cold, electrical and ischemic stimulation. Pain, 58(3), 403-411.

Jensen, M.P., Karoly, P., & Braver, S. (1986). The measurement of clinical pain intensity: a comparison of six methods. Pain, 27(1), 117-126.

Jensen, M.P., Turner, J.A., Romano, J.M., & Karoly, P. (1991). Coping with chronic pain: a critical review of the literature. Pain, 47(3), 249-283.

Jensen, M.P., Turner, J.A., Romano, J.M., & Lawler, B.K. (1994). Relationship of pain-specific beliefs to chronic pain adjustment. Pain, 57(3), 301-309.

Keefe, F.J., & Block, A.R. (1982). Development of an observation method for assessing pain behaviour in low back pain patients. Behaviour Therapy, 13, 363-376.

Keefe, F.J., Bradley, L.A., & Crisson, J.E. (1990). Behavioral assessment of low back pain: identification of pain behaviour subgroups. Pain, 40(2), 153-160.

Keefe, F.J., Caldwell, D.S., Queen, K., Gil, K.M., Martinez, S., Crisson, J.E., Ogden, W., & Nunley, J. (1987). Osteoarthritic knee pain: a behavioral analysis. Pain, 28(3), 309-321.

Keefe, F.J., Crisson, J.E., & Snipes, M.T. (1987). Observational methods for assessing pain: a practical guide. In J.A. Blumenthal & D.C. McKee (Eds.), Applications in Behavioral Medicine and Health. Sarasota, FL: Professional Resource Exchange, 67-94.

Keefe, F.J., Crisson, J., Urban, B.J., & Williams, D.A. (1990). Analyzing chronic low back pain: the relative contribution of pain coping strategies. Pain, 40(3), 293-301.

Keefe, F.J., & Dunsmore, J. (1992a). Pain behavior. Concepts and controversies. American Pain Society Journal, 1(20), 92-100.

Keefe, F.J., & Dunsmore, J. (1992b). The multifaceted nature of pain behavior. American Pain Society Journal, 1(20), 112-144.

Keefe, F.J., & Lefebvre, J.C. (1994). Behaviour therapy. In P.D. Wall and R. Melzack (Eds.), Textbook of Pain. Third Edition. London: Churchill Livingstone, 1367-1380.

Keefe, F.J., Salley Jr., A.N., Lefebvre, J.C. (1992). Coping with pain: conceptual concerns and future directions. Pain, 51(2), 131-134.

Keefe, F.J., Wilkins, R.H., & Cook, W.A. (1984). Direct observation of pain behaviour in low back pain patients during physical examination. Pain, 20, 59-68.

Keefe, F.J., Wilkins, R.H., Cook, W.A., Crisson, J.E., Muhlbaier, L.H. (1986). Depression, pain, and pain behaviour. Journal of Consulting and Clinical Psychology, 54(5), 665-669.

Keppel, G. (1982). Design and analysis: A researcher's handbook. New Jersey: Prentice-Hall, Inc.

Kerns, R.D., Haythornthwaite, J., Rosenberg, R., Southwick, S., Giller, E.L., Casey Jacob, M. (1991). The Pain Behavior Check List (PBCL): Factor structure and psychometric properties. Journal of Behavioral Medicine, 14(2), 155-167.

Kleinke, C.L., & Stephenson Spangler, A. (1988). Psychometric analysis of the audiovisual taxonomy for assessing pain behaviour in chronic back pain patients. Journal of Behavioral Medicine, 11(1), 83-94.

Lawson, K., Reesor, K.A., Keefe, F.J., & Turner, J.A. (1990). Dimensions of pain-related cognitive coping: cross-validation of the factor structure of the Coping Strategy Questionnaire. Pain, 43(2), 195-204.

Lethem, J., Slade, P.D., Troup, J.D.G., & Bentley, G. (1983). Outline of a fear-avoidance model of exaggerated pain perception - I. Behavior Research and Therapy, 21(4), 401-408.

Levine, F.M., & DeSimone, L.L. (1991). The effects of experimenter gender on pain report in male and female subjects. Pain, 44(1), 69-72.

Linton, S.J., & Melin, L. (1982). The accuracy of remembering chronic pain. Pain, 13, 281-285.

Linton, S.J., Melin, L., & Götestam, K.G. (1985). Behavioral analysis of chronic pain and its management. In M. Hersen, A. Bellak, and H. Eisler (Eds.), Progress in behavior Modification Volume 18. New York: Academic Press.

Lipman, J.J., Blumenkopf, B., Parris, W.C.V. (1987). Chronic pain assessment using heat beam dolorimetry. Pain, 30, 59-67.

Loeser, J.D., & Fordyce, W.E. (1983). Chronic pain. In J.E. Carr & H.A. Dengerink (Eds.), Behavioral science in the practice of medicine. Amsterdam: Elsevier.

Maier, S.F. (1989). Learned helplessness: Event covariation and cognitive changes. In S.B. Klein & R.R. Mowrer (Eds.), Contemporary learning theories: Instrumental conditioning theory and the impact of biological constraints on learning (pp., 73-110). Hillsdale, NJ: Erlbaum.

Maier, S.F., & Jackson, R.L. (1979). Learned helplessness: All of us were right (and wrong): Inescapable shock has multiple effects. In G.H. Bower (Ed.), The Psychology of Learning, Vol. 13, New York: Academic Press, 155-218.

Maier, S.F., & Warren, D.A. (1988). Controllability and safety signals exert dissimilar proactive effects on nociception and escape performance. Journal of Experimental Psychology: Animal Behavior Processes, 14(1), 18-25.

Main, C.J., & Waddell, G. (1991). A comparison of cognitive measures in low back pain: statistical structure and clinical validity at initial assessment. Pain, 46(3), 287-298.

Malow, R.M., Grimm, L., Olson, R.E., (1980). Differences in pain perception between myofascial pain dysfunction patients and normal subjects: a signal detection analysis. Journal of Psychosomatic Research, 24, 303-309.

Martinez-Urrutia, A. (1975). Anxiety and pain in surgical patients. Journal of Consulting and Clinical Psychology, 43, 437-442.

Mechanic, D. (1962). The concept of illness behaviour. Journal of Chronic Disease, 15, 189-194.

Melzack, R. (1983). Concepts of pain measurement. In R. Melzack (Ed.), Pain measurement and assessment. New York: Raven Press.

Melzack, R., & Wall, P.D. (1965). Pain mechanisms: a new theory. Science, 150, 971-979.

Melzack, R., & Wall, P.D. (1982). The Challenge of Pain. New York: Penguin Books.

Merskey, H. (1986). (Ed.) Classification of chronic pain: Descriptions of chronic pain syndromes and definitions of pain terms. Pain, Supplement 3.

Merskey, H. (1992). Limitations of pain behavior. American Pain Society Journal, 1(2), 101-104.

Merskey, H., & Bogduk, N. (1994). Classification of chronic pain. Description of chronic pain syndromes and definitions of pain terms. Second Edition. Seattle, WA: IASP Press.

Miller, S.M. (1979). Controllability and human stress: Method, evidence and theory. Behaviour Research and Therapy, 17, 287-304.

Miller, S.M., (1981). Predictability and human stress: toward a clarification of evidence and theory. In L. Berkowitz (Ed.), Advances in Experimental Social Psychology, 14, 203-256.

Miron, D., Duncan, G.H., & Bushnell, M.C. (1989). Effects of attention on the intensity and unpleasantness of thermal pain. Pain, 39(3), 345-352.

Naliboff, B.D., & Cohen, M.J. (1989). Psychophysiological laboratory methods applied to clinical pain patients. In C.R. Chapman and J.D. Loeser (Eds.), Advances in pain research and therapy: issues in pain measurement, Volume 12. New York: Plenum Press, 365-386.

