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THE IMPACT OF AEROBIC ENDURANCE ENHANCEMENT ON CHRONIC PAIN FROM WORK RELATED INJURY.

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BY

HERCULES GRANT

thesis submitted to the Faculty of Graduate Studies and Research in partial fulfillment of the requirements for the degree of Master of Education.

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Edmonton, Alberta

Fall 1993

ISBN 0-315-88166-6

UNIVERSITY OF ALBERTA

RELEASE FORM

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TITLE OF THESIS: **The Impact of Aerobic Endurance Enhancement on Chronic Pain From Work Related Injury.**

DEGREE: Master of Education

YEAR THIS DEGREE GRANTED: 1993

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The undersigned certify that they have read, and recommend to the Faculty of Graduate Studies and Research for acceptance, a thesis entitled **The Impact of Aerobic Endurance Enhancement on Chronic Pain From Work Related Injury** submitted by **Hercules Grant** in partial fulfillment of the requirements for the degree of **Master of Education.**

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Dedication

My work is dedicated to my wife, Faith, and my two loving daughters, Nicki and Candace. They have had to put up with my irritability during the course of the past several months as I complete this thesis. Without them life would be rather empty.

This thesis is also dedicated to my deceased grandfather, Hercules Carty, w' om I did not get to know, though his influence on my life is immeasurable.

Abstract

Pain is a phenomenon emerging from a field of multiple personal influences. It can be made objective to some degree by identifying "pain behaviors". These specific pain behaviors are the result of years of social interaction and life experiences in general. That is, one's socio-historical background including education may be pertinent to pain behavior. These influences, reflected in pain behaviors, by and large demonstrate an individual's orientation, or "being-in-the-world".

Chronic pain presents in itself a unique problem for the simple reason that it has been going on for a long time. The element of time allows the features of the client's coping style to become salient. These styles of coping with pain have been "deposited" through one's personal history and experiences which are embodied in the body schema. The usual feelings of helplessness and loss of control over one's health in chronic pain are the result of inadequate coping styles. Such styles influence the perceived level of discomfort.

Aerobic power is an important variable in physical performance. It is a part of the background contributing to one's orientation to life events such as illness and pain. For this reason it impacts on the meaning and significance given to pain.

The researcher in this study maintains that enhanced aerobic power improves perceived self-efficacy of the chronic pain client and so improves the overall attitude towards coping In this study the aerobic power of fifteen chronic pain clients who had work related injuries were increased by cycle aerobic training. They were compared on Visual Analogue Scale (VAS) readings and Pain Algometry to a control group of twelve clients with similar injuries who did not enter the aerobic training program. The findings were that the treatment group demonstrated significantly improved aerobic capacities, decreased VAS readings, and decreased pain sensitivity on Pain Algometry when compared to controls.

The findings of this investigation suggest aerobic power enhancement can be used to decrease perceived pain levels in this select population. The suggested mechanism of

action is at the level of the individual's perceived self-efficacy to handle his or her condition.

Acknowledgements

Dr. Bruce Bain, who acted as my supervisor, has been a major influence on my approach to this work and my graduate training in general. For his kindness and genuine concern, I am eternally grateful.

I also wish to acknowledge Dr. Yagesh Bhambhani's assistance, his openness, and genuine willingness to offer direction.

Dr. Bob Frender, my first teacher in graduate school, impressed me with his thoroughness and discipline. His example has been inspiring.

My thanks also go to the the WCB Rehabilitation Centre management and staff, especially Paul Beaulne, the clinical analyst, as well as the members of the fitness unit.

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I. INTRODUCTION

Human performance occurs within the natural, cultural, and historical milieu of the person. One's reaction to pain and illness is a function of these three factors, as well as his or her particular "situation" with respect to these factors. As the French psychologist and philosopher Merleau-Ponty (1962) puts it, we are "situated" participants in a relentless and unending socio-historical drama. Phrased differently, one's explanation of the behavior and reaction to pain and illness must proceed with an appreciation of the cultural and historical influences on the life of the individual. Long gone are the days when pain was viewed as solely a physiological phenomenon and treated in that fashion.

One's identity is intricately weaved into how he or she interacts with the immediate environment. This identity develops as the individual schematizes the environment with the reciprocal schematization of the self possessing abilities and vulnerabilities. A term given to this interaction of self and environment is "body schema" (Wapner et al., 1965). The individual's sense of efficacy develops through the body schema along with interpretations of illness and pain. Such interpretations in most cases dictate the level of physical activity when one is in pain. The capacity to perform physical activity may be objectively estimated by ascertaining the individual's aerobic power (Astrand & Rodahl, 1977).

Aerobic power, one might say, is germane to how the individual interacts with the immediate environment. The unique variable of aerobic power, has implications not just for individual physical performance, but at a deeper and more substantial level for the pain client. These implications are at the level of one's capacity to exist and interact in harmony with one's surroundings. In this regard then, one's perception of pain may depend on perceived self-efficacy for physical function which in turn may be tied to the individual's aerobic power. Whether or not this is so is not known for sure. Further, exactly how aerobic power relates to chronic musculoskeletal pain has so far been poorly explored.

Significance of the Study

A more comprehensive view of the pain experience and chronic pain in particular has been precipitated by the escalating costs of treating chronic pain. The loss in productivity from work related injury is staggering. In Alberta alone, claims costs of such injuries exceeded $400 million in 1991 (Alberta Worker's Compensation Board Report, 1991). Treating pain accounts for most of this cost.

Beyond the economic cost, personal suffering from chronic pain can be devastating. The client's independence in physical functioning is most often threatened with feelings of helplessness and hopelessness. Families come apart under the strain of the condition with divorce rates being typically higher than the rest of the population (Peters, 1990).

It has been my experience, as a physical therapist, that most chronic pain clients have been a part of many unsuccessful therapies. Many of these clients have become disillusioned and resentful, viewing treatment outcome as controlled by chance factors or even fate. Most clients have had one or more unsuccessful surgeries and are at a loss for solutions.

To mitigate some of the dysfunctional effects of chronic pain, physicians are now prescribing various forms of aerobic and resistance training (Raithel, 1989). This trend is indeed contrary to the past where such patients were shielded from most physical activity. Yet the basis for these forms of therapy has never been clearly established.

Aerobic conditioning as a form of therapy is largely physical activity within the control of the individual. It could be beneficial in offering the person a feeling of mastery over the condition, thus eliminating feelings of helplessness. Further, it may have the added effect of eliminating or preventing therapies with side effects which is the case with many forms of pain medication. It may also augment the effects of surgery, or even make surgery unnecessary.

Because of its potential benefits, aerobic training as a form of therapy requires scientific exploration. This being the case, one has to address aerobic power and aerobic training as solutions for pain in both its practical and theoretical realms.

Definition of Terms

Chronic Pain

Pain resulting from work related injury lasting for more than six months was designated "chronic pain" for this study. No surgery was being contemplated for the injury.

Pain Algometry

This is a measure of pain sensitivity in a localized area through the application of a pressure gauge or pain threshold meter. It gives the sensitivity tolerance in kilograms per square centimetre (Fischer, 1987).

Cycle Aerobic Training

Physical training on a stationary cycle for 15 to 20 minutes within one's target heart zone (Astrand & Rodahl, 1977) needed to effect cardiovascular improvement in fitness. Target heart rate zone was taken to be between 70% and 85% of maximum heart rate.

Aerobic Power ($\dot{V}o_2$ max)

This is the maximum rate at which oxygen can be utilized in the body expressed in litres per minute or millilitres per kilogram per minute. It can be considered an indicator of the efficiency of the individual to deliver and utilize oxygen while performing physical tasks.

Self-efficacy

The concept of self-efficacy emerged from Bandura's social learning theory. Its main assertion is that one behaves in accordance with one's perceived levels of ability. Emotional states and reaction as well as thought patterns are a result of one's sense of efficacy in a particular situation.

II. REVIEW OF THE LITERATURE

In this review, I will address the historical and contemporary conceptions of the pain phenomenon. From the outmoded Cartesian model to the establishment of the Gate Control paradigm, I will demonstrate the broadening of the approach to pain in science and health care. Along these lines, it is imperative that I identify some salient factors, physical and psychological, which contribute to and determine "pain behavior". Finally, I will look at approaches to the treatment of pain with my greatest emphasis on the potential impact of enhancing aerobic power through physical endurance training.

Conceptions of Pain

Historical Conceptions of Pain

Today, most professionals who treat chronic pain consider sociocultural and psychological factors as integral to the pain experience. Moreover, interaction of these variables with the client's physiological status may be much more important in chronic pain than in acute pain.

Beecher (1956), working as an Allied physician in World War II, amply demonstrated the importance of factors other than the purely physiological in the pain experience. In this benchmark study, Beecher found that combat soldiers who were severely injured in action reported very little pain. Nevertheless, these same soldiers complained of the discomfort of intravenous infusion in a "normal" way.

Beecher concluded that these soldiers saw their severe injuries not as great damage to their health, but rather as some sort of reprieve from the ultimate threat of death on the battlefield. In his study, Beecher was among the first investigators to look at the meaning associated with injury and how it affects the pain response. Because of the severity of the conditions under which his findings were made, one might be skeptical of its reproducibility or even its relevance. However, Beecher reported no altered states of consciousness in the soldiers studied. More importantly, these findings are of enormous significance in our appreciation of the phenomenon of pain.

Prior to Beecher's study and even subsequent to it, medicine operated as if pain fitted completely into the Cartesian model. This model stipulates that pain intensity is derived from a direct relationship with the degree of tissue damage. The idea of disproportionality between pain intensity and tissue damage resulted in the development of the Gate Control paradigm of pain (Appendix A). First postulated by McGill psychologist Melzack and the American physiologist Wall (1965), the Gate Control Theory underlies most present-day approaches to the treatment of chronic pain.

