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UNIVERSITY OF ALBERTA

ATHLETIC PAIN IN COMPETITIVE SWIMMING

BY

BLAIR GARNET WHITMARSH

A thesis submitted to the Faculty of Graduate Studies and Research

in partial fulfillment of the requirements for the degree of

DOCTOR OF PHILOSOPHY

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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 **ATHLETIC PAIN IN COMPETITIVE SWIMMING** submitted by **BLAIR GARNET WHITMARSH** in partial fulfillment of the requirements for the degree of **DOCTOR OF PHILOSOPHY**.

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DEDICATION

This work is dedicated in memory of my Dad, GARFIELD GARNET WHITMARSH. He was a wonderful, loving father who always encouraged me and told me that I could do anything that I desired. I am eternally grateful for his love, patience, instruction and mentoring that he so willingly gave. I love him very much and will never forget him.

ABSTRACT

The athlete who demonstrates a higher pain tolerance in most situations is expected to achieve a higher level of performance than the athlete who possesses a lower level of pain tolerance (Hogg, 1992). This dissertation presents a three-study examination of athletic pain in competitive swimming. The first two studies examined a cognitive-behavioral pain management program for athletes using a single-subject research design. The third study was an in-depth look at the way that competitive swimmers experience pain in their sport and the ways in which they attempt to deal with it. The third study was a phenomenologically based study within a qualitative research design and was conducted with competitive swimmers from a provincial and national competitive level. The global objective of all three studies was to determine if an athlete's ability to tolerate high levels of pain can be improved through a mental skills training program designed specifically for athletes involved in repetitive, aerobically based sports such as running, cycling, or competitive swimming. The results from the first two studies indicated that while the mental skills training did help some of the swimmers improve their performance on the swimming tests and pain tolerance indicators, most of the swimmers did not improve to a statistically significant degree. The third study was designed to re-evaluate the role that pain and the tolerance of pain

plays in swimming performance. A phenomenological research method was utilized to gain a greater understanding of pain perception with competitive swimmers. Interview data was analyzed using the concept mapping methodology which resulted in the development of a concept map that included seven pain perception themes: description of pain, experiential effects of pain, coping techniques, importance of mental attitude, the interaction of situational significance, emotional consequences, and acknowledgment of pain in competitive swimming.

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CHAPTER 1

Introduction

Throughout life people are confronted with many situations in which the ability to tolerate pain is extremely important. Individuals undergoing major surgery, or those suffering from a terminal illness, must cope with severe pain on a daily basis. Women in labor must also endure intense pain. Increased pain tolerance is, in fact, beneficial in most medical and dental procedures. The characteristics of high pain tolerance, however, are beneficial not only to the medical field, but are also desirable in the area of athletics. It is generally believed by coaches that the athlete who has a high level of pain tolerance is, in most situations, more likely to achieve a higher level of performance than the athlete with a low level of pain tolerance.

Different types of pain may be associated with different sports. The pain experienced in boxing is different from that experienced in hockey, which differs yet again from that experienced in endurance sports like competitive running and swimming. Boxing pain may be characterized as intense pain lasting a relatively short period of time, while the pain experienced in endurance sports may be characterized by extreme discomfort, lasting for a long period of time.

Furthermore, athletes are not equal in their ability to tolerate pain. Pain tolerance is probably a learned skill, and may even be the most important psychological skill that an athlete can develop. It is surprising that sport researchers and coaches do not make an effort to develop this mental ability to its full potential

Overview of the Problem

Coaches and athletes of repetitive, aerobically based sports indicate that athletic pain is part of the sport experience. Pain is defined as "an unpleasant sensory and emotional experience associated with actual or potential tissue damage, or described in terms of such damage" (International Association for the Study of Pain, [cited in Weisenberg, Friedman, Sieglaub, Colleen, 1987]). Following extensive involvement with the Canadian Swimming Team (1980-92) as sport psychology consultant, Hogg (1992) stated that the ability to tolerate high levels of athletic pain is a key factor in athletic success. The athlete who demonstrates a higher pain tolerance in most situations is expected to achieve a higher level of performance than the athlete who possesses a lower level of pain tolerance. As well, Hogg (1992) observed that athletes who cognitively push themselves to their limits actually perceive themselves as more satisfied with both the performance process and performance outcome.

A research program in athletic pain tolerance is justified for both practical and theoretical reasons. From a practical perspective, busy schedules have

dictated that swim coaches and their swimmers spend relatively little time developing the psychological ability of pain tolerance to its full potential; therefore, in order for a psychological intervention program to be utilized in a training setting it must be effective, relevant and easy to administer. Since cognitive-behavioral programs have been demonstrated to be effective in improving medical and/or clinical pain tolerance (Berntzen, 1987; Fernandez and Turk, 1989; Miechenhaum, 1985) , a sport-specific program may be effective in improving athletic pain tolerance in a field setting (Whitmarsh and Alderman, 1993).

From a theoretical perspective, pain tolerance research in the sport setting has been limited. The majority of existing research deals with a comparison of the pain tolerance of different types of athletes (Ryan and Kovacic, 1966; Egan, 1987) and the pain tolerance for athletes with injury (Ievleva and Orlick, 1991; Masters and Lambert, 1989; Nideffer, 1983). Morgan (1978, 1980) has conducted research in pain tolerance with injury free marathon runners while others (Scott and Gijsbers, 1981; O'Connor, 1992; Unestahl, 1992) have conducted research based on Morgan's work with associative and dissociative styles of attention-distraction. Other research pertaining to increasing pain tolerance of the injury free athlete in an attempt to improve performance has been conducted by McCall and Malott, 1984, and Williams and Kinney, 1991.

This dissertation involves a series of three related studies. The first two

studies examine a cognitive-behavioral pain management program for athletes using a single-subject research design. All subjects in the first two studies are from the sport of competitive swimming. The third study is an in-depth look at the way that competitive swimmers experience pain in their sport and the ways in which they attempt to deal with it. This study is a phenomenological study conducted with provincial and national level competitive. The overall objective of the research program was to determine if an athlete's ability to tolerate high levels of pain can be improved through a mental skills training program designed specifically for athletes from repetitive, aerobically based sports.

Statement of the Problem

Toleration of high levels of pain is invariably required for success in certain sports. Bill Koch, silver medalist at the 1976 Olympics in the 30 km cross country skiing race, reported that 90 percent of his success could be attributed to his ability to tolerate pain (Iso-Ahola and Hatfield, 1986) and Greg LeMond, three time winner of the Tour de France (considered by many to be the most gruelling race in sport) is quoted as saying, " ... the best climbers are those ones who can stand the most pain ... in pro cycling everything hurts, but you just ride through it (Avins, [cited in Egan, 1987])." Competitive swimming is similar to such other endurance sports as track, cross country skiing and cycling. One member of the Canadian swim team stated, "In the middle of the race I start hurting (physically) and it is

really hard because that is when I hurt the most. At the end of the race there is physical pain but I know that I am done so I can deal with it." However, all athletes are not equal in their ability to tolerate the pain and discomfort associated with both training and competition. Pain control or tolerance is dependent upon psychological factors and is therefore likely a learned or acquired skill (Melzack and Wall, 1988; Woodrow, Friedman, Sieglaub, and Colleen, 1972). Besides tolerating pain, the self-awareness of how much pain can be psychologically controlled, the length of time that pain can be controlled, and the effects of pain on performance is a significant skill that an elite athlete should develop. Like most of the psychological skills, the ability to tolerate high levels of athletic pain is equally important in training as it is in competition. In fact, endurance athletes spend many more hours training than they do in competition and the ability to push through hard training makes the competitions seem that much easier. Hogg (1992) indicated that many national level swimmers, devoid of this skill, failed to fulfil the intent of the stressful training sets especially at high altitude camp and consequently lost out on the true training potential. In other words, swimmers unable to manage the pain associated with the use of high altitude training protocols were unable to take full advantage of the training benefits that high altitude training is believed to offer.

While pain tolerance research in the sport setting has been limited, considerable research has been conducted in perceived exertion with endurance

athletes. It is true that the concept of perceived exertion (Borg and Noble, 1974; Pandolf, 1987) is related to athletic pain tolerance. However, there is a distinction that must be made between the athlete experiencing pain and/or discomfort and the athlete's rating of perceived exertion (RPE). Pandolf (1987) stated that perceived exertion is a global term that comprises local and central physiological determinants of RPE . Athletic pain tolerance is a sensory and emotional experience (Egan, 1987; Fernandez and Milburn, 1994; Heil, 1995; and Matlin and Foley, 1992) and is a by-product of the exertion level. In other words, a competitive swimmer must exert themselves at a high level to be competitive in the swimming environment. As a result of the high exertion level, the swimmer will most likely experience a high level of athletic pain The purpose of a mental skills program to control for athletic pain is to decrease the debilitating effects of physical pain while maintaining a high RPE.

A second distinction is made between the athlete who experiences pain as a result of an injury and the healthy athlete who is experiencing pain/discomfort over time as a natural part of the athletic experience. An athlete who is injured should be involved in rest and rehabilitation or risk the chance of further injury. The sensory and emotional aspects of pain make it essential for a mental skills program to include cognitive restructuring to assist athletes in pain perception. Cognitive restructuring or reframing consists of changing negative, debilitating perceptions into positive, beneficial ones. In this way, the mental skills program

can assist athletes to distinguish between the pain that is natural to athletics and the pain that causes or aggravates injury.