Naliboff, B.D., Cohen, M.J., Schandler, S.L., & Heinrich, R.L. (1981). Signal detection and threshold measures for chronic low back pain patients, chronic illness patients and cohort controls to radiant heat stimuli. Journal of Abnormal Psychology, 90, 271-274.

Öhlund, C., Lindström, I., Areskoug, L.E., Eek, C., Peterson, L.E., & Nachemson, A. (1994). Pain behavior in industrial subacute low back pain. Part I. Reliability: concurrent and predictive validity of pain behavior assessments. Pain, 58(2), 201-209.

Oostdam, E.M.M., & Duivenvoorden, H.J. (1987). Description of pain and the relationship with psychological factors in patients with low back pain. Pain, 28(3), 357-364.

Overmier, J.B., & Seligman, M.E.P. (1967). Effects of inescapable shock upon subsequent escape and avoidance learning. Journal of Comparative and Physiological Psychology, 63, 28-33.

Parsons, T. (1958). Definitions of health and illness in light of American values and social structure. In E.G. Jaco (Ed.), Patients, physicians, and illness. New York: Free Press.

Peacock, E.J., Wong, T.P., & Reker, G.T. (1993). Relations between appraisals and coping schemas: Support for the congruence model. Canadian Journal of Behavioural Science, 25(1), 64-80.

Peters, M.D., & Schmidt, A.J.M. (1992). Differences in pain perception and sensory discrimination between chronic low back pain patients and healthy controls. Journal of Psychosomatic Research, 36(1), 47-53.

Philips, H.C. (1987). Avoidance behaviour and its role in sustaining chronic pain. Behaviour Research and Therapy. 25(4), 273-279.

Phillips, K. (1989). Psychophysiological consequences of behavioral choice in aversive situations. In A. Steptoe & A. Appels (Eds.), Stress, personal control and health. Chichester, UK: John Wiley & Sons Ltd.

Pilowsky, I. (1978). Dimensions of hypochondriases. British Journal of Psychiatry, 113, 89-93.

Prkachin, K.M. (1992). The consistency of facial expressions of pain: a comparison across modalities. Pain, 51(3), 297-306.

Prostack, M., McGrath, P., & Murray, K. (1990). Measurement of spontaneous strategies for coping with experimental pain. Unpublished manuscript. Department of Psychology, Dalhousie University, Halifax, Nova Scotia.

Rachman, S. (1988). Panics and their consequences. In S. Rachman & J. Maser (Eds.), Panic: Psychological perspectives. Hillsdale, NJ: Eribaum.

Rachman, S.J. (1990). Fear and courage, Second Edition. New York: Freeman.

Rachman, S., & Arntz, A. (1991). The overprediction and underprediction of pain. Clinical Psychology Review., 11, 339-355.

Rachman, S., & Levitt, K. (1985). Panics and their consequences. Behaviour Research and Therapy, 23(5), 585-600.

Rachman, S., & Lopatka, C. (1988). Accurate and inaccurate predictions of pain. Behaviour Research and Therapy, 26(4), 291-296.

Radnitz, C.L., Appelbaum, K.A., Blanchard, E.B., Elliot, L., & Andrasik, F. (1988). The effect of self-regulatory treatment on pain behaviour in chronic headache. Behaviour Research and Therapy, 26(3), 253-260.

Reesor, K.A., & Craig, K.D. (1988). Medically incongruent chronic back pain: physical limitations, suffering, and ineffective coping. Pain, 32(1), 35-45.

Romano, J.M., Syrjala, K.L., Levy, R.L., Turner, J.A., Evans, P., & Keefe, F.J. (1988). Overt pain behaviours: Relationship to patient functioning and treatment outcome. Behaviour Therapy, 19, 191-201.

Rosenstiel, A.K., & Keefe, F.J. (1983). The use of coping strategies in chronic low back pain: Relationship to patient characteristics and current adjustment. Pain, 17, 33-44.

Roth, S., & Bootzin, R.R. (1984). Effects of experimentally induced expectancies of external control: an investigation of learned helplessness. Journal of Personality and Social Psychology, 29(2), 253-264.

Sacks, C.H., & Bugental, D.B. (1987). Attributions as moderators of affective and behavioral responses to social failure. Journal of Personality and Social Psychology, 53(5), 939-947.

Schmidt, A.J.M. (1987). The behavioral management of pain: a criticism of a response. Pain, 30, 285-291.

Schmidt, A.J.M., & Arntz, A. (1987). Psychological research and chronic low back pain: a stand-still or breakthrough? Social Science and Medicine, 25(10), 1095-1104.

Schwartz, D.P., DeGood, D.E., & Shutty, M.S. (1985). Direct assessment of beliefs and attitudes of chronic pain patients. Archives of Physical medicine and Rehabilitation, 66, 806-809.

Seligman, M.E.P., & Maier, S.F. (1967). Failure to escape traumatic shock. Journal of Experimental Psychology, 74, 1-9.

Sheehan, D., & Sheehan, K. (1983). The classification of phobic disorders. International Journal of Psychiatric Medicine, 12, 243-266.

Sigurdsson, A., & Maixner, W. (1994). Effects of experimental and clinical noxious counterirritants on pain perception. Pain, 57, 265-275.

Spanos, N.P., Brown, M.J., Jones, B., & Horner, D. (1981). Cognitive activity and suggestions for analgesia in the reduction of reported pain. Journal of Abnormal Psychology, 90, 554-561.

Spielberger, C.D., Gorsuch, R.L., & Lushene, R.E. (1970). STAI Manual for the State-Trait Anxiety Inventory. Palo Alto, CA: Consulting Psychologists Press.

Syme, S.L. (1989). Control and health: a personal perspective. In A. Steptoe & A. Appels (Eds.), Stress, personal control and health. Chichester, UK: John Wiley & Sons Ltd.

Thompson, S.C. (1981). Will it hurt less if I can control it? A complex answer to a simple question. Psychological Bulletin, 90(1), 89-101.

Thorndike, R.M. (1978). Correlational procedures for research. New York: Gardner Press.

Toomey, T.C., Mann, J.D., Abashian, S., & Thompson-Pope, S. (1991). Relationship between perceived self-control of pain, pain description and functioning. Pain, 45(2), 129-133.

Troup, J.D.G., & Videman, T. (1989). Inactivity and the aetiopathogenesis of musculoskeletal disorders. Clinical Biomechanics, 4, 173-178.

Tunks, E., & Bellisimo, A. (1988). Coping with the coping concept: a brief comment. Pain, 34(2), 171-174.

Turk, D.C., & Flor, H. (1987). Pain > pain behaviours: the utility and limitations of the pain behaviour construct. Pain, 31, 277-295.

Turk, D.C., Meichenbaum, D., & Genest, M. (1983). Pain and behavioral medicine: a cognitive-behavioral perspective. New York: The Guilford Press.

Turk, D.C., & Rudy, T.E. (1987). Towards a comprehensive assessment of chronic pain patients. Behaviour Research and Therapy, 25(4), 237-249.

Turk, D.C., & Rudy, T.E. (1988). Toward an empirically derived taxonomy of chronic pain patients: integration of psychological assessment data. Journal of Consulting and Clinical Psychology, 56, 233-238.

Turk, D.C., Rudy, T.E., Stieg, R.L. (1988). The disability determination dilemma: toward a multiaxial solution. Pain, 34(3), 217-229.

Turk, D.C., Wack, J.T., Kerns, R.D. (1985). An empirical examination of the "pain behaviour" construct. Journal of Behavioral Medicine, 8, 119-130.

Turner, J.A., & Romano, J.M. (1984). Review of prevalence of coexisting chronic pain and depression. In C. Benedetti (Ed), Advances in pain research and therapy, Volume 7. Rave Press: New York, 123-131.