Melzack and Wall postulated that the individual and the pain are modulated by emotional, motivational, and cognitive factors. The Gate Control theory questioned the Cartesian model of a one to one relationship of pain and pathology. It seriously challenged the three centuries old mind-body dichotomy proffered by Rene Descartes which ruled the practice of medicine until very recently. This challenge heralded a new way of viewing and managing pain. It offered a modern conceptualization of pain closely resembling that of Aristotle who some two and a half centuries ago rejected a purely physical explanation of pain. He had suggested that pain had an emotional and affective component. Aristotle might have been somewhat ahead of his time!

Current Conceptions of Pain

The Multifaceted Attributes

The delay in recovery of chronic pain cases allows many factors impacting on pain to become more salient. These factors usually remain dormant in cases of a short injury-recovery cycle, as in most cases of acute pain. Stresses on relationships and the efficacy of coping styles, not foremost in the issue of acute pain, have to be addressed in chronic pain. Indeed this calls for a rather comprehensive approach, fully recognizing emotional, motivational and cognitive factors, if therapy is to be effective.

Of greatest significance to therapy is the background of the client being treated. Background implies not only the physiological parameters such as degree of tissue damage, but also the psychological and sociocultural elements of the case. The multifaceted attributes inherent to chronic pain cannot be understated. What are the prevailing influences which cause the client to react the way he or she does? How can this information be used to effect comprehensive and empathetic rehabilitation?

The lingering Cartesian model. Despite major progress in medical science, the battle with chronic intractable pain seems to be only just beginning. The diagnosis of chronic pain syndrome, highlighting all the difficulties of longstanding pain, only came about in clinical practice in the last ten years. Hitherto, chronic pain was viewed as mere tardiness in the natural physiological healing process. There was no attempt on the part of conventional medicine to appreciate a dynamic complex of cognition, affect, and behavior which feed into and make up chronic pain as an entity.

In standard medical practice, establishing a diagnosis evolves from looking for a particular physiological source that propagates the pain of the client. This established approach to pain is indeed flawless in most cases. It also represents the Cartesian model of a clear distinction between mind and body. However, the Cartesian model is inappropriate and even counterproductive when treating chronic pain. The client who is forced to "doctor shop" while trying to find a curable cause for the chronic pain is likely to develop resentment and inappropriate coping strategies. These factors further complicate the process of rehabilitation, adding to the already diverse human response to pain.

The noted physiologist and pain researcher Wall (1983) reported that in only 20 % of emergency room cases can highly trained clinicians predict the intensity of the pain response from the type or degree of tissue damage. There is great variation in the other 80 %; some show more pain response than clinicians anticipate from the tissue damage, while others show far less. How can we explain this enormous range in acute pain responses, never mind those of chronic pain? The natural response is to offer the explanation of individual differences. But beyond heredity and genetics, how do these differences come about?

The broader appreciation of pain. Three great contributors to the cognitive-behavioral management of pain, Turk, Meichenbaum, and Genest (1983), classified pain as a multifaceted and multidetermined phenomenon like many states of the human condition. This implies that we appreciate pain not only as a feature of a focal physiological damage, but also with deep sociocultural determinants and levels of efficacy which dictate the reaction to pain. Such a broad understanding of pain, though important in cases of acute pain, is absolutely critical to any effective approach to treating the chronic pain client.

Great strides have been made in battling chronic pain with cognitive-behavioral modification and other forms of behavioral therapy (Turk et al, 1983; Fordyce, 1976). These forms of therapy utilize a broad approach and the work of Fordyce (1976) in particular has spawned many clinics with the sole purpose to treat chronic intractable pain. Therapy in these clinics try to account for the uniqueness of individual behavior towards pain, and by so doing "situate" the condition. In this way, therapy can engage the whole and unique individual, thus realizing increasing degrees of success.

Dutch medical psychologists, Schmidt and Arntz (1987), reflecting on the work of Fordyce, asserted that therapies which do not view pain as a multifaceted phenomenon may account for the protraction of the period of recovery. Supportive of this assertion is the American Anthropologist Maryanne S. Bates (1987) who suggests that the course of any painful condition is highly influenced by the attentiveness of the individual, and the significance which he or she gives to the condition. Indeed, the attentiveness and significance given to pain may be characteristic of certain cognitive and affective styles, especially feelings of ability to cope. These styles, in turn, have sociocultural determinants.

The individual processes information in ways suitable to the particular situation as he or she perceives it. Of critical importance to the nature of this perception is the relevant background subtending the whole pain experience. For example, how is the pain experience influenced by physical conditioning and self-efficacy vis-à-vis functional activity? What are the particular styles of attending to the painful experience? How threatening is the pain? As Merleau-Ponty (1962) puts it, our experience is not a mechanistically determined process, but it has a fundamental underpinning which may not be always apparent.

Determinants of the Pain Experience

As Wall (1983) reported, health professionals appear to be able to predict the severity of pain reaction to physical injury in only 20% of emergency room cases. Nevertheless, one cannot dispute the importance of tissue damage in pain reaction. However what one has to study is the unique behaviors which accompany tissue damage or perceived tissue damage. In looking at these behaviors, one is attempting to render more objective a most subjective experience. Further, we can study variables such as aerobic power and its influence on such "pain behaviors".

Pain Behaviors

To render the experience of pain somewhat objective, it is necessary to look at specific behaviors which usually coincide with subjective pain reports. Turk et al. (1983), who defined pain behaviors as those activities that lead an observer to label the individual as being in pain, grouped pain behaviors into three categories:

1. The first category is pain complaints.
   This includes the individual's verbalizations
   about the presence of pain as well as in such
   ways as grimacing and moaning.
2. The second category of pain behavior is
   that of impaired functioning. We know
   the individual is in pain because he or

she demonstrates reduced levels of purposeful physical activity. Interpersonal relationships may also be impaired.

3. The third category is referred to as somatic interventions. This category includes all attempts at pain control, such as the use of medication, soliciting sympathy, and seeking various forms of treatment.

Identifying pain in behavioral terms render the condition less mysterious. It also helps us to look at precursors to such behaviors which may offer some direction for therapy.

Learning and Pain

For a full appreciation of the pain experience, one must explore all potential influences which create particular behaviors in relation to pain. In light of the findings of Wall (1983) that in only 20% of cases do the degree of tissue damage and severity of pain appear proportional, I must expose the idea of the susceptibility of pain to social learning. It is also important that I determine how a variable such as aerobic power may be relevant to pain.

Pain behaviors may be a part of the coping mechanism of the individual imparted to him or her from family members or cultivated socioculturally. Fordyce (1976) sees such pain response as a learned, operant behavior susceptible to self-regulation. He successfully utilizes such an approach in his pain therapy programs. One mechanism by which pain behaviors can apparently be passed on is through vicarious learning.

Vicarious learning. The American psychologist, Ganon (1982), asserted that the pain experience is regulated through electrochemical processes and attention to the pain stimuli. He also believed that the degree of attention to the pain stimuli is the result of "conditioning processes", which are themselves culturally related. Ganon viewed the pain response to be passed on, at least in part, through some sort of social interaction. To Ganon, some form of conditioning or learning was germane to the pain response. The experiments of Prkachin and Craig (1986) supported this latter view of Ganon.

Prkachin and Craig (1986), from the University of British Columbia studied social modelling in an attempt to explain the individual differences commonly seen in pain behavior. On the basis of a baseline assessment, 42 female undergraduates with the highest and another 40 with the lowest pain thresholds were selected from a sample of 127 students. These participants were then given electrical shocks to the level of their pain thresholds. Their tolerance levels to the shock when each student was alone, or in the presence of another student with similar or dissimilar threshold were monitored.

Subjects whose thresholds were initially high demonstrated decreased thresholds when paired with a low threshold participant. This experiment was important in demonstrating the readiness with which pain behavior or apparent pain tolerance is learnt.

A similar study performed by Turkat, Guise and Carter (1983) at Vanderbilt University in the USA further demonstrated the importance of vicarious learning on pain behavior. They exposed 22 experimental subjects to high avoidant pain behavior models and low avoidant pain models, while a pain stimulus was applied to the subject. The subjects who were exposed to high avoidant pain models tolerated the experimental pain for fewer seconds and also did significantly less work in the face of pain.

These results along with those of Prkachin and Craig (1986) point strongly to a role for vicarious processes in the development of reactions to painful stimuli. Though these findings were laboratory findings and not clinical, their implications for social interaction and the pain response are clear. Further along this continuum of social interaction, learning and pain behavior are the dynamics in the family.

The family and pain. Belgian researchers, Violon and Giurgea (1984), reported 78 % of chronic pain patients had significantly more pain patients in their families than the rest of the population. Their conclusion was that patients with a family history of pain may have a greater sensitivity to pain or a greater tendency toward pain behavior. However, these researchers did not implicate social interaction in explaining their findings. Neither did they proffer a genetic explanation. Violon and Giurgea did not mention the sampling technique used and so one can be suspicious of the external validity of the findings.

A follow-up study in the USA by Turkat, Kueznierczk, and Adams (1984) found headache sufferers had significantly more family members with headache when compared to controls. The authors did not report whether the family members lived together or not. Neither did they report what order relatives were studied. As with Violon and Giurgea (1984), it is not possible to differentiate between a genetic explanation, and an environmental or learning explanation of these findings.

However, a study by psychologists at the University of Georgia in the USA, Edwards, Zeichner, Kuczmierczyk, and Boczkowski (1985), pointed to the environment of family members as a strong link with the frequency of pain reports. They also concluded that pain models in the home had a stronger influence on females than males.

The international research team of Feuerstein, Sult, and Houle (1985) also found that family characteristics in addition to work environment were predictive of affective and evaluative dimensions of pain. According to Dennis Turk, the noted American pain researcher, along with his colleagues Flor and Rudy (1987), the family undoubtedly contributes to the perpetuation of chronic pain problems. But the actual translation of familial influences into the sensory experience of pain is poorly explained. Culture, viewed as an amalgamation of family dynamics, is undoubtedly involved in the whole pain experience.