Implications for the Sport of Swimming and Sport in General

The sport of swimming has come to a point where swimmers follow the same kind of training programs and share similar physiological and technical attributes. It is the use of psychological skills that separate superior swimmers from good swimmers with potential (Hogg, 1995; Maglischo, 1993). Swimmers who are self-aware of their own strengths and weaknesses, use appropriate goal-setting techniques, and are able to employ mental skills to create the ideal performance and emotional states are more likely to achieve optimal performances. However, according to Hogg (1995), athletes are not as well versed in mental skills as coaches often presume. Hogg (1992; 1995) observed that swimmers trained in mental skills used them to advantage and enjoyed greater performance satisfaction. However, a large number of swimmers have not fully explored their mental possibilities. Hannula (cited in Hogg, 1995) stated that it is important for coaches to recognize that if they want their athletes to undergo and sustain training over an extended period, then mental skills must be taught and applied by coaches and swimmers alike. Since it is recognized that mental skills are extremely valuable for both coaches and athletes it is important to conduct meaningful research that examines the effectiveness of specific programs of mental skill

acquisition.

The results from this dissertation will have four important implications for mental skill acquisition within sport in general as well as specifically for competitive swimming.

1. This dissertation will provide an indepth and realistic assessment of the effectiveness of a sport-specific cognitive-behavioral program in improving athletic pain tolerance.
2. Swimming is a training-orientated sport in which high physiological and psychological demands are placed upon the athlete. A program that is effective in assisting athletes to overcome these demands and understand their physical limits would be beneficial to the sport of competitive swimming.
3. An effective sport-specific cognitive-behavioral program will have an effect on coaching practices and athlete understanding of sport especially in terms of sufficient time devoted to mental preparation to balance physical preparation. Specifically, it will help coaches teach athletes to be sensitive to pain and to diminish the debilitating effects of pain.
4. Appropriate mind set techniques accompanied with physical training that is specifically controlled in terms of intensity will bear a greater

effect than physical training that is unaccompanied by the integration of mental skills.

Theoretical Approach to Pain

Very little is known about the pain receptors in the body primarily because the attention of physiological investigators has largely been focussed on the afferent nerve fibres rather than the receptors (Rollman, 1991). However, it would appear that pain receptors are free nerve endings that act in a nonspecific manner. The free nerve endings may be activated by temperature, mechanical stimuli, or chemicals released by damaged tissue.

The afferent nerve fibres are divided into three distinct groups based upon their diameter, rate of conducting impulse and absence or presence of the myelin sheath. The three groups are: the myelinated A-beta and A-delta fibres and the unmyelinated C-fibres. The A-beta fibres with a diameter of 5 to 20 microns (a micron is one-thousandth of a millimetre) are relatively large, rapidly conducting (30-100 m/s), and maximally responsive to weak mechanical stimulation and light pressure. The A-beta fibres mediate epicritic/phasic pain which is associated with early warning and is identified with pain that is characterized by a sharp and pricking sensation (Chakour, Gibson, Bradbeer, and Helme, 1996). The A-delta fibres have an intermediate size of 1 to 5 microns, a moderate conduction velocity (5-10 m/s), and respond best to intense pressure, heat or chemical stimulation.

These fibres have often been labeled "myelinated nociceptors" because of their high threshold and the finding that stimulation of A-delta fibres often give rise to a sharp, pricking pain that is similar to the A-beta fibres but at a more intense level. The unmyelinated C-fibres have a narrow size of .3 to 2 microns and are slow conductors (1-2 m/s). They are the most common fibre in most peripheral nerves and respond best to noxious levels of stimulation in their small receptive fields (Rollman, 1991; Melzack and Wall, 1988). They have been implicated in protopathic/topic pain perception that is often described as dull, burning or aching resulting in the institution of protective behaviors (Chakour et al., 1996). The fibres weave an intricate course into the spinal cord where they bifurcate and ascend or descend several spinal segments (Jaros, 1991). They eventually enter the gray matter of the cord, wherein they synapse on intermediate neurons or tracts.

In 1965, Melzack and Wall proposed the gate-control theory of pain in an attempt to bring together the strengths from past theories, namely specificity theory and pattern theory, into a comprehensive theory of pain. The specificity theory of pain uses the designation of free nerve endings as specific pain receptors in tissue which project via pain fibres and a pain pathway to the pain centres in the brain. The assumption that receptors are specialized has been proven true and is included in the gate-control theory of pain (Melzack and Wall, 1988). The pattern theory of pain proposes that stimulus intensity and central summation are the

critical determinants of pain. According to pattern theory, pain results when excessive stimulation of receptors and pathological conditions cause the total output of cells to exceed a critical level (Weisenberg, 1975).

Melzack and Wall's theory proposes that a neural mechanism in the dorsal horns of the spinal cord acts like a gate which controls the flow of nerve impulses from peripheral fibres to the central nervous system. The degree to which the flow of nerve impulses increases or decreases is regulated by the afferent nerve fibres and by influences from the higher brain centres. When the amount of information passing through the gates exceeds a critical level, it activates three different neural areas responsible for pain experience.

The three neural areas or systems are called the sensory-discriminative system, the motivational-affective system, and the cognitive-evaluative system. The sensory-discriminative system carries information concerning the location and intensity of the stimulation. The motivational-affective system carries information about the escape behaviors and aversive qualities of the stimulation or suffering. The cognitive-evaluative system subserves the interpretation of the pain experience (Rollman, 1991). The three systems then correspond to the central control process and interact a part of a parallel processing network (Melzack and Casey, 1968) or as part of a sequential processing network (Price, 1988) to provide pain information to the brain. The central control process can either open or close the gate by activating the large (C) fibres. Thus, modification of cognitive processes

such as adaptive expectations or attentional focus could function to close the gate and reduce pain (Beach, 1981).

The interest of the gate-control theory for the field of sport psychology is that the theory contains an element of cognitive control for both physiological and psychological pain. It proposes that anxiety, attention and past experience can effect the pain process. It seems that some central activities such as high arousal or anxiety may open or close the gates to all bodily inputs. Therefore, maladaptive activities (ie. arousal or anxiety) must be identified and inhibited before the mechanism responsible for pain perception is activated (Melzack and Wall, 1988).

The input that triggers pain is often referred to as noxious stimulation. However there is little neurological evidence of noxious stimulation; each stimulus only generates a wave of energy that travels along a neural pathway (Pen and Fisher, 1994). In other words, what makes these waves of stimuli noxious is how a person perceives and recognizes them (Brena, 1972). Pain has a distinctly unpleasant, affective quality. It can be overwhelming, demand immediate attention, disrupt ongoing behavior and thought, and motivate individuals to stop the pain as quickly as possible. It can lead to needless disruptions of functional coping behavior. This is why certain athletes have higher or lower pain tolerance levels than others. The ability to tolerate pain is largely dependent on how an individual perceives the pain experience (Pen and Fisher, 1994).

The brain maintains a moment-to-moment awareness of both the body and the

surrounding physical environment. With each new stimulus the brain takes notice, adjusts, organizes, and evaluates each new stimulus. Chapman (1980) states that this ongoing process is termed perception and the pain experience is one aspect of perception. The varied reactions to pain can be explained largely by the athletes' level of anxiety, previous experience with pain, the attitude of the athlete, and the coping mechanism available to the athlete (Chapman, 1980). Any painful situation that attracts prolonged attention will surely have an affect on the performance of the athlete.

The parallel-processing model, however, proposes a different mechanism (Dar and Leventhal, 1993; Leventhal and Everhart, 1980). This model suggests that individuals, through experience with noxious stimuli, form a schema that represents both the sensory and emotional aspects of the pain experience which could be likened to the sensory-discriminative and motivational-affective systems of the gate-control theory. Further pain encounters will invoke the existing schema and make adjustments that reflect overall pain experiences if necessary. The pain schema contains a representation of the noxious stimulus together with related emotions, sensations, and images which become associated with the noxious stimulus through previous experience. The pain schema acts as an attention selector. In other words, the schema determines which aspects of the pain experience will enter focal awareness.

Taylor and Crocker (1981) (cited in Dar & Leventhal, 1993) state that a pain

schema causes the stimulus to be perceived in a way consistent with the structure of the schema and would bias the interpretation and perception of the noxious stimulus. Since pain is most often associated with distress, the parallel-processing model assumes that the pain schema is a distress schema. Therefore, when one experiences pain, the components of the situation that are congruent with the schema are brought into awareness. The sensory features are processed simultaneously with the fear, anger and other distress emotions elicited by the stimulus. When individuals are instructed to attend solely to the sensory features of the stimulus, the existing schema is overridden. The experience is then construed mainly in terms of its sensory features. If negative emotions associated with pain increase suffering and make the experience more "painful" it only makes sense that processing the noxious stimulus as a primarily sensory experience should reduce the pain and distress (Dar and Leventhal, 1993).