Vlaeyen, J.W.S., Pernot, D.F.M., Kole-Snijders, A.M.J., Schuerman, J.A., Van Eek, H., & Groenman, N.H. (1990). Assessment of the components of observed chronic pain behaviour: the Checklist for Interpersonal Pain Behaviour (CHIP). Pain, 43(3), 337-348.

Vlaeyen J.W.S., Van Eek, H., Groenman, N.H., & Schuerman, J.A. (1987). Dimensions and components of observed chronic pain behaviour. Pain, 31, 65-75.

Wade, J.B., Dougherty, L.M., Hart, R.P., Rafii, A., & Price, D.D. (1992). A canonical correlation analysis of the influence of neuroticism and extraversion on chronic pain, suffering, and pain behavior. Pain, 51(1), 67-74.

Waddell, G., Main, C.J., Morris, E.W., Dipaola, M., & Gray, I.C.M. (1984). Chronic low back pain, psychological distress and illness behaviour. Spine, 9, 209-213.

Waddell, G., Newton, M., Henderson, I., Somerville, D., & Main, C. (1993). A fear-avoidance beliefs questionnaire (FABQ) and the role of fear-avoidance beliefs in chronic low back pain and disability. Pain, 52(2), 157-168.

Waddell, G., Pilowsky, I., & Bond, M.R. (1989). Clinical assessment and interpretation of abnormal illness behaviour in low back pain. Pain, 39(1), 41-54.

Waddell, G., & Richardson, J. (1992). Observation of overt pain behaviour by physicians during routine clinical examination of patients with low back pain. Journal of Psychosomatic Research, 36(1), 77-87.

Wade, J.B., Dougherty, L.M., Hart, R.P., Raffi, A., & Price, D.D. (1992). A canonical correlation analysis of the influence of neuroticism and extraversion on chronic pain, suffering, and pain behavior. Pain, 51(1), 67-74.

Walker, L.S., & Greene, J.W. (1991). The Functional Disability Inventory: Measuring a neglected dimension of child health status. Journal of Pedeatric Psychology, 16(1), 39-58.

Wall, P.D. (1994). Introduction to the edition after this one. In P.D. Wall and R. Melzack (Eds.),The Textbook of Pain. Third Edition. Edinburgh: Churchill Livingstone.

Wall, P.D., & Melzack, R. (Eds.). (1989). The Textbook of Pain (2nd ed.). London: Churchill Livingstone.

Wardle, J. (1984). Dental pessimism: negative cognitions in fearful dental patients. Behaviour Research and Therapy, 22, 553-556.

Weickgenant, A.L., Slater, M.A., Patterson, T.L., Atkinson, J.H., Grant, I., & Garfin, S.R. (1993). Coping activities in chronic low back pain: relationship to depression. Pain, 53(1), 95-103.

Weisenberg, M. (1980). Understanding pain phenomena. In S. Rachman (Ed.), Contributions to Medical Psychology Volume 2. Oxford: Pergamon Press.

Weisenberg, M., Wolf, Y., Mittwoch, T., & Mikulinger, M. (1990). Learned resourcefulness and perceived control over pain: A preliminary examination of construct validity. Journal of Research in Personality, 24, 101-110.

Williams, D.A., & Keefe, F.J. (1991). Pain beliefs and the use of cognitive-behavioral coping strategies. Pain, 46(2), 185-190.

World Health Organization. (1980). International classification of impairments, disabilities and handicaps - A manual of classification relating to the consequences of disease. Geneva: Author.

Zelman, D.C., Howland, E.W., Nichols, S.N., & Cleeland, C.S. (1991). The effects of induced mood on laboratory pain. Pain, 46, 105-111.

# APPENDIX A
## Subject Selection Checklist

## SUBJECT SELECTION CHECKLIST

Patient's name: _____

Clinician: _____ Treating physician: _____

Date completed: _____ Physician consent (date): _____

**Inclusion: Patient must meet the following criteria:**

Yes

☐ 1. Male

☐ 2. Age 19 - 65

☐ 3. English fluency

☐ 4. In treatment for chronic benign low back pain i.e., current or past diagnosis of: Chronic mechanical low back pain; Acute low back strain; Recurrent low back strain

☐ 5. Has been in pain for three or more months (may be in any stage of treatment/recovery)

**Exclusion: No current or past diagnosis of:**

No

☐ 6. Hypertension

☐ 7. Cardiac or vascular disease

☐ 8. Rheumatic fever

☐ 9. Severe or allergic reactions to cold

☐ 10. Previous frostbite to left arm or hand

☐ 11. Left arm or hand abnormality such as disease, surgery, or chronic pain

☐ 12. Current major affective or psychiatric disorder

☐ 13. Pain due to malignancy, herniated disc or systemic disorder

☐ 14. Other equally painful or debilitating medical disorder including, Osteophyte, Lumbar Spondylolysis, Degenerative Facet Tropism, Acute Low Back Strain of less than three months duration, Acute Trauma, Ankylosing Spondylitis of the lumbar region

☐ 15. Previous experience with water immersion procedures

Dalhousie University

Department of Psychology
Halifax, Nova Scotia
Canada B3H 4J1

(902) 494-3417
FAX: (902) 494-6585

May, 1992

**Procedures for subject recruitment**

1. Identify potential subjects from current or past cases;
2. Determine subject suitability according to "Subject Selection Checklist";
3. Obtain verbal consent from patient's physician (please note physician's name and date consent was obtained on selection form);
4. Ask patient whether they would participate in the research;
5. Obtain informed consent;
5. Patient completes questionnaires at clinic and is informed they will receive a phone call from me to set up appointment at Dalhousie;
6. I will then call patient to arrange appointment at Dalhousie;
7. I will call you to arrange an appointment to rate patient's level of handicap and pick up questionnaires.

Thank you,

Richard Braha, M.Sc.
Ph.D. Candidate

# APPENDIX B
## Group Demographic Characteristics

Paired list of pain and control group subjects' demographic characteristics matched for age and education

| Group | | | | | |
|---|---|---|---|---|---|
| Pain | | | Control | | |
| #[a] | Age | Educ[b] | #[a] | Age | Educ[b] |
| 02 | 24 | 12 | 05 | 20 | 10 |
| 04 | 25 | 10 | 30 | 24 | 12 |
| 17 | 28 | 11 | 09 | 25 | 12 |
| 08 | 31 | 09 | 36 | 25 | 12 |
| 39 | 31 | 12 | 28 | 25 | 12 |
| 06 | 31 | 13 | 29 | 26 | 16 |
| 19 | 32 | 08 | 27 | 27 | 12 |
| 13 | 32 | 09 | 10 | 29 | 12 |
| 03 | 32 | 12 | 38 | 29 | 15 |
| 37 | 34 | 11 | 34 | 30 | 12 |
| 12 | 34 | 13 | 32 | 30 | 14 |
| 14 | 38 | 08 | 35 | 32 | 11 |
| 11 | 38 | 13 | 21 | 34 | 11 |
| 41 | 39 | 10 | 18 | 36 | 10 |
| 15 | 40 | 12 | 22 | 36 | 11 |
| 26 | 41 | 08 | 24 | 38 | 09 |
| 07 | 44 | 05 | 23 | 47 | 08 |
| 40 | 47 | 09 | 31 | 49 | 12 |
| 16 | 47 | 10 | 20 | 51 | 10 |
| 25 | 52 | 09 | 33 | 54 | 14 |
| 01 | 59 | 09 | | | |

Note. N=41. [a] Subject number. [b] Years of education.

# APPENDIX C
## Coping Strategies Questionnaire

## 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.

WHEN I FEEL PAIN. . .

_____ 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.

0 1 2 3 4 5 6

No control — Some control — Complete control

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.