Ethnocultural dynamics. Arab-American nursing researcher Abu-Saad (1984), studying pain in Arab-American boys and girls, found that these girls were more apt to offer psychological causes for their pain than the boys. Abu-Saad concluded that these results showed cultural expectations that Arab-American girls should be more emotional, expressive, and sensitive in their behavior than the boys. The sample size in this study was rather small, 11 girls and 16 boys. One should question the representativeness of such a small sample.

Edwards et al. (1985), like Abu-Saad (1984), pointed to differences in family expectations for male and female, and the overall process of socialization to explain pain behavior differences. Their conclusion was that familial dynamics and early influence of familial pain may play an important role in predisposing individuals to certain pain behaviors. They implicated parental modelling, which naturally is influenced by cultural dynamics, to explain these behavioral reactions.

Edwards et al. (1985) explained this parental modelling as follows. The specific pattern of pain behaviors in the individual is probably the consequence of vicarious reinforcement acquired through the observation of these parental models obtaining secondary gains for their behaviors. An important shortfall of this study however is its use of a retrospective design. Reporting past episodes of pain, as these subjects did, is likely to be fraught with problems of inaccurate recall of the pain experiences.

However the findings of Edwards et al (1985) and Abu-Saad (1984) are consistent with those of Prkachin and Craig (1986). They all suggests that different social modelling influences may be responsible for the substantial individual differences commonly seen in pain behavior.

Ethnicity and socioeconomic status. The larger question of social modelling and pain must include the impact of culture and ethnicity. Weisenberg and Caspi (1989) working in Israel, investigated the effects of sociocultural family origin and educational level on verbal ratings of pain and pain behavior during childbirth in 83 women. These were of Arab and Western European backgrounds. The lower the level of education across both groups the higher their rating of pain. Also the Arab group of women demonstrated more pain behaviors and reported higher levels of pain than the Western group. Along with ethnicity, this study introduced the variable of educational level as having an effect on pain.

Similarly, Columbia University Public Health researchers, Lipton and Marbach (1984), looked at interethnic differences of five American ethnic groups. Using a

35-item scale to measure the pain experience, they found some differences on the 12 items that tested emotionality in the face of pain, namely, stoicism versus expressiveness.

On these 12 items, African-Americans, Italian-Americans, and Jewish Americans were very similar, and distinctly different from Irish-Americans and Puerto Ricans. Of significance was the degree of intraethnic heterogeneity observed. There was a greater similarity between subjects of different ethnic groups in the same socioeconomic level (SES) than subjects in the same ethnic group with different SES.

Lipton and Marbach (1984) concluded from their study that though there were group similarities in the general pain response, each group was quite different with regard to factors which influence the responses. SES was more significant in determining pain response than ethnicity. Such a finding strengthens the argument for vicarious learning as it implies various social constraints as fundamental to the pain experience. In other words, the meaning of pain, which may be different for different groups, affects the pain response.

Lipton and Marbach (1984) completed their study before that of Weisenberg and Caspi (1989). In both studies however, social and educational variables appear to be more influential than ethnicity in pain behavior.

In a more recent publication, Greenwald (1991) asserted that there are really no ethnic differences in pain perception. However, there is variation in the meaning associated with the painful experience across different groups. Miller and Kraus (1990), two American psychiatrists, expressed a similar view. Bates (1987), using a "Biocultural Model" of pain, hypothesized that certain ethnocultural attitudes toward pain are the result of social comparison and social learning processes.

The most recent development supporting this position came from an international research team doing a crosscultural study on back pain. Sanders et al (1992) investigated chronic low back pain in America, Japan, New Zealand, Colombia, Italy, and Mexico. The main explanations which they gave for the apparent cross-cultural differences in the clients behavior to the pain were:

1. differing social expectation across cultures,
2. differing levels of attention given to pain,
3. differing levels of self-perceived ability and willingness to cope.

Indeed culture weighs heavily on the significance attached to various life experiences. Culture also impacts factors of personality which are relevant to pain and rehabilitation.

Personality Factors

Contemporary research has shown a strong relationship between the pain experience and personality factors, which are themselves malleable to social interaction. For example, Dutch researchers Oostdam and Duivenvoorden (1987) administered questionnaires, including the Minnesota Multiphasic Personality Inventory (MMPI) to 82 patients hospitalized for low back pain. Their goal was to determine the relationship between the clients' description of pain and personality factors such as lying, correction, depression, hysteria, and hypochondriasis. Results indicated a significant relationship between the presence of these five psychological factors and the duration of pain.

Similarly in Sweden, Carlsson (1986) reported that personality factors are related to variables that pain clients use to describe the consequences of pain. Notably, these clients had significantly more negative childhood experiences and less inhibition of aggression than did controls. These were the only two major differences found between the clients and a control group in Carlsson's study. The participants in that study were drawn from a diverse pain population, namely, pain in different body parts. This is as opposed to the study of Oostdam and Duivenvoorden (1987), which looked only at low back cases. Carlsson also utilized a control group which strengthened the internal validity of her findings.

The findings of Carlsson that negative childhood experiences and diminished control of aggression were significant in the pain experience suggest psychosocial experiences are integral to pain. Clearly psychological factors which themselves are at the heart of personality are essential "ingredients" in the backdrop that supports the pain experience and one's efficacy in coping.

Significance, perception, and self-efficacy. The concept of personality and social interaction as a determinant of the pain response adds to, and is consistent with the Gate Control Theory of pain. The significance given to a particular pain experience will influence its perception. This significance may be a function of the type and degree of tissue damage; but, it is also a function of cognitive and affective experiences which are socioculturally determined influences of personality.

The meaning and significance attached to pain may be influenced, not only by personality, but by perceived physical bodily states of efficacy. Such perceived states determine, in part, coping styles.

Crisson and Keefe (1988) of Duke University in North Carolina reported that such clients tend to rely on maladaptive coping strategies, and often rated their ability to decrease their disability as poor. There is a diminished sense of efficacy in these clients. One view that is gaining in acceptance in the field of chronic pain, is that there is a strong association between one's perception of his or her ability to control pain and the variations in magnitude and frequency of pain episodes (Toomey, Mann, Abashian & Thompson-Pope, 1991).

Turk and Fernandez (1990) asserted that the determinants of pain reports and pain responses included controllability of the symptoms, that is, the sense that one can alleviate further suffering. Learned helplessness (Seligman, 1975), with a tendency to "catastrophize" is a direct result of perceived loss of control over one's circumstances. Such a phenomenon is applicable to illness, pain, and recovery.

Maladaptive thoughts reinforce a negative behavioral tendency often seen in association with diminished physical activity. An increased level of fear and avoidance of activity readily develop in these clients (Lethem, Slade, Troup, & Bentley, 1983). Pain is perceived as that much more threatening with a heightened state of emotional arousal. These states can be related to the diminished level of efficacy in chronic pain clients.

A study by a multidisciplinary team of health professionals, Dustman et al. (1990), shows some parallel between self-efficacy and a sense of well being. These researchers aerobically trained 30 healthy men in their twenties, and another 30 in their fifties. The participants all reported an improved sense of well-being and demonstrated better functioning on neurocognitive tests post-training. One explanation for the improved sense of well-being could be an improvement in perceived self-efficacy as a result of better physical performance in activities of daily living. In offering an explanation of improved perceived self-efficacy, one must realize that this was not a disabled population with apparent feelings of physical inadequacy. Therefore one might anticipate an even more dramatic effect with this type of training on a population with diminished self-efficacy as is the case with the chronic pain client.

Linton (1985), working in occupational medicine in Sweden, studied activity levels and pain intensity in clients with chronic back pain. He reported that these clients had markedly diminished their physical activity since injury. However when these same clients increased their level of activity there was no increase in pain. A possible explanation for this is that the diminished activity level is supported by fear of pain and a decrease in perceived efficacy to perform physical activity.

Schmidt (1985) investigated a similar group of clients and had similar findings. He concluded that these clients experience failures daily and develop a negative attitude towards their physical capabilities. Hence, the diminished physical activity and performance is more the result of lowered perceived self-efficacy reinforced by physical deconditioning. This deconditioning is due to inactivity rather than to any physiological limitation from the injury.

Another theory offered by Schmidt and Arntz (1987) is one of lowered tolerance to proprioceptive stimuli in pain clients. They demonstrated that these clients tended to overestimate bodily sensation such as tiredness. As a result these clients showed a lowered tolerance to activity. Utilizing such a theory, it is possible that endurance training could offer a form of physical systematic desensitization to the lowered threshold of bodily sensations. Such desensitization would then elevate the pain threshold while promoting increased activity levels and might be a useful form of treatment.

The Treatment of Pain

Traditional Approaches

Relieving suffering is fundamental to health care. The treating professional views the symptom of pain as a phenomenon which ought to be eliminated. At times, this goal of pain elimination as an end in itself is impractical, and even inappropriate. Such is the case for chronic intractable pain, when loss of physical function and its remediation may be the sensible takeoff point for rehabilitation, rather than direct pain reduction strategies.

The pharmaceutical industry has developed a plethora of drugs to meet the need for direct pain sensation reduction. Surgical techniques have been refined over the years, as well as the use of physical agents for the identical purpose of symptom reduction.

Nevertheless, more than 20,000 surgical cases for back pain in the USA fail to accomplish pain reduction every year (Backletter, 1992). Drug addiction from prescription medication remains a very significant problem in the chronic pain population, and in any event many of the medications prescribed have a low efficacy in chronic pain treatment (Nachemson, 1992). The efficacy of physical agents in this population is also very low and in some cases their use is counterproductive (Nachemson, 1992).