This begins to have a carryover effect by altering the pain schema to be more sensory based rather than emotionally based. The distress schema begins to be replaced by a sensory schema. This new sensory schema directs an athlete to focus attention on the noxious stimulus in subsequent exposures. Dar and Leventhal (1993) state that the new sensory schema causes a person to perceive primarily the sensory features of the stimulus rather than the emotional, distress-provoking features. This was confirmed with research that showed that providing athletes with some type of sensory information to describe their cold-pain

experience will decrease their perceived pain during cold immersion (Carman and Knight, 1992; Ingersoll and Mangus, 1992; Streator, Ingersoll, and Knight, 1995).

Operational Definitions

It is possible that several of the concepts below have broader, general meanings in other disciplines. However, in this dissertation the concepts are operationally defined within the context of the pain management program thus delimited, specific definitions are given.

Application and Follow-Through - the third and final phase of stress inoculation training in which clients apply the knowledge and skills acquired during the first two phases of the training.

Attention Diversion - a mode of thinking in which the individual concentrates on something else in order to alleviate a stressful or painful situation. This may be done by concentrating on physiological and /or technical demands during an activity (internal) or by intentionally focussing one's thoughts on something completely different than the activity currently engaged (external).

Cognitive-Behavioral Approach - the cognitive-behavioral approach to mental skills training consists of using both cognitive and behavioral methods to make behavior change. Cognitive methods include providing information about an upcoming event, distraction, imagery and self-calming statements. Behavioral techniques attempt to modify pain through behavior modification or physical

intervention and include methods such as relaxation, biofeedback, desensitization, modelling, and assertion training (Turk, Meichenbaum, and Genest, 1983).

Conceptualization - the first phase of stress inoculation training in which clients receive education from a theoretical perspective about their problem situation.

Critical Swimming Velocity - swimming velocity that can be maintained without exhaustion over a long period of time (Smith, 1992).

Discomfort - unpleasant sensory and emotional experience associated with the athletic experience. Discomfort is a natural part of the athletic experience and is not physically harmful to the athlete (Whitmarsh and Alderman, 1993).

Gate-Control Theory - a comprehensive theory of pain that accounts for the influence of psychological processes on pain perception and response. It is the first theory to successfully demonstrate a link between the physiological and psychological influences of pain perception and to recognize that modifying pain through a variety of cognitive interventions is possible. Originally developed in 1965 by Melzack and Wall. (Beach, 1981; Melzack and Wall, 1988).

In Vitro - practicing newly acquired psychological skills through the use of imaginal situations.

In Vivo - practicing newly acquired psychological skills through the use of real-

life situations.

Pain - refers to an unpleasant sensory and emotional experience associated with actual or potential tissue damage, or described in terms of such damage. (International Association for the Study of Pain [cited in Weisenberg, 1987]).

Pain Perception - awareness of pain through physical sensation and affective evaluation of its effects. It is a complex phenomenon that involves physiological factors, pain tolerance, pain related memories, goals, self-appraisals, self-efficacy attributions, problem-solving skills, and cognitive skills (Jensen and Karoly, 1992).

Pain Threshold - refers to the level of stimulus at which the subject first recognizes pain or discomfort. This is more dependent upon physiological factors (Merskey and Spear, 1967 [cited in Woodrow et al., 1972]).

Pain Tolerance - refers to the level of stimulus at which the subject can no longer tolerate the pain and must attempt to decrease the severity of the stimulus. This is more dependent on psychological factors (Mersky and Spear, 1967[cited in Woodrow et al., 1972]). According to Maglischo (1993), pain tolerance is one factor that affects a swimmer's ability to maintain fast speeds. Swimmers who can tolerate more pain can swim at maximal speed for greater distances.

Physical Discomfort - an uncomfortable, but natural part of the athletic experience which is not physically harmful to the athlete. An example of this

would be the discomfort experienced by a swimmer near the end of a 1500 metre freestyle or 400 metre individual medley.

Skills Acquisition - the middle phase of stress inoculation training which provides clients with psychological skills to assist them in handling their problem situation.

Stress Inoculation Training (SIT) - a treatment program made up from a variety of stress inoculation techniques to help clients deal with psychological stress and pain. The SIT paradigm consists of three phases: conceptualization, skills acquisition and rehearsal, and application and follow-through.

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CHAPTER 2

Examination of a Cognitive-Behavioral Pain Management Program for Increasing Athletic Pain Tolerance with Competitive Swimmers

The ability to tolerate pain is an important life skill because throughout life people are confronted with a variety of painful situations. Thus, the ability to tolerate and control physical pain through the use of a positive psychological mind set is of particular importance. However, not only is the ability to tolerate moderate to high pain important for success in life, it is of added importance for the elite swimmer. Given equal physical attributes, the athlete who demonstrates a higher pain tolerance would be expected to achieve a higher level of performance in most situations than the athlete who possesses a lower level of pain tolerance. As well, it has been observed that athletes who cognitively push themselves to their physical and mental limits actually perceive themselves as more satisfied with both the performance process and the performance outcome (Hogg, 1992).

There are different definitions of "pain". However, the currently accepted definition by the International Association for the Study of Pain (Merskey, 1986), is "an unpleasant sensory and emotional experience associated with actual or potential tissue damage, or described in terms of such damage". As indicated by

Price (1988), the critical aspect of this definition is that it defines pain in terms of human experience and not in terms of the stimulus. As well, this definition acknowledges two important elements of pain. These are: (a) a sensory perception associated with actual or potential tissue damage, and (b) an unpleasant emotional feeling accompanying this sensory perception.

Since an important element of the definition of pain is the existence of actual or possible tissue damage, how can coaches and sport psychologists ethically train athletes to tolerate higher levels of pain without leading them to injury? Terminally ill patients or women in childbirth labor are trained to tolerate pain to improve their life quality because the pain is inevitable. In other words, their situation dictates that they will experience pain and they must learn to live with it the best they can. For the athlete it is different. Athletes have two choices that they can make in painful athletic situations. They can choose to stop training and competing which will eliminate the pain along with the potential training effect or they can continue training and learn to cope more effectively with the expected or experienced physical pain.

With this in mind, a distinction is made between the athlete who experiences pain as a result of an injury and the healthy athlete who is experiencing pain/ physical discomfort as a natural part of training or competition. The athlete who is experiencing physical pain associated with tissue damage should be involved in a rest and rehabilitation program. However, the athlete who

is experiencing physical discomfort (ie. no actual or potential tissue damage) must learn to more effectively cope with that discomfort. Physical discomfort may be appropriately defined as "an unpleasant and sensory emotional experience with no actual or potential tissue damage, however, often described in terms of such damage." Therefore, it is important that any cognitive-behavioral program designed to improve athletic tolerance of physical discomfort include an element of accurate pain perception

A second distinction is made between the athlete experiencing physical discomfort and an athlete's rating of perceived exertion (RPE). The concepts of perceived exertion (Borg and Noble, 1974; Pandolf, 1987) and athletic pain (Hogg, 1995; Whitmarsh and Alderman, 1993) are at times used synonymously by athletes and coaches. However, there is a distinction between the two concepts. Pandolf (1987) stated that perceived exertion is a global term that comprises local and central physiological determinants of RPE . The intensity of the athletic pain is somewhat dependent upon the levels of exertion and fatigue. Athletic pain is therefore a by-product of the exertion level. The purpose of the cognitive-behavioral program for the control of athletic pain is to decrease the debilitating effects of the pain while maintaining a high RPE.

In 1965, Melzack and Wall proposed the gate-control theory of pain in an attempt to bring together strengths from past theories into a comprehensive theory of pain. Melzack and Wall (1988) proposed that a neural mechanism in the dorsal

horns of the spinal cord acts like a gate and controls the flow of nerve impulses from peripheral fibres to the central nervous system. The degree to which the flow of nerve impulses increases or decreases is regulated by the large and small fibres and by influences from the brain. When the flow of nerve impulses exceeds the critical level the neural areas responsible for pain experience are activated.

The relevance of the gate-control theory to the field of sport psychology is that the theory contains an element of cognitive control. It proposes that anxiety, attention and past experience can effect the pain process. It seems that some central activities such as excitement or anxiety may open or close the gates to all bodily inputs. Therefore, maladaptive signals from the body must be identified and inhibited before the mechanism responsible for pain perception is activated (Melzack and Wall, 1983).

The term "cognitive approach", with respect to pain tolerance, implies a technique in which pain is managed through thought and belief. The central assumption of the cognitive approach is that an athlete's expectations, ideas, and "cognitions" of his or her environment can influence what he or she will see and feel. Faulty cognitions and irrational beliefs can lead to anxiety, increased sympathetic nervous system activity and, ultimately, worry, stress and pain. Cognitive methods, therefore, include such techniques as providing information about an upcoming event and teaching individuals to use cognitive coping skills such as distraction, imagery and calming self-statements (Tan, 1982; Beauchamp,

Halliwell, Fournier, & Koestner, 1996; Hogg,1995, 1997b; Thomas & Fogarty, 1997).

Beach (1981) proposes that coping skills can be divided into two main categories: those which are aimed at enabling the individual to block out the pain, and those which require acknowledgement or confrontation of the stimulation. Those techniques which encourage the blocking out of stimulation include analgesia instructions and attention-diversion. The most common skill of the second type is positive attributional patterning - the skill of self-talk.