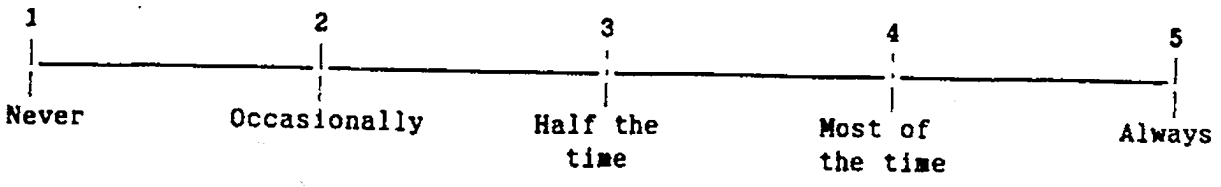
0 1 2 3 4 5 6

Can't decrease it at all — Can decrease it some what — Can decrease it completely

# APPENDIX D
## Pain Behavior Check List

PBC
Patient

Please rate how often you did each of the following when in pain during the past week. Use the following scale to choose a number to rate each behavior.




_____ 1. Grimaced.

_____ 2. Held or supported painful part of body.

_____ 3. Questioned, "Why did this happen to me?"

_____ 4. Distorted walk.

_____ 5. Frequently shifted posture or position.

_____ 6. Requested to be excused from tasks or activities.

_____ 7. Took medication.

_____ 8. Moved extremely slow.

_____ 9. Limped.

_____ 10. Sat with a rigid posture.

_____ 11. Moved in a guarded or protected fashion.

_____ 12. Moaned.

_____ 13. Used a cane, walker, cervical collar, or back or leg brace.

_____ 14. Requested help in walking.

_____ 15. Stooped while walking.

_____ 16. Lay down during the day.

_____ 17. Was irritable.

_____ 18. Avoided physical activity.

_____ 19. Sighed.

_____ 20. Clenched teeth.

# APPENDIX E
## Medical Information Questionnaire

## Medical Information

Code

1. Name: _____ 1. ___
2. Date of Birth: ___/___/___ (dd mm yy) 2. ___
3. Marital Status: _____ 3. ___
4. What is your current diagnosis? _____
_____ 4. ___
5. When did you receive this diagnosis? ___/___/___ (dd mm yy) 5. ___
6. When did your symptoms begin? ___/___/___ (dd mm yy) 6. ___
7. Do you suffer from any other medical problems? 7. ___
   1. _____
   2. _____
   3. _____
8. What medications are you currently taking? 8. ___
   1. _____
   2. _____
   3. _____
9. Are you currently employed? 9. ___

   Yes ___ No ___
   If so, Part-time ___ Full-time ___

10. Are you currently on paid leave from work? 10. ___

    Yes ___ No ___

11. If you are currently umemployed, how long have you been unemployed? _____ 11. ___
12. If you are currently on paid leave from work, how long have you been off work? _____ 12. ___

# APPENDIX F
# WHO Handicap Scale

## HANDICAP SCALE[1]

Centre : _____ Subject: _____

Rater : _____ Date : _____

### INSTRUCTIONS FOR RATERS

Raters must be familiar with WHO criteria for assessing handicap (see footnote for reference).

For each of the seven handicap dimensions listed below, circle the appropriate level of disadvantage experienced by the subject as a result of impairment or disability.

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 1. Orientation | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| 2. Physical | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| 3. Mobility | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| 4. Occupation | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| 5. Social | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| 6. Economic | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| 7. Other | 0 | 1 | 2 | 3 | X | X | X | X | X | 9 |

Total score: _____

### RATER'S COMMENTS

[1] Based on criteria provided by the World Health Orginization (1980) in "International Classification of Impairments, Disabilities, and Handicaps: A manual of classification relating to the consequences of disease".

# APPENDIX G
## Self-reported Disability and Handicap

Activity Inventory

When people have pain, it is sometimes difficult for them to do their regular activities. Did you have any physical trouble or difficulty doing these activities today because of this pain? Circle the best answer.

| | | | | | |
|---|---|---|---|---|---|
| Walking to the bathroom: | No Trouble | A Little Trouble | Some Trouble | A Lot of Trouble | Impossible |
| Walking up the stairs: | No Trouble | A Little Trouble | Some Trouble | A Lot of Trouble | Impossible |
| Doing something with a friend/ spouse: | No Trouble | A Little Trouble | Some Trouble | A Lot of Trouble | Impossible |
| Doing chores or housework: | No Trouble | A Little Trouble | Some Trouble | A Lot of Trouble | Impossible |
| Eating regular meals: | No Trouble | A Little Trouble | Some Trouble | A Lot of Trouble | Impossible |
| Being up all day without a nap or rest: | No Trouble | A Little Trouble | Some Trouble | A Lot of Trouble | Impossible |

Remember, you are being asked about difficulty due to pain

| | | | | | |
|---|---|---|---|---|---|
| Riding the bus or travelling in the car: | No Trouble | A Little Trouble | Some Trouble | A Lot of Trouble | Impossible |
| Being at work or school all day: | No Trouble | A Little Trouble | Some Trouble | A Lot of Trouble | Impossible |
| Exercising: | No Trouble | A Little Trouble | Some Trouble | A Lot of Trouble | Impossible |
| Reading or doing work at home: | No Trouble | A Little Trouble | Some Trouble | A Lot of Trouble | Impossible |
| Watching TV: | No Trouble | A Little Trouble | Some Trouble | A Lot of Trouble | Impossible |
| Walking the length of a football field: | No Trouble | A Little Trouble | Some Trouble | A Lot of Trouble | Impossible |
| Running the length of a football field: | No Trouble | A Little Trouble | Some Trouble | A Lot of Trouble | Impossible |
| Going Shopping: | No Trouble | A Little Trouble | Some Trouble | A Lot of Trouble | Impossible |
| Getting to sleep at night and staying | No Trouble | A Little Trouble | Some Trouble | A Lot of Trouble | Impossible |

# APPENDIX H
## Observational method of pain behaviour assessment for use during experimentally induced pain: Coding Manual

Appendix A

Original and modified observational methods of rating pain behaviours[1]

| Behaviour | Original | Modified |
|---|---|---|
| Guarding | Abnormally stiff, interrupted, or rigid movement while changing from one position to another (i.e., when recording sit or during pacing). It includes patients using canes or walkers, and cannot occur during a stationary position (i.e., sit, std, rec). The movement must be hesitant or interrupted, not merely slow. | Abnormally stiff, interrupted, or rigid movement while changing from one position to another (i.e., when getting in and out of chairs or during step-ups). It includes using canes or walkers, putting hands on thigh(s) to push self up (e.g., during step-ups or standing), and cannot occur during a stationary position. It can include using the edges or back of chair or railings to assist while changing positions, wobbling or losing balance during movement. The movement must be hesitant or interrupted, not merely slow. |

[1] Original taxonomy taken from Keefe, Crisson, & Trainor (1987). It should be noted that several versions of this taxonomy have been used. This appendix was produced for comparison purposes only, and is not intended for use as a research instrument. Training seminars and more detailed information are apparently available. Researchers interested in the original methodology should contact Dr. Francis Keefe, Box 3926, Duke University Medical Centre, Durham, NC 27720, U.S.A..