Exercise as a form of therapy is widely used, but there is no widespread focus on physical performance as the hub around which chronic pain rehab should take place; neither is there a concerted effort to prove the efficacy of various forms of exercise. It is usually a mere adjunct to other established therapies; and so its main function of improving perceived self-efficacy through enhancing physical function is underestimated.

The Effects of Endurance Exercise

There has been some debate as to the usefulness of exercise in chronic pain. So far investigations have taken place in medical conditions such as fibromyalgia, but not in chronic pain from work related injury.

In one such study, McCain et al (1988) offered strong evidence for positive effects of endurance exercise training on chronic pain. They treated 34 patients who were diagnosed with fibrositis/fibromyalgia syndrome, a chronic pain disorder. The treatment consisted of 20 weeks of either aerobic training or flexibility exercises. The clients were randomly assigned to the two training groups after passing the necessary criteria for such training. The patients who underwent the endurance training program reported a 23% decrease in perceived level of pain on the Visual Analogue Scale, while the patients in the flexibility training group reported only a 7% decrease.

McCain et al (1988) did not report the level of significance in this study and so one has to be cautious in interpreting these results. They also did not provide adequate demographic information, so generalizability of these results might be questionable. Despite these drawbacks, the trend established in the study by McCain and his colleagues is clear: endurance training has a positive therapeutic impact on the pain experience.

In addition to reproducing these findings in other pain populations, one has to debate the possible causes for these results. Are the findings due to alteration in physical performance and self-efficacy due to the exercise? Or, are the findings due to the effects of alteration in the level of circulating endorphins?

How exercise affects pain: The putative effects of endorphins. Endorphins are the natural pain-killing substances, analogous to morphine, generated by the body when in pain (Watkins & Mayer, 1982). Melzack and Wall (1983) hypothesized that endorphin levels might be manipulated through some form of "conditioning". They did not specify the type of conditioning. However, it is conceivable that physical endurance training might be an excellent method to manipulate these endorphin levels as a part of pain rehabilitation.

Harber and Sutton (1984) of Mc Master University demonstrated an increased level of endogenous opiates (endorphins) in normal subjects after a physical endurance training program. The Cleveland psychiatrist, Davis (1983), made a similar observation in marathoners. Harber and Sutton (1984) also found that it took longer for experimental subjects to notice artificially induced pain after a one mile run when compared to a placebo injection. With this work in mind, it is conceivable that endurance activities can elevate endorphin levels in the body immediately after the activity, as well as in a more enduring physically conditioned state. The effect of chronically elevated endorphin levels may be considered the most desirable result of training for the pain client.

Elevated endorphin levels have been strongly implicated not only in pain reduction, but also in mood changes. Several authors (Fobes, 1989; Harber & Sutton, 1984) have noted reduction in tension and anxiety associated with elevated endorphin levels. Altered mood states associated with long distance running is well known in athletic circles as the "runner's high". According to the Australian researchers, Taylor and Hinton (1986), the "runner's high" is an exceptional experience characterized by feelings of analgesia and euphoria.

The mood-altering effects of an elevated endorphin level may be useful in mitigating the psychosocial stress associated with chronic pain. This stress is often manifested by heightened anxiety and tension in these patients (Turk & Fernandez, 1990).

Sports medicine researchers, Crews and Landers (1987), showed that humans trained in physical endurance adapted to some types of stress better than the untrained. In this experiment, stress responses were investigated in trained and untrained subjects while they performed mental tasks of increasing difficulty. The responses to accident scenes and surgical operations were also investigated for stress reaction in volunteers. Crews and Landers felt that the significantly higher resistance to stress in the trained subjects might have been due to the exercise acting as an "inoculating" agent to the intrusion of psychosocial stress. One might suggest that these are effects of elevated endorphin levels; but these investigators did not offer such an explanation for their findings.

A group of American psychologists, Offenbach, Chodzko, and Ringel (1990), demonstrated that low levels of cardiovascular fitness are associated with behavioral slowing in tasks requiring accelerated responses in men over 50 years old. They stipulated that physical fitness had an important effect on mental functioning at least in this population. However, Offenbach et al., (1990) did not explain the type of mental functioning beyond the responses they used in this study. One must be cautious in applying these findings to pain rehabilitation. Nevertheless, improved scores on some cognitive tasks along with the other reported effects of endurance training can indeed make enhancement of cardiovascular fitness a potent force in pain rehabilitation.

The work of the US Army researcher, Fobes (1989), might have inspired Offenbach et al., (1990). Fobes believed that elevated endorphin levels were associated with enhanced learning and a greater suggestibility. He administered exogenous opiates, the chemical equivalent of endorphins, to normal subjects and reported emotional changes similar to the "runner's high". Subjects experienced emotional changes ranging from a sense of well-being to euphoria accompanying a loss of anxiety. Fobes postulated that endorphins are involved in information processing including an influence on all aspects of perception. He feels that endorphins mediate attention by regulating awareness, thus affecting sensory input at the attentive and perceptive levels. Fobes concluded that increasing endorphin levels results in analgesia as well as altering cognition, affect, and subsequent behavior.

Interpretive Summary of the Literature

Prior to Beecher's mid-twentieth century findings on pain in the battlefields, medical science did not appreciate the cognitive, emotional, and motivational aspects of the phenomenon called pain. The benchmark study of Beecher provided the groundwork that spawned our present Gate Control paradigm.

The Gate Control Theory renders obsolete the so-called mind-body dichotomy as it relates to pain, and fully acknowledges the multifaceted quality of pain. Vicarious learning, with its impact on family, culture, and personality, becomes relevant to the pain experience.

Remarkably, there has been little attention in the literature to physical capability or perceived capability on the pain experience. Furthermore no attempt has been made to satisfactorily integrate body schema into a conceptual framework of pain.

However, along the lines of physical capability in the pain experience, aerobic conditioning showed positive effects in fibromyalgia clients. Nevertheless, fibromyalgia denotes a select group of pain clients. No one has tried to demonstrate similar findings in chronic pain from work related injury. More importantly, no one has attempted to explain the interaction of physical capability and pain at a deeper theoretical level.

Research Hypothesis and Objectives

My initial objective in this study was to demonstrate that a group of clients with chronic pain from work related injury can improve their aerobic power through cycle training. Secondly, I sought to demonstrate that with such improved aerobic capabilities the perception of pain in these clients will be significantly reduced.

I hypothesized that for individuals with chronic pain from work related injury, improved aerobic power would decrease reported pain while decreasing pain sensitivity.

III. DESIGN AND METHODOLOGY

This chapter outlines the methods and procedures used in the study to establish the effect of cycle aerobic training, a form of physical endurance training, on chronic pain from work related injury. The design is termed a quasi-experiment (Borg & Gall, 1989) since it was not possible to randomly assign participants to the treatment and control groups. Appropriate statistical measures were used to account for the lack of random assignment.

Participants

Criteria for Inclusion in the Study

The all male participants of the study had pain for greater than six months with no surgery being contemplated by their physicians. The injury had to have been work related with a known accident causing the injury. Clients with diagnoses of fibrositis or fibromyalgia were excluded from the study. Those with multiple areas of tenderness with no clear diagnosis were also excluded. Participants ranged in age from 19 to 45 years old and had no history of heart or lung ailments. No participants were on medication for the duration of the study.

Twenty seven male participants out of an initial total of 38 completed this study. They were volunteers from among chronic pain clients on Worker's Compensation in the city of Edmonton, Alberta. The eleven individuals who did not complete the study either had to restart medication use, due to a flare-up of the condition, or simply dropped out of the study for personal reasons.

The treatment group consisted of 15 clients who were attending a rehabilitation program at the Worker's Compensation Rehabilitation Centre, Edmonton, Alberta.

These clients were made aware of the study on initial admission interview to the centre by various therapists and case managers. Clients interested in volunteering for the study were referred to the experimenter who ensured that the volunteer met the criteria for the study (Appendix B). On average, one in every three potential treatment group clients who met the criteria refused participation in the study.

The control group in the study were twelve chronic pain Worker's Compensation clients not in attendance at the Rehabilitation Centre. These volunteers were recruited by phone from a list of clients awaiting admission to the centre. It was necessary to recruit the control group in this way since clients in attendance at the centre became demoralized, even dropping out of the study when they realized they were a part of the control group. To prevent control group demoralization I resorted to using those clients on the waiting list as our control group. Potential participants for the control group refused participation in nine out of every ten clients contacted.

Apparatus

Physical Activity Readiness Questionnaire

The Physical Activity Readiness Questionnaire (Canadian Standardized Test of Fitness, 1986) is a screening device developed by Health and Welfare Canada for participants in fitness activities. Individuals with any positive results on the questionnaire were automatically excluded from the study.

Visual Analogue Scale

The visual analogue scale (VAS) is a 10 centimetre horizontal line with poles of zero for "no pain" and 10 for "worst pain imaginable". The participant was asked to rate his level of pain between zero and 10 by marking a point on the scale with a pen.

Pain Algometry

The pain algometer is a force dial used to estimate the amount of force a certain surface area of the body can take before the participant reports the pain to be too uncomfortable. The maximum reading is 11 kilograms per squared centimetres on the dial.

Modified Astrand Test of Aerobic Capacity

The Modified Astrand Test is an indirect estimate of aerobic power which is very popular due to its ease of administration. The test was carried out an a Monark Bicycle Ergometer 818 by a Certified Fitness Appraiser.

Other apparatus included the Sporttester PE3000 which is a heart rate monitoring device, as well as a Tycos Sphygmomanometer, and a Monark Exercise Bicycle for cycle aerobic training.

Measures and Reliability

Three variables were measured in this study.

1. The concept of pain was operationalized by using self-report of perceived pain severity with the VAS. To measure the construct of pain, the VAS was thought to be the most sensitive (Huskisson,1974). It is highly reproducible and has an intercorrelation coefficient up to 0.88 with other established pain measures (Jensen, Karoly & Braver, 1986).
2. Because of the multifaceted nature of pain, it was important that we use more than one measure. Our second measure of the construct of pain was a pain sensitivity measure using a Pain Algometer. This measure has been reported to be

extremely useful in measuring soft tissue sensitivity (Kraus, 1981) with an interrater reliability of up to .86 (Jaeger, Reeves, Graff-Radford & Fischer, 1984).