There has been considerable evidence that strategies aimed at blocking out aversive sensations are effective in increasing pain tolerance. After an intensive review of the literature, Fernandez and Turk (1989) determined that cognitive strategies were effective in 85% of the investigations. They found that each of the individual classes of strategies attenuated pain significantly. However, the problem solving imagery strategies were most effective in most situations, while strategies involving repetitive cognitions or acknowledgment of pain sensations were among the least effective. In other words, imagery strategies were more effective than those strategies that utilized internal and/or external distractions such as mental activity or those focusing on the pain directly.

Stress inoculation training (SIT) is not a single technique, but a treatment program made up of a variety of stress management and emotional control techniques. Hanin and Syrja (1995) recognized the importance of identifying all

the emotions that come into play during athletic performance. SIT provides individuals with a set of coping skills to deal with the emotions that are a by-product of stressful and painful athletic events. The SIT paradigm contains three phases: conceptualization, skills acquisition and rehearsal and, application and follow-through. Each of these phases has a number of components which interact to provide effective stress and anxiety management of emotional situations.

The conceptualization phase of SIT has two main objectives. The first is to collect data which will allow the athlete and the trainer to develop an understanding of the problem whereas the second objective is to enhance the athlete's problem solving skills by training him or her to become self-aware and interpret situations with greater sophistication (Meichenbaum and Genest, 1983). Once the client has a clear conceptual understanding of the pain and its personal effect, the trainer provides the athlete with the necessary pain-reducing skills. The purpose of the second phase is to ensure that the athlete develops the capacity to effectively execute coping responses. In this phase athletes are trained in a variety of skills including relaxation, distraction and imagery training, and self-instructional training. The final phase of SIT has as its purpose the implementation of coping responses in day-to-day athletic situations and to maximize the likelihood of generalized change. It cannot be assumed that the skills learned in the second phase will necessarily be implemented in all athletic situations. To achieve this goal the trainer can employ a variety of techniques

including creative imagery rehearsal, role-playing, and graduated in vivo practice.

Method

Subjects

Eleven female swimmers from the city of Edmonton participated in and completed the study. The swimmers, who ranged in ability from the provincial level to the national level, were all members of the same swimming club. The subjects ranged in age from 13 to 21 years with a mean age of 15.7 years. All swimmers had extensive experience at training distance events (mean = 6.45 years) and some had competed in distance events (400m, 800m, 1500m freestyle, 200m butterfly, and 400m individual medley) prior to becoming involved in the study. All of the swimmers were volunteer subjects and signed a consent form acknowledging that the study would involve some physical discomfort or pain. Competitive swimmers experience pain in swimming regularly in training and competition. The pain induced in this study may go beyond their normal swimming experience but it did not go beyond what would be expected of them at the elite levels of competitive swimming.

Based on a review of literature it was hypothesized that 1) a cognitive-behavioral training program will improve athletic pain tolerance as evidenced by subjective pain ratings, 2) swimmers able to enhance their ability to tolerate high levels of physical discomfort through mental skills utilization should see a

corresponding improvement in times on the swimming tests, and 3) swimmers perceived pain level will be directly related to their level of physiological exertion as evidenced through heart rate measurements and blood lactate levels.

Quasi-Experimental Design

Due to the individual differences among athletes for pain tolerance adaptation (Whitmarsh and Alderman, 1993) and the unique individuality of the pain tolerance program, a single-subject design referred to as an AB design was employed for this study. Single subject research design is particularly well suited to research on behavior modification and is widely employed in counselling and psychotherapy (Borg and Gall, 1989). Various other single subject designs, such as a multiple baseline across individual design, may have been utilized. However, there are three reasons why the AB design was preferred. First, the study was an exploratory study to examine the effectiveness of the cognitive-behavioral pain management program developed by Whitmarsh (1992) in a sport-specific field setting. Second, all of the subjects were from the same swimming club. Therefore, to avoid data contamination it was necessary that all subjects receive the mental skills training at the same time. Finally, the study took place during the month of June, the start of the fourth macrocycle (final 10 weeks of the season), and significant end of season swimming competitions were in the immediate future. Coaches are concerned with sudden drastic changes to a training program especially during the fourth macrocycle. For this reason, the mental skills training

program was implemented as soon as possible so that the swimmers' preparation for the upcoming competitions might not be adversely affected.

Measures

Critical Swimming Velocity. Critical swimming velocity is defined as the highest swimming velocity that can be maintained without exhaustion (anaerobic threshold) over a long period of time. The assessment of critical swimming velocity is an established and accepted method for assessing endurance performance in competitive swimming and is based on the concept of critical power (Smith, 1992). It is expressed as the slope of a straight line between swimming distance and duration for various swimming distances performed all-out from 50m up to 1500m (Smith, 1992).

Specifically, the procedures to assess critical swimming velocity were conducted over two sessions and were consistent with the protocols suggested by Smith (1992). During the first session, swimmers were instructed to swim 1200m freestyle as fast as possible at a relatively even pace. After the 1200m swim and a four minute recovery period, a push 50m "flat out" freestyle sprint was conducted and the time recorded. The second session was conducted using a 600m freestyle and a 200m freestyle in place of the 1200m and 50m freestyle swims. According to the protocols (Smith, 1992), a time for each of 50m, 200m, 600m, and 1200m swims is required to determine an accurate measure of critical swimming velocity.

Perceived Discomfort Intensity. Perceived discomfort intensity was

measured through the use of a numerical rating scale, called the Ratings of Perceived Discomfort scale, with descriptive terms at and between the extremes (Thorn and Williams, 1989). The scale consisted of evenly spread demarcations ranging from 0 to 100 on a vertical line. The descriptive anchors *no discomfort, just noticeable discomfort, moderate discomfort,* and *excruciating discomfort* were used to correspond to pain levels of 0, 10, 50, and 100, respectively. There is no anchor at 90 to correspond with the anchor at 10 because the scale only measures discomfort from the anchor of 10 through to the anchor of 100. The 0 anchor is not an indication of discomfort but rather of no discomfort.

Subjects were asked to report their discomfort levels at the completion of the 600m and 1200m swim tests. Numerical rating scales have been shown to be valid measures of pain intensity based on their consistency with other pain assessment measures (Jensen, Karoly and Braver, 1986).

Profile of Mood States. The Profile of Mood States (POMS) inventory, developed by McNair, Lorr, and Droppleman (1971), is a list of sixty-five mood adjectives that are thought to encompass the total mood structure of an individual. The inventory was derived through factor analysis and measures six identifiable mood/affect states: Tension-Anxiety; Depression-Dejection; Anger-Hostility; Vigor-Activity; Fatigue-Inertia; and Confusion-Bewilderment. The POMS inventory has been extensively used in a variety of athletic situations including diagnostic assessment (Morgan, 1980; Morgan, Brown, Raglin, O'Connor, &

Ellickson, 1987), comparisons of athletes with non-athletes (Fuchs & Zaichowsky, 1983; Porter, 1985), and assessing the acute effects of exercise and sport participation on mood (Berger & Owen, 1988;) Terry (1995) did a thorough review on the efficacy of mood state profiling with elite performers. The POMS inventory was administered 15 minutes before each of the heart rate test swims.

The POMS inventory was not designed as a prediction instrument thus utilizing it for that purpose has been problematic in other studies (Renger, 1993). However, the purpose of using POMS in this study was simply to assess the athletes' state of mental health prior to any swim testing.

Reported Method of Coping with Pain. Subjects completed an open-ended question at the completion of each testing session in which they were asked how they coped with the discomfort and whether they utilized the psychological methods learned from the pain management program. The accuracy of the open-ended question was dependent upon memory recall and subject honesty. Responses were classified by two independent raters into one of four categories: (a) relaxation, (b) attention diversion, (c) self-instruction, and (d) catastrophizing. When the raters did not independently agree on the category a mutual decision was made on the most appropriate category.

Heart Rate. Heart rate was monitored at the completion of every swim using a Treffene heart rate monitor designed specifically to measure the heart rate of competitive swimmers.

Blood Lactate. Blood lactate levels were assessed at the completion of the 1200m and 600m test swims to assess the levels of lactate accumulation achieved as a consequence of the training sets and as an indicator of intensity of effort. Lactate levels in an exercising body are dynamic and the point when an individual will reach peak lactate accumulation is dependent upon a number of factors that are not under the athlete's control. These factors are: production of lactate by the working muscles, efflux from the working muscles to the blood, oxidation by non-working muscle tissue and other organs such as the liver and heart and, accumulation in muscle and blood where it can be harvested for analysis (Bishop and Martino, 1993).

In this study, the blood sample was taken from the finger tip, by a registered and approved technician, at exactly four minutes following the swim test. The four minutes did not allow subjects time to completely recover from the distance swim, but did allow sufficient time for lactate to accumulate in the blood (Bishop and Martino, 1993).

Procedure

In the pretreatment phase, critical swimming velocity was assessed once per week for two weeks in a manner consistent with the protocol suggested by Smith (1992). The protocol for the test swims was completed in the following manner:

Session 1: Swimmers were instructed to swim 1200m freestyle as fast as possible at a relatively even pace. After the 1200m

swim and a 4 minute rest period, a push 50m freestyle "flat out" sprint was conducted and recorded.