Appendices: Braha, R.E.D., Goodman, J., & McGrath, P.J. (1993). Rating overt pain behaviour in experimentally induced pain conditions: preliminary validation of modifications to existing techniques. IASP 7th World Congress on Pain, Paris, France, August 22-27.

| | | |
|---|---|---|
| Bracing | Position in which an almost fully extended limb supports and maintains an abnormal distribution of weight. It cannot occur during movement (i.e., pacing, shifting), and must be held for at least 3 seconds. It most frequently is the gripping of the edge of a bed while sitting, but can also be grasping a table, cane, or walker while standing. What appears to be bracing during movement is termed guarding. It can occur with a leg if patient leans against wall using no other support, but is not simply the sifting of weight when standing. | Position in which an almost fully extended limb supports and maintains an abnormal distribution of weight. It cannot occur during movement (i.e., during step-ups or while changing from seated to standing position or vice versa). It most frequently is observed as the gripping of the edge of the railings of the step-up platform, or the back of a chair while sitting. It can also include the subject leaning on their knees or thighs with arms extended while sitting, or leaning on their elbows. This can also occur during hand (M/H) or back (M/B) movement, as long as the moving part of the body is not the part which is targeted in the brace. For example, the subject may show bracing while standing by leaning one arm against the railing while engaging in hand or arm movement (M/H) with their arm. What appears to be bracing during movement should be noted as guarding. It can occur with a leg if a subject leans against a wall using no other support, but is not simply the shifting of weight when standing. |

Appendices: Brahn, R.E.D., Goodman, J., & McGrath, P.J. (1993). Rating overt pain behaviour in experimentally induced pain conditions: preliminary validation of modifications to existing techniques. IASP 7th World Congress on Pain, Paris, France, August 22-27.

| | | |
|---|---|---|
| Rubbing | Touching, rubbing, or holding the affected area which includes low back, hips, and legs for a minimum of 3 seconds. It includes patients' hands in pockets or behind the back, but not the hands folded in lap. It can occur during an interval of movement or nonmovement. Patients' palm(s) must be touching the affected area to be considered rubbing during a "sit." If a clear view is not available, a rub is recorded if touching can be reasonably inferred from the patient's position. | Touching, rubbing, or holding the affected area which includes low back, hips, buttocks and legs prior, during or after the standing, step-up or immersion tasks, or the elbow, forearm, hand and fingers prior, during or after the immersion tasks. It can include subjects' hands in pockets or behind the back, but not the hands folded in lap. It does not include the subject drying off their arm following an immersion task, nor does it include rubbing the face or neck. It can occur during an interval of movement or nonmovement. Patients' palm(s) and/or palm side of fingers must be touching the affected area to be considered rubbing. If a clear view is not available, a rub is recorded if touching can be reasonably inferred from the subject's position. |
| Grimacing | Obvious facial expression of pain which may include furrowed brow, narrowed eyes, tightened lips, corners of mouth pulled back, clenched teeth. It often resembles wincing. Observer must be alert to catch this. It often occurs during a shift. | Obvious facial expression of pain which may include furrowed brow, narrowed eyes, tightened lips, corners of mouth pulled back, clenched teeth. It often resembles wincing. It can also include exaggerated staring or looking at the arm which is currently being held in the cold water immersion tank, or while resting it in their lap. Observer must be alert to catch this. It often occurs during a shift in movement and during a sigh. |

Appendices: Brahe, R.E.D., Goodman, J., & McGrath, P.J. (1993). Rating overt pain behaviour in experimentally induced pain conditions: preliminary validation of modifications to existing techniques. IASP 7th World Congress on Pain, Paris, France, August 22-27.

| | | |
|---|---|---|
| Sighing | Obvious exaggerated exhalation of air, usually accompanied by shoulders first rising and then falling. Cheeks may be expanded. | Obvious exaggerated exhalation of air, usually accompanied by shoulders first rising and then falling. Cheeks may be expanded. This can also include grunting. Sighing is recorded as "S", grunting is recorded as "S/G". |
| Hand or Arm Movement | N/A | This can include opening and closing of the immersed hand following immersion in an exaggerated manner, rotating the immersed arm from the elbow in an exaggerated manner. This does not include shaking water from the hand or arm following immersion or movement of the hand or arm while subject is drying arm off but does include extended (> 1 second) clenching of the affected fist following immersion. |
| Back Movement | N/A | This can include stretching of the lower back by either twisting from hips backward or from side to side, fidgeting or repositioning in chair while seated during the immersion tasks or during rest periods during the standing or step-up tasks, including arching of the back and shifting position. It can also include stretching the shoulders upward, backward or forward as well as squatting and/or crouching. Back movement is often accompanied by sighing. |

Appendices: Braha, R.E.D., Goodman, J., & McGrath, P.J. (1993). Rating overt pain behaviour in experimentally induced pain conditions: preliminary validation of modifications to existing techniques. IASP 7th World Congress on Pain, Paris, France, August 22-27.

**Pain Behavior Scoring Sheet**

Date: _____

Subject # ____ Tape # ____ Condition ____ Rater ____

| | | Interval Score | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Counter | Interval | G | B | R | F | S | M/A | M/B | Total |
| | Cold Water | | | | | | | | |
| | Pre-Immersion | | | | | | | | |
| | Immersion 1 | | | | | | | | |
| | Break 1 | | | | | | | | |
| | Get Ready 1 | | | | | | | | |
| | Immersion 2 | | | | | | | | |
| | Break 2 | | | | | | | | |
| | Get Ready 2 | | | | | | | | |
| | Immersion 3 | | | | | | | | |
| | Break 3 | | | | | | | | |
| | Get Ready 3 | | | | | | | | |
| | Immersion 4 | | | | | | | | |
| | Break 4 | | | | | | | | |
| | Get Ready 4 | | | | | | | | |
| | Immersion 5 | | | | | | | | |
| | Break 5 | | | | | | | | |
| | Step-Ups | | | | | | | | |
| | Get Ready 1 | | | | | | | | |
| | Step-Up 1 | | | | | | | | |
| | Break 1 | | | | | | | | |
| | Get Ready 2 | | | | | | | | |
| | Step-Up 2 | | | | | | | | |
| | Break 2 | | | | | | | | |
| | Get Ready 3 | | | | | | | | |
| | Step-Up 3 | | | | | | | | |
| | Break 3 | | | | | | | | |
| | Standing | | | | | | | | |
| | Get Ready 1 | | | | | | | | |
| | Standing 1 | | | | | | | | |
| | Break 1 | | | | | | | | |
| | Get Ready 2 | | | | | | | | |
| | Standing 2 | | | | | | | | |
| | Break 2 | | | | | | | | |
| | Get Ready 3 | | | | | | | | |
| | Standing 3 | | | | | | | | |
| | Break 3 | | | | | | | | |

# APPENDIX I
## Low and high predictability verbal instructions

BERTHA Ph.D.

Audio Instructions

Warm tank

1. This audio tape will take you through each activity you will participate in today. Please listen carefully to the taped instructions. Try your best to complete each task. First, be seated next to the room temperature tank. Do not "test" the water. Wait for instructions before you lower the cradle into the water.

2. Now, gently rest your arm in the cradle with your hand laying flat on the support webbing. Try not to tense your arm. This tape will tell you when to lower the cradle into the water and when to raise the cradle out of the water. Once in the water, do not move your hand. Just keep the hand relaxed. You won't need to keep your arm in the water for more than 30 seconds.

3. Now, slowly lower the cradle to the bottom of the tank.

---
(30" delay)
---

4. Now, slowly raise the cradle out of the water.

5. You may remove your arm from the cradle and dry it off.

6. Move your seat next to the other tank and gently rest your arm in the cradle. Do not lower your arm in the water until this tape asks you to.

---
(30" delay)
---

PREDICTING PAIN

Cold Tank 1

By now you should be seated next to the cold water tank. When this tape says "PREDICT" say out loud how painful you think keeping your arm in the cold water tank will be on a scale of 0 to 10. 0 being not at all painful and 10 being the worst imaginable pain.

At the end of each activity, this tape will ask you to "RECALL", this means say out loud how painful the activity actually was at its worst -- use the same 0 to 10 scale.

Don't spend too much time deciding, just say out loud whatever first comes to mind. You will not need to keep your arm in the water for more than 30 seconds.

1. O.K. "PREDICT"

Remember, after you lower your arm into the water, say out loud the word "NOW" the moment you feel any painful sensations.

3. Slowly lower the cradle to the bottom of the tank.

---
10" delay
---

4. Raise the cradle out of the water.

5. "REPORT".