3. The aerobic power was measured by the Modified Astrand test. This test measures the individual's efficiency of utilizing and accessing oxygen while working at certain levels of intensity on the Monark bicycle. It is a well established submaximal test of aerobic power, and the most useful for these circumstances. The standard error for this submaximal test may be up to 15 %, as reported by Astrand (Astrand & Rodahl, 1977).

All calculations of aerobic power were performed using a computer program, the Canadian Standardized Test of Fitness 3 University of Alberta version (1981).

Procedure

Informed Consent

It was emphasized to both groups that the study was fully voluntary and bore no relation whatsoever to the Compensation claim. An informed consent (Appendix C) was signed by each participant after a full explanation of the study was given by the researcher. Expectations were outlined to the participant and understood by him. Participants were advised of the absence of any penalty for non-participation, and the freedom to discontinue the study at any time for whatever reason. Each individual was also advised that debriefing would take place at the end of his participation in the study. After fielding the participants questions, I allowed him to sign the consent form. No participant was allowed into the study who did not sign the form.

Upon completion of the consent form, the participant completed a Physical Activity Readiness Questionnaire (Canadian Standardized Test of Fitness, 1986).

Individuals with positive results on this questionnaire were excluded from the study as they were deemed at risk for injury in the testing.

Pretest

After the participant signed the informed consent form and completed the Physical Activity Readiness Questionnaire, the latter was checked for contraindications to physical fitness testing. With no contraindications, the individual was assigned to pretesting on a given day. Instructions were given for the pretest with full explanation of the procedure.

For pretesting each participant was to wear loose fitting clothing, preferably a jogging outfit. His last meal and cigarette, if a smoker, would be at least one hour before testing. Immediately prior to testing, the participant was asked to rate his pain on a VAS (Appendix D). He was asked to report medication use if any.

Following this, I gave a full explanation of the Pain Algometer and its use to the participant. Two measurements were then taken with this device to estimate pain tolerance in the individual. The first measurement was taken over the anteromedial surface of the right tibia which was unaffected by any pathology. The second measurement was taken over the painful site which was identified by the participant as the most painful spot. The painful site was landmarked so that it could be precisely identified for posttest measures.

The next step in the pretest was the estimation of aerobic power using a Modified Astrand Test (Astrand & Rodahl, 1977) (See Appendix E). Height and weight measurements were obtained and the aerobic test on a Monark cycle ergometer 818 completed under the guidance of a Certified Fitness Appraiser. The Appraiser offered a full explanation of the aerobic test to the participant prior to testing. Clear instructions were given to discontinue the test with any breathlessness, chest pain or dizziness.

Of 38 clients selected for the study 30 participants completed the pretest. Those assigned to the control group were advised to maintain current levels of physical activity and to refrain from taking up a fitness program for the next six weeks. Those individuals assigned to the treatment group were assigned a place in the Rehabilitation Centre cycle aerobics program.

Treatment

The initial estimation of aerobic power was used to gauge the level of training at which the individual should begin his program. Each participant was taught how to monitor his heart rate after his target heart rate zone for a training effect was estimated (Astrand & Rodahl, 1977).

The training period was for six weeks at four sessions per week. After a two minute warm up on the cycle, each participant cycled for twelve minutes initially increasing by two minutes every session to a maximum of 20 minutes. This level was usually attained by the second or third week depending on the individual's level of comfort with the workload. For the first week heart rate was monitored every two minutes by a fitness therapist to ensure the target heart rate zone was reached. Workload was adjusted to maintain the individual in this zone for at least 15 minutes by the third week. A three to five minute cool down period with freewheeling and lowered workload was a part of every session.

During the six week training session, the experimenter was in close contact with the participant, his medical file, and his fitness therapist. Any changes in his status such as medication use or flare-up of his condition was monitored.

Post-test

At the end of six weeks, each participant in the study was retested individually using a similar protocol to the pretest. The VAS was completed followed by the pain sensitivity measures using the Pain Algometer. The individual was asked about his use of any new therapeutic modality or medication during the course of the six weeks. In addition, the control group participants were also asked of their physical activities during the last six weeks to ensure they did not start an aerobic fitness program. Each participant then completed the aerobic capacity retest using the same protocol as in the pretest. Only 27 participants completed the posttest.

Each participant was debriefed after completion of the posttest. It was emphasized to the individual that the results were of a single study which needed to be confirmed by further studies. However, they were told that a carefully prescribed cycle aerobic program may be beneficial.

Summary

In this quasi-experimental study, the pain response to aerobic training was measured. Twenty seven male participants, all on Worker's compensation benefits from work related injury, were studied. These individuals had pain for longer than six months as a direct result of their injury. They were divided into a treatment group (n=15) and a control group (n=12). The aerobic power of both groups was measured initially as the pretest along with measures of pain. The treatment group underwent a six week cycle aerobic training to increase aerobic power. Both groups were tested at the end of six weeks for differences in aerobic power and measures of pain.

IV. RESULTS

Pre-test Equivalence of Experimental and Control Groups

Background Physical Variables (Age, Weight, and Height)

Researchers at New York's Columbia University, (Marbach, Schwartz & Link, 1992) reported that the choice of an appropriate control group is one of the most difficult problems in the methodology of chronic pain research. Nevertheless, the use of most inferential statistics such as in the pretest-posttest control group design demand equality between the control and treatment groups.

Table 1 shows the descriptive statistics for age, weight, and height which are known to have some influence on aerobic power (Astrand and Rodahl, 1977). No significant difference was noted between the treatment and control groups on these variables. However, in the case of age and weight, one ought not to overlook two points of detail. First, the age spread of the treatment group was larger than for the control group as shown by the standard deviation. The second point worth noting was that on average the experimental group was six kilograms heavier than the control group. This may be indicative of higher activity levels in the control group.

Table 1

Age, Weight, and Height Means for the Treatment and Control Groups

		Physical Characteristics					
Group		Age(yrs)		weight(kg)		Height(cm)	
	n	$\bar{x}$	SD	$\bar{x}$	SD	$\bar{x}$	SD
Treatment	15	30.9	7.2	86.9	17.3	177.6	8.2
Control	12	30.4	3.1	80.9	16.4	177.1	7.2

Aerobic Power

The means of the estimated aerobic power, in millilitres of oxygen per kilogram per minute, for treatment and control groups at the pretest and posttest stages were compared. As noted in Table 2, a significant difference was found between the two groups at pretest level. This initial difference was taken into account when the posttest results for all the variables were considered.

Table 2

Pretest and Posttest Aerobic Power Means of the Treatment and Control Groups

		Time			
Group		Pretest(mlO_2/kg/min)		Posttest(mlO_2/kg/min)	
	n	$\bar{x}$	SD	$\bar{x}$	SD
Treatment	15	30.7	9.0**	38.7	12.3
Control	12	41.0	9.8**	39.3	8.7

Note. The groups showed a significant difference at pretest level, which disappears at posttest. No significant change in body weight occurred.

**p<.01

Pain Sensitivity

Table 3 indicates a significant increase in pain algometer readings for the treatment group at the completion of the training period. This reading was obtained from the painful site which the participant identified at pretest. The site was landmarked and precisely identified so that the identical site was also used for posttest.

The increased reading denotes an increased ability for the individual to tolerate pressure over the site. This is interpreted as decreased pain sensitivity.

The second site on which the pain algometer was used was the anteromedial surface of the right tibia which had no tenderness or injury. The majority of the participants were able to tolerate the maximum force recorded on the algometer of 11 kilograms per squared centimetres. This would indicate that there was no hypersensitivity in the participants. It may also indicate that using a tibial measure was unnecessary for this population.

Experienced Pain

Experienced pain as reported on the VAS was taken prior to the aerobic test at both the pretest and the posttest. Reported pain was significantly decreased in the treatment group at the posttest level. The control group reported no change in pain that was statistically significant as shown in Table 4.

Table 3

Mean Pretest and Posttest Pain Algometer Readings in the Control and Treatment Groups

		Time			
Group		Pretest(kg)		Posttest(kg)	
	n	$\bar{x}$	SD	$\bar{x}$	SD
Treatment	15	3.8	1.7*	5.5	2.8*
Control	12	4.5	3.2	4.9	3.4

Table 3 (continued)

Note. There is a significant increase in ability to tolerate pressure from pretest to posttest in the treatment group. This indicates decreased pain sensitivity.

*p<.05

Table 4

Mean Pretest and Posttest Visual Analogue Scale (VAS) Measures in the Treatment and Control Groups

		Time			
Group		Pretest		Posttest	
	n	$\bar{x}$	SD	$\bar{x}$	SD
Treatment	15	4.6	2.1**	3.6	2.5**
Control	12	4.1	1.9	4.3	1.9

Note. The treatment group showed a significant difference at the pretest and posttest levels. There was no significant change in the control group. VAS measures are between 0 and 10.