Session 2: Swimmers were instructed to swim 600m freestyle as fast as possible at a relatively even pace. After the 600m swim and a 4 minute rest period, a 200m full effort freestyle swim was conducted and recorded.

Following the two assessments of critical swimming velocity, subjects received psychological training based on the Cognitive-Behavioral Pain Management Program for Athletes (Whitmarsh, 1992). Posttreatment assessment occurred one week after the completion of the psychological training for all subjects. The data collection procedures replicated the pretreatment sessions. However, instead of completing a descriptive questionnaire, subjects completed an evaluative questionnaire related to the mental skills intervention.

Mental Skills Training. The Cognitive-Behavioral Pain Management Program for Athletes (Whitmarsh, 1992) is a program based on stress inoculation training (SIT) and is an adaptation of programs designed by Turk, Meichenbaum, and Genest (1983) and Meichenbaum (1985). The adaptations were made in order to make SIT more relevant for the sport setting and acute physical discomfort tolerance. This sport related SIT program consists of the same three phases as the earlier SIT programs, namely, education and conceptualization, skills acquisition, and consolidation and application.

The training was conducted through the use of four different workbooks in which subjects received information, practical examples, and helpful exercises to complete. The first workbook provided information on pain perception and the physiological/psychological connection of pain based on the gate-control theory of pain (Melzack and Wall, 1988). Athletes were taught to view physical discomfort as a four stage process and become more self-aware of the effects that discomfort can have on athletic performance. The second and third workbooks consisted of skills acquisition training which is considered to be the most effective phase of the program (Whitmarsh and Alderman, 1993). In these workbooks, subjects received coping skills training in three areas: relaxation and controlled breathing based on Benson (1975, 1984), and training in subjective imagery, external diversion, and internal diversion. As well, subjects were taught a systematic method of applying self-instructional strategies to deal with the four stages of pain: preparing for the discomfort, confronting the discomfort, coping with the discomfort, and reinforcing/reflecting on successful coping with the physical discomfort. Finally, in the fourth workbook, subjects were given the opportunity to apply the learned techniques in a variety of different sport specific and non-sport specific exercises. Subjects were contacted in person (2 times) and by telephone (2 times) to discuss the workbooks, answer any questions and to encourage the athletes to spend time practising the psychological skills in the program. In addition, three short group sessions (20 minutes) were held to review information and answer questions that

may be beneficial to the entire group.

Results

The data for each treatment phase (Pretreatment and Posttreatment) were analyzed using descriptive statistics and visual inspection of the data consistent with single subject research.

Program Evaluation

Subjects were asked prior to the posttreatment test swims and immediately following the completion of the psychological training to evaluate the program. Two of the questions focused on the subjects' belief about the value of the program. The first question was "Do you believe that the pain management program will help you swim better in the next four test swims?" The second question was "Do you believe that the pain management program will help you swim better overall?" The questions were answered using a 7-point likert scale with the descriptors of "strongly disagree" and "strongly agree" at each extremes. Subjects successful in improving critical swimming velocity demonstrated a higher belief in the value of the psychological program, seen in Figure 1, for improving swimming performance than non-successful subjects.

Finally, subjects were asked to indicate the number of hours they spent practicing the psychological skills on their own time during the four week training

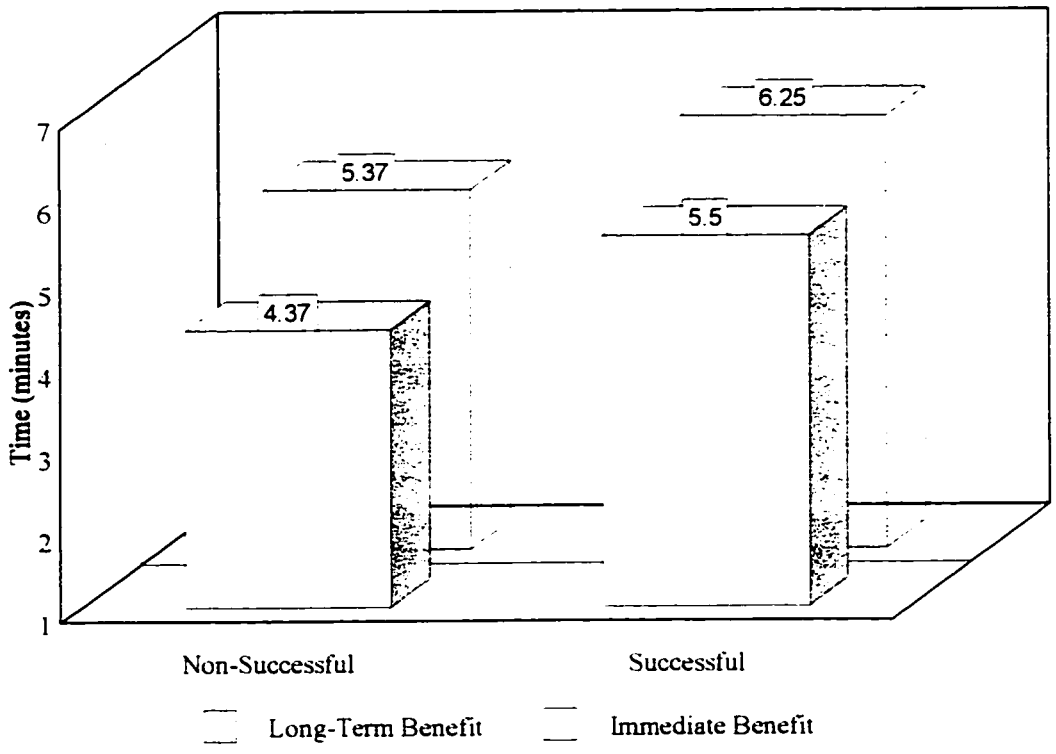

Figure 1: Mean scores of belief in the effectiveness of cognitive-behavioral program for successful and non-successful subjects.

period. Successful subjects spent approximately 43% more time practicing the psychological skills than those who were not successful in improving critical swimming velocity. It is quite likely that this difference is related to their level of belief in the value of the psychological program.

Perceived Pain Intensity

Significant differences were not found in perceived pain intensity from pretreatment to posttreatment using the numerical rating scale. Four of the subjects showed an improvement from pretreatment to posttreatment while seven

subjects showed a decrease in perceived intensity from pretreatment to posttreatment. Data was also examined by comparing group means from pretreatment to posttreatment which demonstrated a slight decrease in perceived pain intensity. The group mean for pretreatment was 65.87 and the posttreatment group mean was 65.68.

It is important to note that there are some interesting differences when the perceived pain intensity data was separated into those subjects who were successful in improving critical swimming velocity and those who were not successful. Successful subjects showed an increase in perceived pain intensity from pretreatment to posttreatment while the non-successful subjects showed a decrease from pretreatment to posttreatment (See Figure 2). This finding was expected and is likely because swimmers who improved their critical swimming velocity were able to push themselves to a higher level of subjective pain while the other swimmers allowed the pain intensity to control how they actually swam.

Reported Method of Coping with Pain

The qualitative data from the open-ended question was categorized into one of four categories: (a) relaxation, (b) attention diversion, (c) self-instruction, and (d) catastrophizing. Post-performance catastrophizing is a negative reaction to discomfort in which the subject makes irrational statements about the severity of the discomfort.

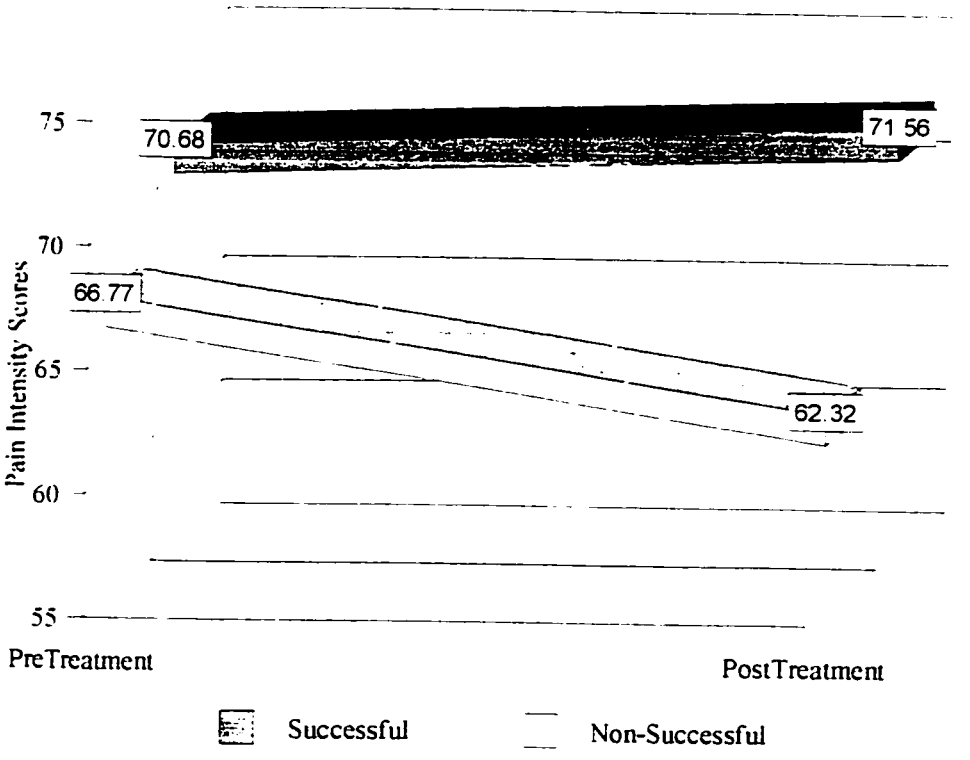

Figure 2: Perceived pain intensity for successful and non-successful subjects at pretreatment and posttreatment.