You may gently pat your arm dry, but try to remain seated if possible. You will now get a 3 minute break. You may stand up and stretch if you need to but return to the seat as soon as the tape says "Get Ready".

---
180" delay
---

Cold Tank 2

1. "GET READY"

2. "PREDICT"

Remember, after you lower your arm into the water, say out loud the word "NOW" the moment you feel any painful sensations.

3. Slowly lower the cradle to the bottom of the tank.

---
40" delay
---

4. Raise the cradle out of the water.

5. "REPORT".

You may gently pat your arm dry, but try to remain seated if possible. You will now get a 3 minute break. Once again, you may stand up and stretch if you need to but return to the seat as soon as the tape says "Get Ready".

---
180" delay
---

Cold Tank 1

1. "GET READY"
2. "PREDICT"

Remember, after you lower your arm into the water, say out loud the word "NOW" the moment you feel any painful sensations.

3. Slowly lower the cradle to the bottom of the tank.

---
10" delay
---

4. Raise the cradle out of the water.

5. "REPORT".

You may gently pat your arm dry. Try to remain seated if possible. This completes part 1. You will now get another 3 minute break. You may stand up and stretch if you need to but return to the seat as soon as the tape says "Get Ready".

---
180" delay
---

stopped here Tape 2

LOW PREDICTABILITY

1. "GET READY"
2. This is part 2.

| lo | hi |
|---|---|
| | 3 |

3. In this activity you will be doing the same thing as before except THIS time the immersion ~~will be [illegible] This time your arm immersed in the cold water until~~ the tape says to raise ~~your~~ the cradle out of the water.

4. "PREDICT"

Remember, after you lower your arm into the water, say out loud the word "NOW" the moment you feel any painful sensations.

5. Slowly lower the cradle to the bottom of the tank.

---
60" delay
---

6. Raise the cradle out of the water.

7. "REPORT".

You may gently pat your arm dry. Try to remain seated if possible. ~~This completes~~ 2 You will now get another minute break. You may stand up and stretch if you need to but return to the seat as soon as the tape says "Get Ready".

---
180" delay
---

HIGH PREDICTABILITY

1. "GET READY"

2. This is part 3. 10 | Wi | 2

3. In this activity you will be doing the same thing as before except THIS time. THE IMMERSION WILL BE FOR ~~only~~ 60 SECONDS. The timer in front of you will count down the seconds. LIKE BEFORE, try to keep your arm immersed in the cold water: the tape will tell you to raise the cradle out of the water when the timer reaches "0".

4. "PREDICT"

-pause-01
Remember, after you lower your arm into the water, say out loud the word "NOW" the moment you feel any painful sensations.

3. Slowly lower the cradle to the bottom of the tank.

---
60" delay
---

4. Raise the cradle out of the water.

5. "REPORT".

You may gently pat your arm dry. Try to remain seated if possible. This completes all the activities involving the water tanks. You will now get another 3 minute break. You may stand up and stretch if you need to.

---
180" delay
---

Pt 2

Please Move to the platform when as soon as the tape says "Get Ready"

- Get Ready

Experiment 1 & 2

1. This is Part 4. Please listen carefully to the taped instructions. Try your best to complete each task. First, stand in front of the platform in the area marked with a square.

PREDICTING PAIN: STEP-UPS

By now you should be standing in front of the platform in the area marked with a square

When this tape says "PREDICT" say out loud how painful you think stepping up and down off the platform at your own pace will be on a scale of 0 to 10. 0 being not at all painful and 10 being the worst imaginable pain.

At the end of each activity, this tape will ask you to "REPORT", this means say out loud how painful the activity actually was at its worst -- use the same 0 to 10 scale.

Don't spend too much time deciding, just say out loud whatever first comes to mind. You will not need to do step-ups for more than 60 seconds.

1. O.K. "PREDICT"

Remember, after you start the step-ups, say out loud the word "NOW" the moment you feel any painful sensations.

2. Begin the step-ups.

---
60" delay
---

3. Stop

4. "REPORT".

You will now get a 3 minute break. You may stretch if you need to but return to the area marked with the square as soon as the tape says "Get Ready".

---
180" delay
---

LOW PREDICTABILITY STEP-UPS

1. "GET READY"

Now you will be doing the same thing as before except THIS time the exercise will [redacted]. Try to keep going at your own pace until the tape says to stop.

2. "PREDICT"

Remember, after you start, say out loud the word "NOW" the moment you feel any painful sensations.

3. Begin the step-ups.

---
180" delay
---

4. STOP!

5. "REPORT"!

You will now get a 3 minute break. You may stretch if you need to but return to the area marked with the square as soon as the tape says "Get Ready".

---
180" delay
---

HIGH PREDICTABILITY STEP-UPS

1. "GET READY"

2. In this activity you will be doing the same thing as before except THIS time, THE exercise WILL last ~~only~~ 180 SECONDS. The timer in front of you will count down the seconds. LIKE BEFORE step-up at your own pace: the tape will tell you to stop when the timer reaches "0".

3. "PREDICT"

Remember, after you start, say out loud the word "NOW" the moment you feel any painful sensations.

4. Begin the step-ups.

---
180" delay
---

5. STOP!

6. "REPORT"!

Hi-Pain

This completes Part 1. You will now get a 3 minute break before the last activity. You may stretch if you need to but return to the area marked with the square as soon as the tape says "Get Ready".

---

180" delay

---

Get Ready

This is Part 4. Please listen carefully to the taped instructions. Try your best to complete each task. First, stand in front of the platform in the area marked with a square.

PREDICTING PAIN: STANDING

By now you should be standing in front of the platform in the area marked with the square.

When this tape says "PREDICT" say out loud how painful you think standing still on the platform will be on a scale of 0 to 10, 0 being not at all painful and 10 being the worst imaginable pain.

At the end of each activity, this tape will ask you to "REPORT". this means say out loud how painful the activity actually was at its worst -- use the same 0 to 10 scale.

Don't spend too much time deciding. Just say out loud whatever first comes to mind. You will not need to stand still on the platform for more than 60 seconds.

1. O.K. "PREDICT"

Remember, after you start, say out loud the word "NOW" the moment you feel any painful sensations.

2. Step-up onto the platform and begin the stationary standing.

---

60" delay

---

3. Stop!

4. "REPORT"!

You will now get a 3 minute break. You may stretch if you need to but return to the area marked with the square as soon as the tape says "Get Ready".

---

180" delay

---

LOW PREDICTABILITY STANDING

1. "GET READY"

Now you will be doing the same thing as before except THIS time the exercise will ~~last longer~~ continue until the tape says to stop. Try to keep going until the tape says to stop.

- Pause 3"

2. "PREDICT"

- Pause 5"

Remember, after you start, say out loud the word "NOW" the moment you feel any painful sensations.

3. Step-up onto the platform and begin the STATIONARY STANDING

---
180" delay
---

4. STOP!

5. "REPORT"!

You will now get a 3 minute break. You may stretch if you need to but return to the area marked with the square as soon as the tape says "Get Ready".

---
180" delay
---

HIGH PREDICTABILITY STEP-UPS

1. "GET READY"

2. In this activity you will be doing the same thing as before except THIS time, the exercise will last ~~only~~ 180 SECONDS. The timer in front of you will count down the seconds. The tape will tell you to stop when the timer reaches "0".

Pause

3. "PREDICT"

Pause 5"

Remember, after you start, say out loud the word "NOW" the moment you feel any painful sensations.

4. Step-up onto the platform and begin the stationary standing

---
180" delay
---

5. STOP!

6. "REPORT"!

You have now completed all the activities. Thank you.

# APPENDIX J
## Video shoot scene directory

Experiment script

Key: Items in brackets indicate scene & actor

Narrator: Richard
Female 1 Discretion: Julie
Technical: Pat

[1. Richard: standing]

Thank you for participating in this research.