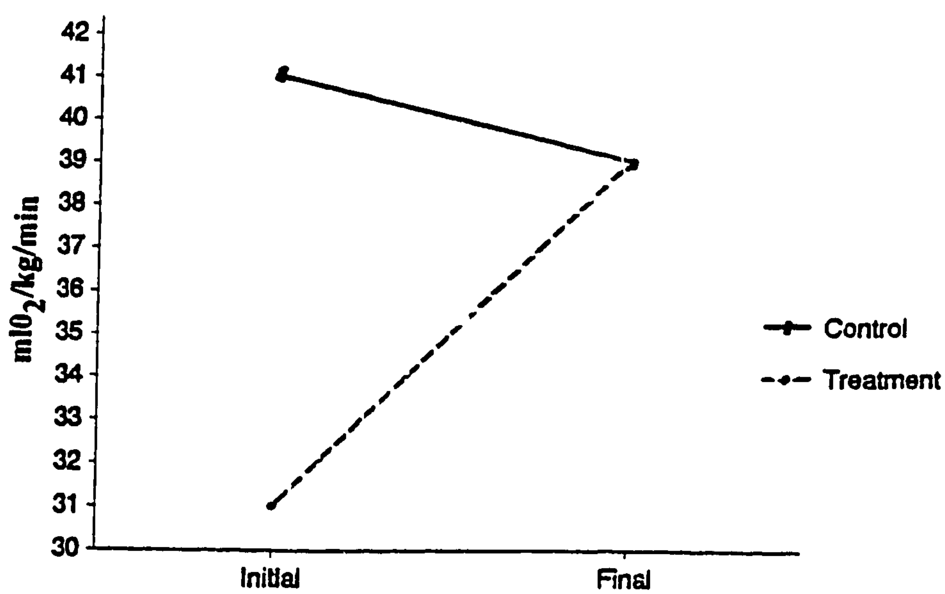
**p<.01

The Effects of Aerobic Training

<u>Aerobic Power</u>

A significant group by time interaction occurred in the aerobic power of the two groups using the two way ANOVA with repeated measures (Appendix F). The treatment group had a significant improvement in aerobic power while the control group almost stayed the same as shown in figure 1. The significant difference between the two groups at pretest, also reported in Table 2, disappeared at posttest due to the increase in aerobic power noted for the treatment group.

<u>FIGURE 1</u>. Group by time interaction for changes in aerobic power in treatment and control groups



Pain Measures

Significant group by time interaction measures were shown for pain measures on the VAS in figure 2 ($p<.01$), and on pain algometry in figure 3 ($p<.05$).

FIGURE 2. Group by time interaction for changes in VAS measures of treatment and control groups

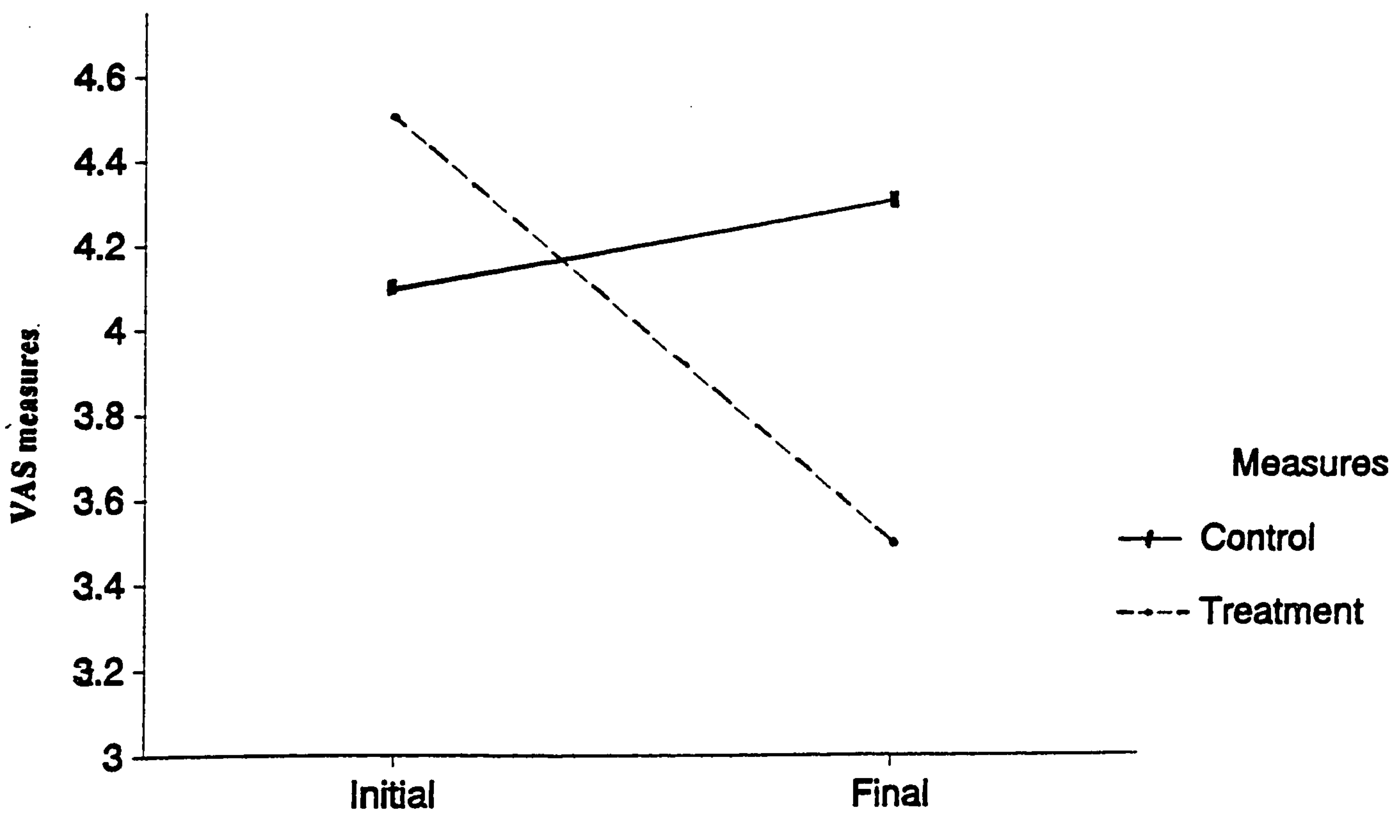
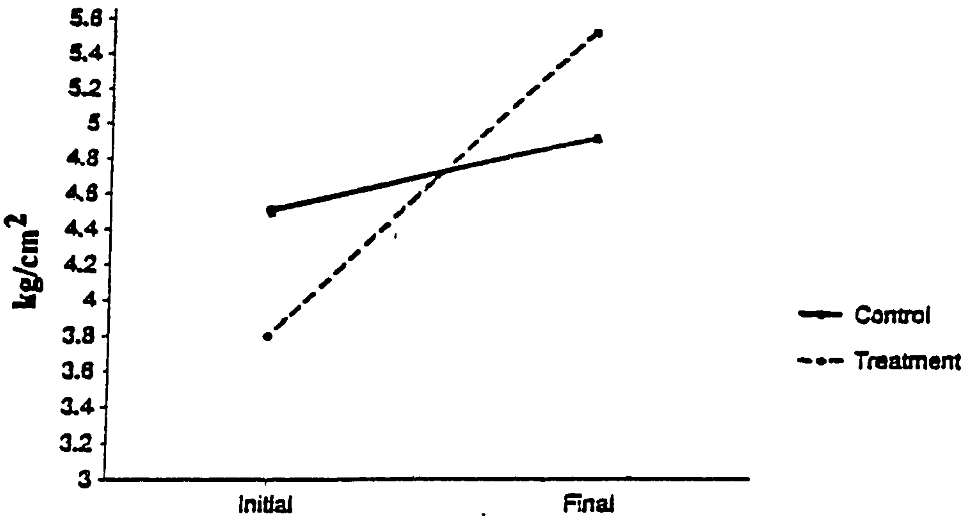


FIGURE 3. **Group by time interaction for Pain Algometry in the treatment and control groups**



Relationship Between Changes in Aerobic Power and Changes in Pain

Pearson correlation coefficients for change in all three variables were calculated and are shown in Table 5. The correlation was performed on combined data from both groups with n=27.

The change in aerobic power correlated negatively with the change in VAS readings ($r = -.38$, $p<.05$). One can interpret this finding as follows. Increasing aerobic power coincides with a decrease in experienced pain as measured by this device, the VAS.

Change in aerobic power correlated positively with the change in pain sensitivity tolerance as measured by pain algometry ($r = .48$, $p<.01$). That is, as aerobic training took effect and aerobic power increased, the individual became less sensitive to pain.

As an additional measure to account for the pretest differences in aerobic power, an Analysis of Covariance, was performed with pretest measures as the covariates. The significance of F for the pain algometry using this procedure was 0.05., and again using ANCOVA, the significance of F for the VAS was 0.02. These results are indeed very similar to the two way ANOVA with repeated measures as shown in Appendix F.

Table 5

Correlation Matrix of Treatment and Control Groups (n=27) on Change Scores for Aerobic Power (Vo_2c), Visual Analogue Scale Scores (VASc), and Pain Algometry (PTMc).

	Vo_2c	VASc	PTMc
Vo_2c	1.00 p=.	-.38* p=.05	.48** p=.01
VASc	-.38* p=.05	1.00 p=.	-.31* p=.12
PTMc	.48** p=.01	-.31* p=.12	1.00 p=.

Note Change in aerobic power coincided with significant changes in reported pain and pain sensitivity.

*p<.05 **P<.01

Summary

Chronic pain clients from work related injury demonstrated the ability to improve their aerobic power on a program of cycle aerobic training. This improved aerobic power coincided with significant reduction in reported pain on the VAS; as well as significant decrease in pain sensitivity as measured by pain algometry.

A significant difference in pretest aerobic power was noted between the groups. This initial difference was taken into account when posttest results for pain measures were considered.

The pretest difference in aerobic power may be due to some self-selection. The control group was recruited by phone and had a much higher refusal rate than the treatment group. Pain clients with an interest in their fitness may be more willing to volunteer for such a study. It was less easy for treatment group members to refuse because of their being clients in the Rehabilitation Centre and so felt somewhat obligated. As well, they were approached in person as opposed to the phone. The pretest-posttest design partially accounted for the inability to randomly assign participants.