The results of the descriptive analysis, shown in Figure 3a and 3b, indicate that subjects showed different strategy utilization from pretreatment to posttreatment. They utilized attention diversion strategies more often during posttreatment than during pretreatment, while decreasing their use of catastrophizing. This may help to explain why most of the athletes did not improve critical swimming velocity. Many studies have indicated that associative strategies are more effective in dealing with pain and/or physical exertion and are used most often by successful, elite athletes (Morgan, 1980; Spink & Longhurst,

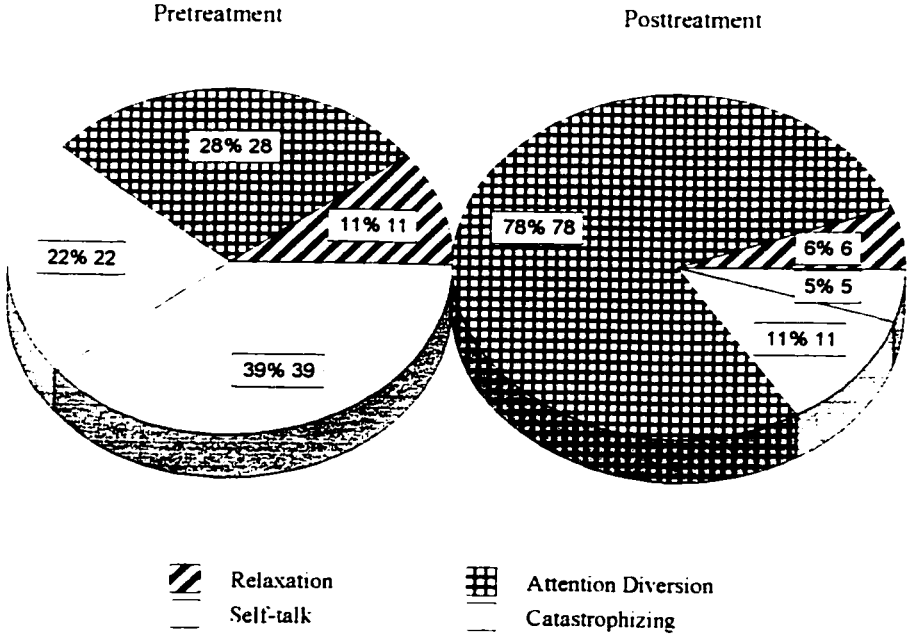

Figure 3a: Cognitive-behavioral methods of pain tolerance utilized by successful swimmers during pretreatment and posttreatment.

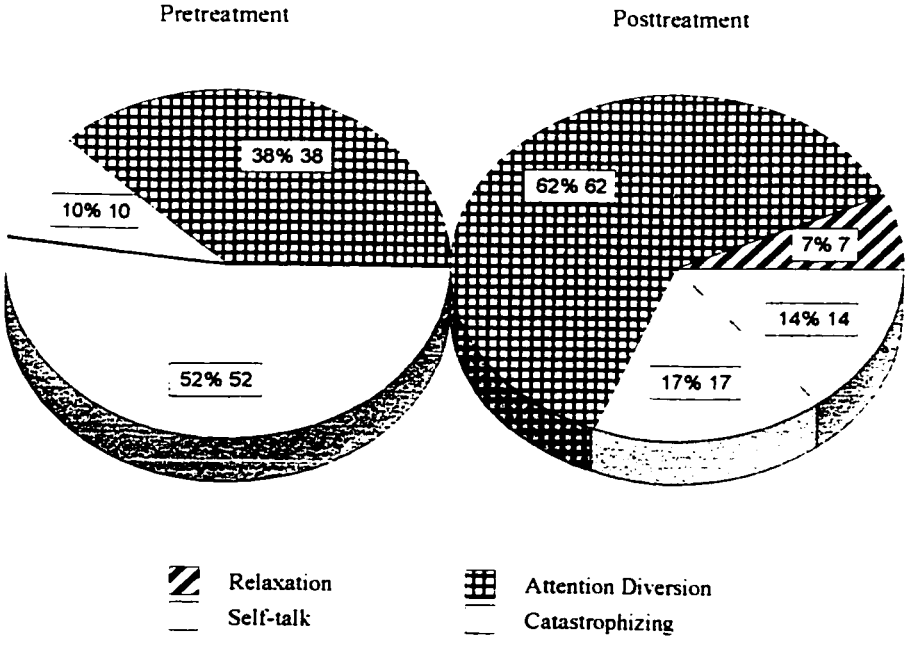

Figure 3b: Cognitive-behavioral methods of pain tolerance utilized by non-successful swimmers during pretreatment and posttreatment

1986; Whitmarsh and Alderman, 1993).

Physiological Measures

Heart rate was recorded at the end of each test swim and blood lactate was measured according to protocols, as outlined earlier, following each 1200 and 600m test swim. The purpose of recording heart rates and blood lactates was to provide physiological measures to correspond with the self-reported perceived pain intensity. In other words, physiological measures were used to provide support for or to shed some doubt on the self-reported information given by the subjects. As expected given the nature of the testing sessions, heart rate and blood lactate levels did provide physiological evidence that the subjects were physically stressed during the swim test. However, significant individual differences between subjects on the physiological measures were not evident. In other words, the eleven subjects had approximately the same heart rate and blood lactate levels during the swim tests making it difficult to differentiate using the physiological data. Therefore, the heart rate and blood lactate measures did not provide any significant information beyond supporting the self-reported data by demonstrating that heart rates and blood lactates were held relatively high and constant throughout all test swims. In other words, physiological evidence was provided that supported the self-report statements that the subjects were in a state of significant discomfort and/or pain during the swim tests.

Critical Swimming Velocity

Critical swimming velocity was used as the swimming performance measure. Critical swimming velocity is established by using a regression analysis to determine the goodness of fit for the 1200, 600, 200, and 50m swims. The number of metre/second were calculated for each swim distance prior to conducting the regression analysis. As may be seen in Figure 4, critical swimming velocity was improved from pretreatment to posttreatment in four of the eleven subjects who completed the study. Initially, this would indicate that the cognitive-behavioral program was ineffective in improving swimming performance. However, while it was not effective in improving critical swimming velocity in seven subjects it did have a positive effect on four subjects. It is interesting to note that three of the successful subjects were the swimmers who had competed at the highest level. It is for this reason that single subject research is most appropriate for many intervention studies. Methods of statistical analysis designed for groups fail to recognize the individual differences that influence performance improvement. The role of single subject analysis methods is to determine the effectiveness of a program with individuals and not the group as whole.

In determining if the change in critical swimming velocity from pretreatment to posttreatment of the four successful subjects demonstrates a significant improvement it is important to differentiate between clinical and

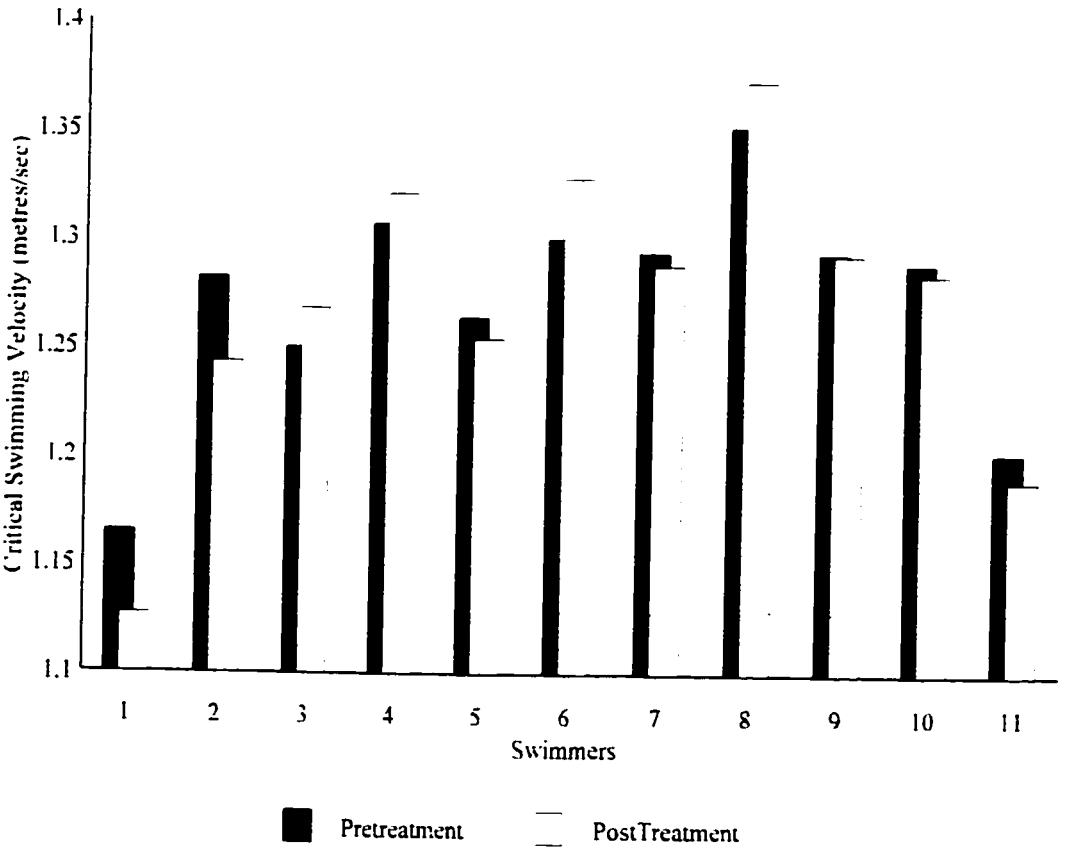

Figure 4: Critical swimming velocity scores at pretreatment and posttreatment.