This research is looking at the extent to which people can predict how different types of activities will feel and at people's reactions during these activities.

[2. Richard pause 5 seconds

Today, you are going to be involved in two different activities. They will take no more than one hour from start to finish.

[3. Water tanks & Pat standing next to Ian J pause

First, you will be doing what we call the immersion activities. These involve the two tubs of water in the corner.

Let's look at what you'll be doing during the immersion activities.
A. McGrath
~~Pat~~ will demonstrate the proper use of the immersion tanks.

[4. Pat sits at warm tank]

First, have a seat and try to find a comfortable position as it is the last hour of the day. Make sure to take off your watch or ring!

[5. Pat puts arm in cradle]

Next, gently rest your arm in the cradle over the tank.

[6. Pat lowers arm into water]

Now, slowly lower your arm to the bottom of the tank in one smooth movement.

[7. Pat lowers arm into water]

This task is to get you used to the equipment and cursion your hand in the water.

During the actual trial, a voice recording will tell you a bell what to do and when to ~~pull~~ raise the cradle out of the water
[Pat removes arm, cradle off].

Next, slide your seat over to the other tank.

[7. Pat moves to cold water tank]

The other tank is filled with cold water.

[8. Pat sits at cold tank]

Again, first, have a seat and try to find a comfortable position next to the tank.

[9. Pat puts arm in cradle]

Next, gently rest your arm in the cradle over the tank.

[10. Pat lowers arm into water]

Now, slowly lower your arm to the bottom of the tank in one smooth movement.

[11. Pat lowers arm into water]

This tank is where you'll do most of the activities.

Once again, during the actual activities, a tape recording will tell you exactly what to do and when to raise the cradle out of the water [Pat removes arm, dries off]. After you've taken your arm out of the water, try to remain seated. You may dry your arm off though.

Pause

[12. Board with Pat pointing]

~~During the first activity, after practising the procedures in the warm water tank,~~ you will be asked to predict how painful you think putting your hand in the cold water ~~will for 60 seconds~~ will be. Then you'll be asked to put your hand in the cold water for sixty seconds. A taped recording will tell you when to put your hand in the water and when to take your hand out of the water. As soon as you take your hand out of the water, the tape will ask you to "report". This means say out loud how painful the activity was on a 0 to 100 scale, 0 being not painful at all, 100 being the worst imaginable pain or pain as bad as it can be!

During each activity, we'd like you to say aloud the word "now!" the moment you begin to feel any painful sensations.

You will do this 3 times. Between each immersion, you will get a 3 minute break, the tape will let you know what to do.

After this, you will hear a description on the tape about the next activity which also involves the immersion tank. Try to do what the tape says as best you can.

---

[13. Platform with Pat standing in front]]

Next, you'll do some exercise activities on the platform in the other corner.

~~The model will demonstrate the activities.~~

You will be asked to do 2 types of activities: step-ups and standing.

Step-ups simply mean climbing onto the platform so that both feet land on the platform. Then step-down and repeat. The model will demonstrate how this is done.

[14. Pat steps-up & down, slowly at first then quicker]

Standing means simply stepping up onto the platform and standing still without holding the railings, or stepping-off.

[15. Pat steps-up & stands still-- stay on platform for last part of narration]

Like in the first activity, the tape will ask you to predict how ~~3~~ painful you think stepping up and down from the platform ~~for three minutes~~ will be. Then the tape will ask you to step up and down off the platform. The taped recording will tell you when to start and stop. As soon as you stop, the tape will ask you to "report". This means say out loud how painful the activity was on a 0 to 100 scale, 0 being not painful at all, 100 being the worst imaginable pain or pain as bad as it can be!

During each activity, we'd like you to say aloud the word "now!" the moment you begin to feel any painful sensations.

You will do this 3 times. Between each time, you will get a 3 minute break, the taped instructions will let you know what to do.

After this, you will here a description on the tape about the next activity which also involves the step-up platform. Try to do what the tape says as best you can.

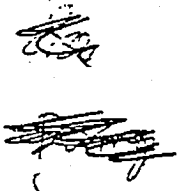
The last activity also involves the platform with railings. This time, the tape will ask you to predict how ~~3~~ painful you think standing still in one spot on the platform ~~for three minutes~~ will be. Then the tape will ask you to step up on the platform and try to stand still for three minutes without touching the railings if you can, and without stepping off if you can. The taped recording will tell you when to start and stop. As soon as you stop, the tape will ask you to "report". This means say out loud how painful the activity was on a 0 to 100 scale, 0 being

not painful at all, 100 being the worst imaginable pain or pain as bad as it can be!

You will do this 5 times. Between each time, you will get a 3 minute break when you may sit down or get off the platform. the taped instructions will let you know what to do.

After this, you will here a description on the tape about the next activity which also involves the step-up platform. Try to do what the tape says as best you can.

Thank you, and [illegible], if you have any questions please feel free to ask.



The tape will explain exactly what you're supposed to do in each activity. During each activity, the tape will ask you to report. This means say out loud how painful the activity was on a 0 to 100 scale, 0 being not painful at all, 100 being the worst imaginable pain or pain as bad as it can be. Also, during each activity, we'd like you to say aloud the word "now"! the moment you begin to feel any painful sensations.

# APPENDIX K
## Three consent forms

Nova Scotia

Victoria
General Hospital

1278 Tower Road
Halifax, Nova Scotia
B3H 2Y9

Our file no:

Consent to act as a subject in a research study

THE EFFECTS OF CONTROL AND HANDICAP ON PAIN

**Principal Investigator**

Richard Braha, M.Sc.
Department of Psychology
Dalhousie University
Halifax, Nova Scotia

**Co-investigators**

Patrick J. McGrath, Ph.D.
Department of Psychology
Dalhousie University
Halifax, Nova Scotia

John Clark, M.D.
Department of Anaesthesia
Victoria General Hospital
Halifax, Nova Scotia

**Introduction and purpose**

You are being asked to participate in a research study at both the Victoria General Hospital and Dalhousie University. The purpose of the study is to determine how pain affects your thoughts and behaviour and how your thoughts and behaviour affect your experience of pain. Before you decide what you want to do it is important that you understand several things that you have a right to know about any research study that you are asked to participate in.

**Nature of study**

If you chose to participate in this study, you will be seen at the Victoria General Hospital and at Dalhousie University. At the Victoria General Hospital you will be asked to complete several questionnaires which look at what you think about your pain and how your pain has affected you. At Dalhousie University you will be asked to participate in four short activities which will look at your reactions to pain. In two of these activities, you will be asked to put one hand and arm in a tub of very cold water. This may become painful. In the other two experiments, you will be asked to stand still in one spot and do some step-climbing onto a one-step high platform. The study will be done over two separate visits. On one day you will be asked to complete the questionnaires at the hospital and, on the other day, you will be seen at Dalhousie University. Each day you will be seen for about 1 hour.

**Expenses**

If you chose to participate in this study, you will receive compensation for some of your expenses. This will include a reimbursement for any transportation and parking costs involved in travelling to the hospital and Dalhousie University.

**Risks and benefits**

None of the tasks you will be asked to do involve any risk of injury. At the hospital, the questionnaires are all paper and pencil tasks which require that you pay attention and your eyes may become tired, but you will be given ample opportunity to rest between tests if you find them tiring. At Dalhousie University, the two activities that involve putting one arm in a tub of very cold water may be uncomfortable and even painful. However, although these activities may be unpleasant, there is no risk of injury. While it is unlikely that you will benefit personally by participating in this study, your participation will help us to better understand the kind of things that affect people's experience of pain. This type of understanding may eventually help us to develop better procedures for treating people with chronic low back pain.

**Withdrawal from the study**

Taking part in this study is entirely voluntary. You are free to refuse to participate. You may also enter the study and withdraw at any time. Your decision whether or not to participate in this study will in no way affect the type or quality of treatment that you will receive for your pain.