V. DISCUSSION AND IMPLICATIONS

Firstly, this chapter will address the support for the initial hypothesis of the study while outlining the limitations of the study. Secondly, I will attempt to present the pain experience from the point of view of the individual identity and his or her "being-in-the-world". I will discuss, within the context of the body schema, the issue of pain, dysfunction, and perceived self-efficacy. Finally, I will give an overview of the implications of my research and the conceptual framework presented in the thesis.

Support for Hypothesis

I hypothesized at the outset that reported pain and pain sensitivity would decrease with improved aerobic power. The results of the study strongly supported this assertion in my population of injured workers. Rather than trying to explain my findings at a "molecular" level, such as increased circulating endorphins, I wish to offer a broad framework within which these findings can be appreciated. Before doing so, I wish to outline the limitations of the study so that a clearer context is given to the discussion.

Limitations of the Study

1. The participants of this study were all Worker's Compensation Board of Alberta clients. The issue of compensation may be an extraneous variable in this study since it has been shown that compensation can affect the period of recovery (Leavitt, 1990).

2. Only male participants (19 to 45 years) were used. This will naturally limit the generalizability of these findings.
3. Individuals who could not cycle on a stationary bike due to cardiovascular risk factors, physical deformity, or danger of pain exacerbation were automatically excluded.
4. Individuals with diagnoses of fibromyalgia or unexplained multiple tender spots were also excluded. An attempt was made to restrict participation to those who neither showed signs of nor reported other rheumatological conditions.

One cannot look at the variables studied in sterile isolation. For a study such as this to be of use, the totality of the pain experience, its meaning, and significance must be incorporated into the findings. Any framework within which we study the variables of pain must countenance this truth.

The Figure-Ground (Field) Representation

All experiences possess meaning which is essential to communication between self and the world. The self-world dialectic then is not a purely objective reality in itself, but a field of phenomena which have particular meanings (Tiemersma, 1989).

Merleau-Ponty (1962) refers to humans as "incarnate beings inhering in the world" with natural and cultural components merging into a single and ultimately

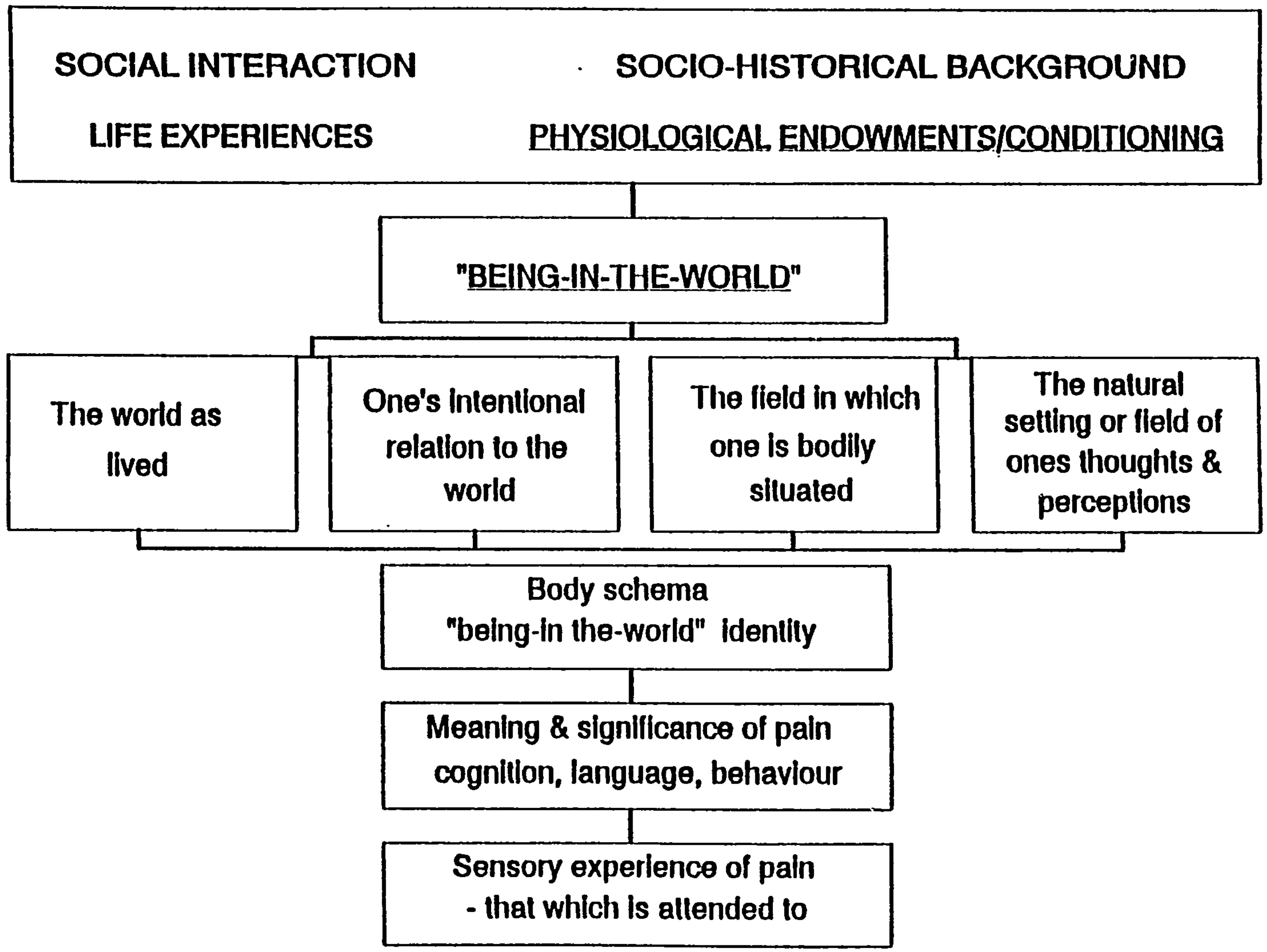


Figure 4: The field from which pain arises

inseparable entity. Our natural world, like our social world, is not merely an amalgamation of individual parts. It is really a permanent field which forms a gestalt, a background to and a part of life experiences in a figure-ground arrangement. This figure-ground relationship is shown in figure 4 in which I attempt to provide a comprehensive backdrop to the pain as experienced. Such a backdrop looks at all potential influences on the individual's life, and so can assist us in determining what pain means to the individual.

I believe that the pain experience must be interpreted and appreciated as a figure set in a field of natural and social life events. The "field" is comprised firstly, of natural events characteristic of and occurring in that physical body presently or having occurred in the past. Aerobic conditioning is important to this portion of the field. Secondly, sociocultural events help to shape human behavior from infancy by embuing life experiences with meaning.

For this reason, an experience like that of chronic pain occurring within its unique natural and sociocultural backdrop possesses meaning and significance for the individual. One dimension of this dynamic that has been neglected is the degree of threat the chronic pain condition presents to the individual. The degree of threat perceived by the client will determine the intensity of reaction to the pain, and likely the extent of the disability. In other words, the level of threat perceived, or the individualized significance of the painful situation will determine the pain behavior.

Perception and Pain Behavior

Every individual reacts to life situations in accordance with his or her perception of the prevailing reality. Bain (1991) describes a participative and a contemplative perception of reality, each of which has a "mature" and an "immature" version. The participative perception is really an organismic response to changing perception of events, while contemplative perception is a suspension of action for analysis and judgement in a situation. Because chronic pain is by definition pain for an unusually protracted period, one would associate it with the judgement and analysis of contemplative perception. However pain behaviors such as moaning and solicitation may indeed be participative rather than contemplative.

Bain (1991) suggested that even in the adult participative perception predominates. For chronic intractable pain such a perception results in the continuation of pain behaviors which are dysfunctional in these clients, tending to lead to catastrophizing of symptoms with diminished self-efficacy.

The art of rehabilitation has to be centred around obtaining a more "mature" type of perception in these clients. Such a level of perception may be generated through the heightened level of self-efficacy which coincides with aerobic endurance training. As Bandura (1982) suggested, self-efficacy can be used as a primary vehicle in behavior change as a result of the alteration in one's perception of himself or herself in the surroundings.

Pain behaviors to the client who has not been rehabilitated represent his or her way of "being-in-the-world" (Merleau-Ponty, 1962). These behaviors come out of one's natural and sociocultural history. In acute pain, these behaviors may be quite appropriate and functional, but for chronic pain they are usually quite dysfunctional, even thwarting recovery.

Pain versus Dysfunction

Effective rehabilitation requires an appreciation of the client's sociocultural background. Rehabilitation also requires a form of "distantiation" (Bain, 1991) in which the client psychologically removes, as much as possible, overall physical function from the association with the pain sensation. Linton (1985) demonstrated that most of the physical dysfunction characteristically seen in chronic pain is an expectation, largely conjured by the client, that pain and dysfunction are in a positively linear relationship.

The strength of such a perceived relationship between pain and level of function has sociocultural underpinnings. For example, the client often believes that the pain and his condition will be alleviated through rest. However rehabilitation of chronic pain requires the inculcation of a "mature" level of perception of the situation. Such perception is characterized by a conscious decision to minimize pain behaviors where dysfunctional, while maximizing perceived self-efficacy.

Endurance training is one means of improving perceived self-efficacy, necessary for change in pain perception and subsequent behavior. This is not an easy task. The sensation of pain exerts a constant pull on the individual's attention for participation in pain behaviors. Though dysfunctional to the recovery process, these behaviors may be immediately gratifying as in the case of successful solicitation of attention from loved ones.

Psychologically distancing pain from physical function and enhancing perceived self-efficacy should be at the heart of rehabilitation. Indeed increasing control over one's body involves distancing oneself from what one is experiencing. "Mature" contemplation in the pain experience necessitates a clear distinction between the body as subject, experiencing pain, and the body as object, capable of willing and executing activity to enhance self-efficacy.

In pain rehabilitation, the client who perceives recovery to be in his or her control, realizable through one's personal efforts, is more apt to be successful (Harkapaa, Jarvikoski, Mellin, Hurri & Luoma, 1990). That is, perceived self-efficacy in the act of coping is directly related to recovery and return to functional living. Indeed, success in effecting recovery is determined by the effectiveness of integrating the body schema with the individual treatment process.