statistical significance. For example, is the change from 1.30 m/s to 1.328 m/s in Subject #8 a significant change? By examining the data using visual inspection the careful observer would determine that the magnitude of the observed differences may not be considered significant in any way. However, clinical significance is quite another matter. Clinical significance questions whether or not the change in critical swimming velocity is significant within the sport of swimming regardless of its statistical significance. If the previously mentioned

values of 1.30 m/s and 1.328 m/s were converted to a "hypothetical" 1500 metre swim the times would indicate a 25 second improvement pretreatment to posttreatment. (see Figure 5) Since swimming races can be decided by tenths or

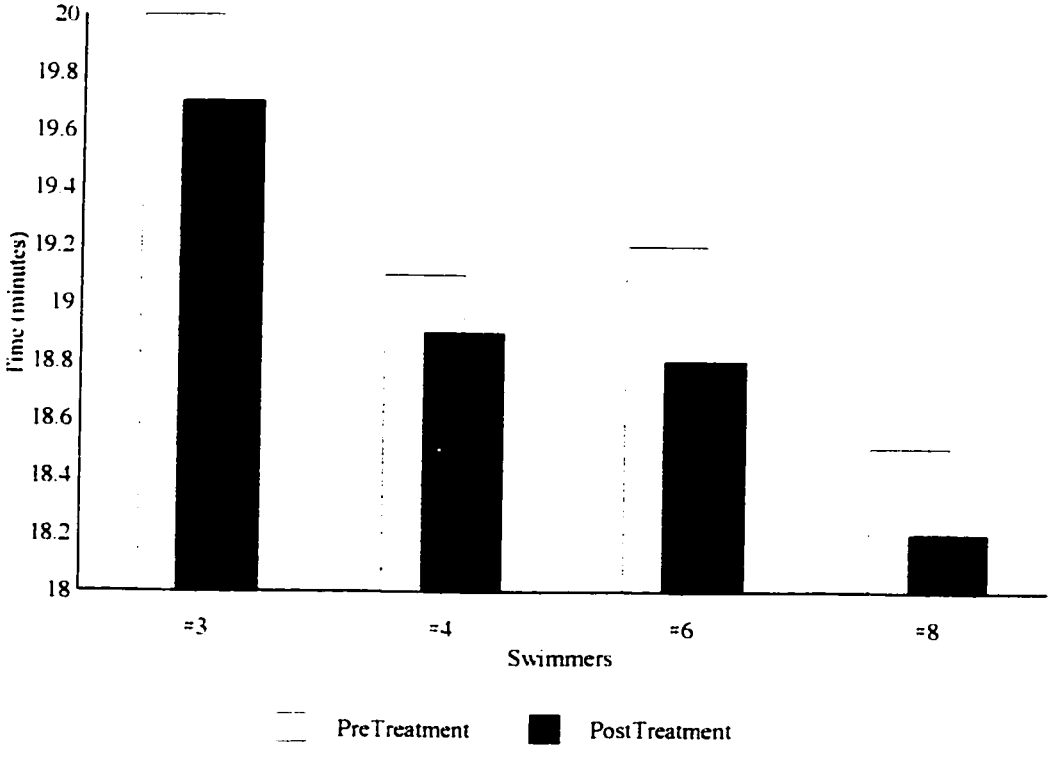

Figure 5: Hypothetical "1500m swim" for successful swimmers using critical swimming velocity data at pretreatment and posttreatment.

hundredths of seconds, a 25 second improvement would be considered to be clinically significant within the sport of swimming.

Profile of Mood States

Profile of Mood States (POMS) was not used as a predictive tool but rather as a means to assess whether or not mood and emotion levels were relatively

consistent or inconsistent from one swim test to the next. By adding up the scores from each of the six scales of POMS, it is possible to arrive at a Total Mood Disturbance Score (TMD). The TMD score was used to determine overall mood level prior to each swim. Some athletes' mood levels were directly associated with their swim times while others showed virtually no relationship between their swim time and their POMS score.

Of the eleven subjects, 5 demonstrated a positive relationship between POMS scores and swim performance, 2 demonstrated a negative relationship and, 4 athletes did not demonstrate a strong relationship pattern at all. The positive relationship indicates that the higher the TMD score the more successful the overall swim performance, whereas a negative relationship indicates the opposite.

When the results are divided into two groups of those successful in improving critical swimming velocity and those that were not some interesting results emerged. The TMD scores for those that were successful decreased an average of 17.6% from pretreatment to posttreatment whereas TMD scores only decreased an average of 2% from pretreatment to posttreatment for those unsuccessful at improving critical swimming velocity. As well, successful swimmers indicated a significant average decrease in fatigue (28%) from pretreatment to posttreatment and a corresponding increase in vigor of 2.7%. Those unable to increase critical swimming velocity indicated an average decrease in fatigue of 5.5% but a significant decrease in vigor (32%) from pretreatment to posttreatment. This data

indicates that the successful swimmers were less fatigued and more energized during the posttreatment swim tests as compared to the pretreatment swim tests than were the unsuccessful swimmers.

Discussion

The purpose of the study was to examine the role of a cognitive-behavioral pain management program for improving athletic pain tolerance in competitive swimmers. Pain tolerance was measured through the use of aerobically based swim test to arrive at Critical Swimming Velocity (Smith, 1992). Since the swim test placed subjects into a state of discomfort and/or pain, it was assumed that an increase in critical swimming velocity would see a corresponding increase in the pain level and the need for increased pain tolerance. The design utilized was a single-subject research design wherein athletes were compared against themselves and not to the group as a whole. Even though all subjects received the same basic psychological training, single subject research design allowed for slight adaptations in the program to suit the differences among the participants such as training schedules, levels of ability, age, and personality.

Pain tolerance is an individual skill and each athlete will have different levels of pain tolerance under different situations (Whitmarsh and Alderman, 1993). As expected, not all of the subjects improved their critical swimming velocity from pretreatment to posttreatment. Interestingly, those athletes who did improve their

critical swimming velocity were the most skilled and experienced swimmers. As well, based on the qualitative data all subjects used more attention diversion strategies during the posttreatment swim tests than in the pretreatment swim tests, whereas the use of catastrophizing decreased significantly from pretreatment to posttreatment.

In employing intervention studies, it is important to distinguish between statistical significance and clinical significance. In the present study, it would be impossible to state that there was any statistically significant difference in the critical swimming velocity data for any of the swimmers since this was a single subject research design and not an experimental group design. However, in the case of competitive swimming a winning performance can be determined by 1/100 of a second, therefore, even a slight improvement in critical swimming velocity can be clinically significant. In this study, the magnitude of the observed differences for some of the swimmers would indicate a significant improvement in swimming performance from pretreatment to posttreatment. Sport psychologists and researchers interested in helping athletes achieve athletic success need to be aware of this important difference and not indiscriminately disregard sport data simply because it does not achieve statistical significance.

Swimmers who were successful in improving their critical swimming velocity indicated a higher belief in the effectiveness of the mental skills program for pain management. This is an important finding because it is possible that

these athletes believed the pain program would be helpful so they were diligent in practicing and applying the skills. Of course, the converse of this is that those athletes that did not have a strong belief in the usefulness of the pain management program did not actually complete the mental training. A measure of mental training compliance may have shed more light on this possibility. An alternative explanation is that these athletes would have improved regardless of the type of mental training they received. In other words, did they improve their critical swimming velocity because of the cognitive-behavioral pain management program or because they were led to believe that it would be of benefit for them? A related concern is that of researcher and/or counsellor contamination. Is the mental skills program responsible for any improvement in critical swimming velocity or is it the person that implemented the mental skills program that is primarily responsible? Finally, what is it about the mental skills program that was effective with four subjects but not effective with seven subjects. It is equally important to examine why a mental skills program is effective for some as it is to examine why the program is not effective for others. These are important questions that need to be investigated in future research.