**Confidentiality**

All identifying data will be kept confidential. Any publications or presentations of the results of this study will include only group data and will not include any individual data. Should you decide at a later date to withdraw from this study, your data will not be included in the results of this study. By consenting to participate in this study you are also agreeing to the researchers obtaining during the study the following information from your medical chart: diagnosis and duration of condition.

**Voluntary consent**

I have read the preceding document or have had it read to me and I understand its contents. I have had the opportunity to ask questions and understand that any further questions can be answered by contacting either Mr. Braha (421-9951) or Dr. John Clark (428-4130). My signature below indicates that I freely agree to participate in the study.

---------- ----------
Signature Date

---------- ----------
Signature of the investigator Date

---------- ----------
Signature of the witness Date

Dalhousie University

Department of Psychology
Halifax, Nova Scotia
Canada B3H 4J1

(902) 494-3417
FAX: (902) 494-6585

Consent to act as a subject in a research study

THE EFFECTS OF CONTROL AND HANDICAP ON PAIN

**Investigators**

Richard Braha, M.Sc.
Department of Psychology
Dalhousie University
Halifax, Nova Scotia

Patrick J. McGrath, Ph.D.
Department of Psychology
Dalhousie University
Halifax, Nova Scotia

**Introduction and purpose**

You are being asked to participate in a research study at both your physiotherapy clinic and Dalhousie University. The purpose of the study is to determine how pain affects your thoughts and behaviour and how your thoughts and behaviour affect your experience of pain. Before you decide what you want to do it is important that you understand several things that you have a right to know about any research study that you are asked to participate in.

**Nature of study**

If you chose to participate in this study, you will be seen at the physiotherapy clinic and at Dalhousie University. At the physio clinic, you will be asked to complete several questionnaires which look at what you think about your pain and how your pain has affected you. At Dalhousie University you will be asked to participate in four short activities which will look at your reactions to pain. In two of these activities, you will be asked to put one hand and arm in a tub of very cold water. This may become painful. In the other two experiments, you will be asked to stand still in one spot and do some step-climbing onto a one-step high platform. The study will be done over two separate visits. On one day you will be asked to complete the questionnaires at the clinic and, on the other day, you will be seen at Dalhousie University. Each day you will be seen for about 1 hour.

**Expenses**

If you chose to participate in this study, you will receive a small cash honorarium. This honorarium will include a reimbursement for any transportation and parking costs involved in travelling to the clinic and Dalhousie University.

**Risks and benefits**

None of the tasks you will be asked to do involve any risk of injury. At the clinic, the questionnaires are all paper and pencil tasks which require that you pay attention and your eyes may become tired, but you will be given ample opportunity to rest between tests if you find them tiring. At Dalhousie University, the two activities that involve putting one arm in a tub of very cold water may be uncomfortable and even painful. However, although these activities may be unpleasant, there is no risk of injury. While it is unlikely that you will benefit personally by participating in this study, your participation will help us to better understand the kind of things that affect people's experience of pain. This type of understanding may eventually help us to develop better procedures for treating people with chronic low back pain.

**Withdrawal from the study**

Taking part in this study is entirely voluntary. You are free to refuse to participate. You may also enter the study and withdraw at any time. Your decision whether or not to participate in this study will in no way affect the type or quality of treatment that you will receive for your pain.

**Confidentiality**

All identifying data will be kept confidential. Any publications or presentations of the results of this study will include only group data and will not include any individual data. Should you decide at a later date to withdraw from this study, your data will not be included in the results of this study. By consenting to participate in this study you are also agreeing to the researchers obtaining during the study the following information from your medical chart: diagnosis and duration of condition.

**Voluntary consent**

I have read the preceding document or have had it read to me and I understand its contents. I have had the opportunity to ask questions and understand that any further questions can be answered by contacting either Mr. Braha (421-9951) or Dr. McGrath (494-3581). My signature below indicates that I freely agree to participate in the study.

| | |
|---|---|
| _____ | _____ |
| Signature | Date |
| _____ | _____ |
| Signature of the investigator | Date |
| _____ | _____ |
| Signature of the witness | Date |

Nova Scotia Rehabilitation Centre

1341 Summer Street
Halifax, Nova Scotia B3H 4K4
Phone 902—422-1787
Fax 902—425-6466

HOWARD L. MOFFATT, B.Sc., B.Ed., M.A.
President, Board of Directors

DAVID R. MYATT, H.C.O.M., C.H.E.
Executive Director

JOHN L. SAPP, M.D., F.R.C.P.(C)
Medical Director

OUR FILE NUMBER

## Consent to act as a subject in a research study

### THE EFFECTS OF CONTROL AND HANDICAP ON PAIN

**Investigators**

Richard Braha, M.Sc.
Department of Psychology
Dalhousie University
Halifax, Nova Scotia

Patrick J. McGrath, Ph.D.
Department of Psychology
Dalhousie University
Halifax, Nova Scotia

William B. Currie, M.A.
Department of Rehabilitation Psychology
Nova Scotia Rehabilitation Centre
Halifax, Nova Scotia

**Introduction and purpose**

You are being asked to participate in a research study at both the Nova Scotia Rehabilitation Centre and Dalhousie University. The purpose of the study is to determine how pain affects your thoughts and behaviour and how your thoughts and behaviour affect your experience of pain. Before you decide what you want to do it is important that you understand several things that you have a right to know about any research study that you are asked to participate in.

**Nature of study**

If you chose to participate in this study, you will be seen at the Nova Scotia Rehabilitation Centre and at Dalhousie University. At the Rehabilitation Centre you will be asked to complete several questionnaires which look at what you think about your pain and how your pain has affected you. At Dalhousie University you will be asked to participate in four short activities which will look at your reactions to pain. In two of these activities, you will be asked to put one hand and arm in a tub of very cold water. This may become painful. In the other two experiments, you will be asked to stand still in one spot and do some step-climbing onto a one-step high platform. The study will be done over two separate visits. On one day you will be asked to complete the questionnaires at the hospital and, on the other day, you will be seen at Dalhousie University. Each day you will be seen for about 1 hour.

**Expenses**

If you chose to participate in this study, you will receive a small cash honorarium. This honorarium will include a reimbursement for any transportation and parking costs involved in travelling to the hospital and Dalhousie University.

**Risks and benefits**

None of the tasks you will be asked to do involve any risk of injury. At the hospital, the questionnaires are all paper and pencil tasks which require that you pay attention and your eyes may become tired, but you will be given ample opportunity to rest between tests if you find them tiring. At Dalhousie University, the two activities that involve putting one arm in a tub of very cold water may be uncomfortable and even painful. However, although these activities may be unpleasant, there is no risk of injury. While it is unlikely that you will benefit personally by participating in this study, your participation will help us to better understand the kind of things that affect people's experience of pain. This type of understanding may eventually help us to develop better procedures for treating people with chronic low back pain.

**Withdrawal from the study**

Taking part in this study is entirely voluntary. You are free to refuse to participate. You may also enter the study and withdraw at any time. Your decision whether or not to participate in this study will in no way affect the type or quality of treatment that you will receive for your pain.

**Confidentiality**

All identifying data will be kept confidential. Any publications or presentations of the results of this study will include only group data and will not include any individual data. Should you decide at a later date to withdraw from this study, your data will not be included in the results of this study. By consenting to participate in this study you are also agreeing to the researchers obtaining during the study the following information from your medical chart: diagnosis and duration of condition.

**Voluntary consent**

I have read the preceding document or have had it read to me and I understand its contents. I have had the opportunity to ask questions and understand that any further questions can be answered by contacting either Mr. Currie (422-1787) or Mr. Braha (421-9951). My signature below indicates that I freely agree to participate in the study.

---------- ----------
Signature Date

---------- ----------
Signature of the investigator Date

---------- ----------
Signature of the witness Date