The Body Schema and the Treatment Process

The body schema is the result of the cognitive organization and structure induced by the interaction with one's environment (Piaget, 1966). Pain behavior is but a representation of the sensitization one has had in one's environment to the reaction to illness and pain.

Merleau-Ponty (1962) described the body as having two distinct layers, the "habitual body" and the "present body". The habitual body as described by Merleau-Ponty is really one's existing orientation to experiences or the nature of one's "being-in-the-world". The habitual body coincides with the ground in the figure-ground representation of experiences. The client with pain is an example of the reported state of Merleau-Ponty's "present body".

Rehabilitation may in fact be best suited by trying to impact the habitual body rather than the present body. Merleau-Ponty talks of a "modified habitual body". This modification would really be an attempt to influence the pain experience in the present body, not by directly altering the figure, but by modifying the ground. By so doing one can hope for a deeper, more solid, and meaningful rehabilitation.

Such rehabilitation attempts to strike at behavior patterns which have been deposited in the form of [illegible] al world (Merleau-Ponty, 1962). The psychosocial world, the ph[illegible]y, and the past, form the habitual body, a backdrop to our actio[illegible] to which we have an opening. The dynamics within the field influence the total structure of the field which in turn motivate the figure or subject, in this case the chronic pain client.

Aerobic endurance training with its noted effects on mood and perception should be considered a force in the "field" of the client. This force is designed to motivate him or her to a new conceptualization of the pain experience, so promoting a "modified habitual body". A new conceptualization makes for adaptive behaviors which are functional and useful. The improved self-efficacy creates harmony between the client's intentions and his or her performance. Such harmony is effective rehabilitation and the ultimate strategy for coping in chronic pain.

Conclusions and Implications

Bain (1991) talks of "body-flexibility" in the perceptive sense as connoting a certain maturity in the body schema. Such maturity allows the individual to distance himself or herself from that being experienced, instead of being lost in organic sensation with the compulsion to react. This process is helped by aerobic training.

Phenomenologists view the body as an expressive space into which behaviors can be incorporated. New behaviors alter the fundamental premise of "being-in-the-world", that is, the fundamental premise of existence. Merleau-Ponty (1962) sees this existence as the base of a metaphorical tree whose trunk is body schema and the branches being perception, cognition, and behavior. The endurance program can alter this base or field and so meaningfully impact on pain perception, albeit indirectly. The training alters the body schema through changes in perceived efficacy and generally one's daily activities, so altering one's worldly existence.

The implications for endurance training in the rehabilitation of chronic pain should be looked at not only in the improvement of physical capacity for the client, but from a broader perspective of perception, body schema, and the clients *milieu naturel* or act of "being-in-the-world". Such a view presents rehabilitation of chronic pain with a challenge to be comprehensive yet empathetic.

Further research in the area of pain should measure an operationalized version of self-efficacy. Stronger controls on participant selection while outlining differences within the chronic pain population makes for important research in furthering this body of knowledge.

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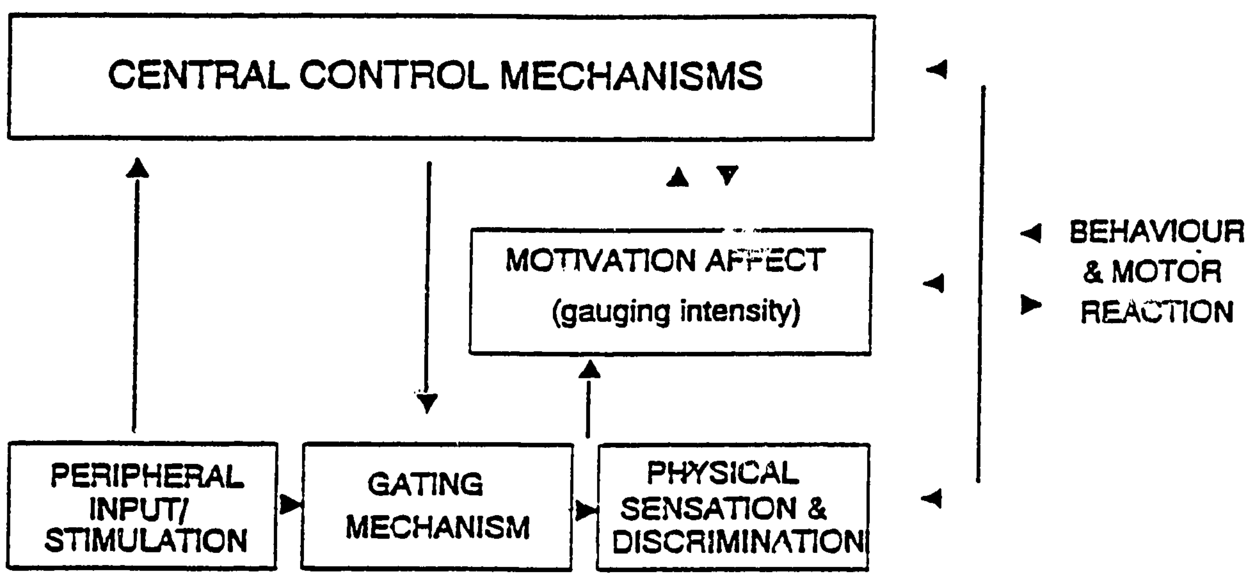
Appendix A

The Gate Control Paradigm

This is an interpretation of the Gate Control Theory according to Melzack and Wall (1965).



Appendix B

Criteria For the Study

This study, approved by the Worker's Compensation Board Rehabilitation Centre Research Committee, looks at the impact of cycle aerobic training on chronic pain from work related injury. Participants are being sought from WCB clientele at the Rehabilitation Centre and from the waiting list. All participants will be expected to complete an informed consent form prior to the program.

The specific criteria for participation are as follows:

1. Males aged 19 to 45 years.
2. No surgery known to be pending.
3. Time since injury greater than six months.
4. No history of fibrositis or fibromyalgia.
5. No history of multiple undiagnosed pain.
6. No history of heart ailments or high blood pressure.
7. No leg stiffness or cramps which may curtail cycling.

....

Hercules Grant.

Appendix C

Informed Consent For Investigative Study.

The Impact of Aerobic Endurance on Chronic Pain From Work Related Injury.

I,..(Print Name), agree to participate in the above named study conducted by Mr. Hercules Grant, a graduate student in Educational Psychology at the University of Alberta.

In this study you may be asked to participate in the following:

1. You may be asked to cycle for about 20 minutes four time per week over a six week period.
2. Your blood pressure and heart rate will be monitored at various stages of your training.
3. You will have your fitness level tested for cycling activity before and after this training program.
4. Estimation of your pain level will be taken at the beginning and end of your program.

I acknowledge that I have read this form and understand the test and training procedures to be administered as well as the purpose of the study. The potential risks have been explained to me and I realize that I am under no obligation to take part or continue if I am in any way uncomfortable. I will discontinue this program if I experience chest pain, breathlessness, dizziness or excessive fatigue. I understand that I can withdraw at any time without penalty, and that my records will be kept confidential by the researcher.

Signature of Participant

Date

Signature of Witness

Appendix D

Participant Information Form

Name:

Diagnosis:

Date of Accident:

	Initial score	Final score
Aerobic Capacity	__________	__________

Pain Algometry

(pain site)

(tibia)

Visual Analogue Scale

0______________________________________**10**

No Pain **Worst Pain Imaginable**

Appendix E

The Modified Astrand Test

The following is the test protocol used at the WCB Rehabilitation Centre Fitness Unit and used on the subjects of this study.

This test follows the principles of the Astrand Test. No rest periods are given between stages which are each four minutes long.

Equipment

Monark Bicycle Ergometer 818

Heart rate monitoring equipment, Sporttester PE3000

Blood Pressure cuff and stethoscope, Tycos Sphygmomanometer

Protocol

1. Adjust the seat on the bicycle ergometer.
2. Take the resting blood pressure while the client sits on the bike.
3. Attach heart rate monitoring equipment and take resting heart rate.
4. Have client pedal for four minutes at a warm-up resistance; then for a further four minutes at a resistance to achieve a heart rate in the target zone (depending on the client's ability to do so).
5. Measure heart rate and blood pressure at four minutes.
6. The second workload should be at an intensity which will achieve a heart rate in the target zone (200

minus client's age to 170 minus client's age). This may or may not be possible depending on the client's injury.

7. Record heart rate at the seventh and eighth minute marks.
8. Record post-exercise heart rate and blood pressure between 30 seconds and one minute and between 2.5 and 3 minutes.
9. The aerobic capacity is then calculated by inputting the above information on heart rate, blood pressure and workload along with age, weight, and height into the computer program CSTF 3 University of Alberta Version.

(This information has been supplied by The WCB Fitness Unit, Edmonton, Alberta).

Appendix F

Results of Two Way Analysis of Variance Showing Group by Time Effect For Each Variable: Aerobic Power, Pain Algometry, VAS

Aerobic Power

Source of Prob. Variation	Sum of Squares	DF	Mean Square	F Ratio
Within+Residual	326.9	25	13.1	
Time	135.9	1	135.9	10.4
Group by Time	311.6	1	311.6	23.8**

**p<.01

Pain Algometry

Source of Prob. Variation	Sum of Squares	DF	Mean Square	F Ratio
Within+Residual	31.0	25	1.2	
Time	13.1	1	13.1	10.5
Group by Time	5.2	1	5.2	4.2*

*p<.05

Visual Analogue Scale Reading

Source of Prob. Variation	Sum of Squares	DF	Mean Square	F Ratio
Within+Residual	14.5	25	.6	
Time	2.6	1	2.6	4.4
Group by Time	4.2	1	4.2	7.3**

**p<.01