It is also of interest to note that subjects who improved their critical swimming velocity reported an increase in perceived pain from pretreatment to posttreatment, whereas the non-successful subjects reported the opposite. This provides an indication that the successful subjects were not able to lessen the pain but were

able to more effectively control the debilitating effects of the perceived pain. Earlier it was stated that athletes have two choices when faced with athletic pain: (1) stop or slow down, and (2) use mental skills to tolerate the pain. The use of mental skills facilitates performance improvement by allowing athletes to increase their effort level even with a corresponding increase in perceived pain. Those who were unable to improve critical swimming velocity chose to decrease the pain by slowing down rather than using mental strategies to overcome the adversity.

Two limitations are evident in the present study. The first limitation is that the psychological training program consisted mostly of psychological workbooks (modules) that were completed by the subjects. The program may have been more successful if more one-on-one counselling had been offered to each of the athletes in order to provide a more comprehensive program. However, the study was conducted prior to significant swim competitions which made it very difficult for subjects to put more than a minimum amount of time into the study. A secondary purpose of the study was to determine if short, self-directed mental skills training would be effective in helping athletes deal more effectively with the complex emotions of pain. The study was conducted during the fourth macro of the competitive season making it difficult to use a stronger research design such as the multiple baseline single-subject design.

The second limitation is that the swimmers ranged in age from 13 to 21 years. The psychological training manuals may have been difficult to fully understand for

younger swimmers as evidenced by their questions to the researchers. In fact, not only were the successful subjects more skilled but they also tended to be older than the non-successful athletes. As well, a higher level of experience with pain in the sport of swimming may be necessary to more fully understand the potential value of an increased ability to tolerate pain. Pain is a complex phenomenon and may not be easily understood by young athletes with little competitive experience. In the future, research with this type of psychological intervention may need to be done with older athletes (15 years and above) and with a greater amount of experience in competitive sport or be modified to cater to the younger athletes (Hogg, 1997a).

This research provides support that a cognitive-behavioral pain management program may improve athletic pain tolerance among some athletes. However, all athletes are different in the way they respond to training and instruction and need to be treated as such. If a psychological intervention program took into greater account the individual differences between athletes and their training schedules, then the program will have a greater chance of being effective. Single-subject research is an excellent choice of research design to not only conduct viable research in the area of sport but to also to provide an individualized program of performance enhancement for athletes.

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CHAPTER 3

Single-Subject Evaluation of a Mental Skills Package for Improving Pain Tolerance in Competitive Swimming

Elite competitive swimmers are highly motivated to achieve athletic success and commit to rigorous training schedules and intense competitions. The physical training and competitions exposes the swimmer to high levels of physical discomfort and/or pain. In fact, pain has become an integral part of most athletes' experiences in sport (Brewer, Van Raalte, and Linder, 1990). According the Morris (1991), pain requires that an athlete blend together his or her physical and mental attributes to most effectively overcome the pain.

Pain has been defined as a "sensory and emotional experience" (Egan, 1987; Fernandez and Milburn, 1994; Heil, 1995; and Matlin and Foley, 1992). Karoly and Jensen (1987) [cited in Brewer et al, 1990, p.363] indicate that " pain perception is a complex phenomenon that involves physiological factors, pain tolerance, pain related memories, goals, self-appraisals, self-efficacy attributions, problem solving skills, and cognitive skills. Each of these psychological or physiological attributes can be adjusted and controlled through effective mental skills application. Pain is a complex phenomenon and athletes differ in the degree

in which they perceive and tolerate pain. Pain tolerance is a learned skill and the development of mental skills can play a significant role in improving athletic pain tolerance (Melzack and Wall, 1988; Whitmarsh and Alderman, 1993).

The International Association for the Study of Pain states that pain is almost always unpleasant and is therefore an emotional experience (Fernandez and Milburn, 1994). Pain induces an emotional experience that every elite swimmer must face on a regular basis and in the case of the competitive swimmer it almost always disrupts performance. Anxiety is the most common emotional response to pain and high levels of anxiety only serve to hamper performance. Hammermeister and Burton (1995) found that while precompetitive anxiety did not impair the performance of endurance athletes, there was a significant negative correlation between negative thoughts during the race and performance. Competitive swimmers would have many negative, pain-related thoughts during training or racing. Brewer, Van Raalte, and Linder (1990) state that pain evokes a form of arousal and that pain affects performance in a manner similar to other forms of arousal.

Hogg (1997) indicates that negative emotions, such as pain anxiety, lead to slower reaction responses, impair decision making, preoccupy or dominate thinking, and invariably lead to ineffective or destructive attributions about performance. This can ultimately lead to the athlete feeling hopeless or dispassionate about their swimming performance. Athletes need to recognize that

personal emotions can positively or negatively influence performance and that it is possible to exercise control over the emotions. The use of basic mental skills may help the athlete cope with the expected emotional responses to pain. Thought stopping, cognitive restructuring, performance cue words, relaxation techniques, creative imagery, distraction strategies, and self-coaching are good strategies to implement (Hogg, 1995).

A "mentally tough" swimmer will have a goal in mind and will use his or her mental skills to continue with the difficult training or challenging race even when faced with excruciating bouts of natural athletic pain. Whitmarsh and Alderman (1993), in a study of competitive rowers, cyclists, and triathletes, observed a positive correlation between a high level of pain tolerance and high achievement in endurance sport. Those athletes that demonstrated the highest levels of pain tolerance were the most experienced and successful in their respective sports. Maglischo (1993), stated that pain tolerance is an important factor that can affect swimming performance and that swimmers who can tolerate more pain can swim at maximal speed for greater distances.

In a study on cognitive strategies and pain tolerance, Pen, Fisher, Sforzo, and McManis (1995), using repeated eccentric contractions against heavy resistance to induce muscle soreness and pain, found that associative cognitive strategies helped to increase quadriceps strength and that both dissociation and association groups perceived that using cognitive strategies enhanced their

performance. Dissociation involves focusing attention away from the pain, and includes distractors that are either internal (ie. mental arithmetic, counting, singing a song) or external (ie. listening to music, watching videos). Association involves either focusing on bodily sensations, maintaining awareness of the physical factors that relate to performance, or changing the appraisal of the pain (Spink, 1988; Williams and Kinney, 1991) Tajet-Foxell and Rose (1995), in a study of professional ballet dancers, found that dancers had higher pain tolerance levels than age matched controls in a cold pressor test. They also reported a more acute experience of the sensory aspects of the pain. It is possible that the body awareness of the dancers, the greater experience with athletic pain, and the deep appreciation of the relationship between pain and physical activity helped them to be more aware of the pain and to tolerate it better. The implications for competitive swimming are that the more self-aware the athlete and the more experience with physical pain the greater likelihood that they will be able to effectively tolerate pain. Spink and Longhurst (1986) suggest that elite swimmers can improve their performance through the use of an appropriate cognitive strategy and that an associative cognitive strategy may be the most beneficial.

Pen and Fisher (1994) indicate that athletes' attitudes towards pain and the cognitive strategies that they use while experiencing pain may be reflected in their pain tolerance levels and performance. The major limitation of most of the pain induction methods is that they are relatively safe and the athlete can terminate the

induced pain at any time and see an instant decrease in severity. Pen and Fisher (1994) argue that it is possible that the pain tolerated in experimental settings would be much higher than real-life situations because the athlete knows the experimental pain is safe and controllable. Even though Pen and Fisher (1994) are mostly concerned with sport injury rehabilitation the implications for performance enhancement are clear. Exercise-induced pain is a pain induction technique which may alleviate this problem and provide realistic levels of pain to tolerate. Competitive swimmers must endure high levels of pain on a regular basis in training and in competition. Consequently, research into swimming pain should be able to replicate real-life swimming pain.

Competitive swimmers can choose from two options when faced with a painful athletic situation. They could choose to stop or slow down during the training session or race and eliminate the pain. This choice is effective in pain reduction but it also reduces the training effect and racing performance. The other choice is to learn to cope more effectively with the pain by developing mental skills to the fullest. Heil (1995) stated that an athlete's survival in his or her sport is often dependent upon a successful outcome. Competitive swimmers spend endless hours in the pool and weight room to get physically prepared for competition. Therefore, the competitive swimmer who desires to be the best must choose to tolerate the pain that is natural to competitive swimming.

This study was designed to overcome many of the weaknesses of the first

study. This was accomplished by developing a longer and more extensive mental skill program to include individual counselling, utilize older and more experienced swimmers as subjects, use a more challenging and tightly controlled swim test, and conduct the study with a multiple baseline single-subject research design.

Method

Subjects

Swimmer #1: The first swimmer was a 17 year old male with twelve years of competitive swimming experience. His best swimming events were the 50m freestyle, 100m freestyle, 50m breaststroke, and the 100m breaststroke. During the competitive season he trained approximately 18 hours per week (including weights) with 1 hour per week of training during the off-season. He indicated that he did experience high levels of physical discomfort while training or competing in swimming. When he is experiencing physical discomfort in swimming, he "either accepts the pain and deals with it or he tries to block out the pain". When he was 12 years old he did experiment with psychological relaxation and preparation cassette tapes with a former swim coach.

Swimmer #2: The second swimmer was a 17 year old male with twelve years of competitive swimming experience. His best swimming events were the 1500m freestyle, and 200m butterfly. During the competitive season he trained approximately 18 hours per week (including weights) with no training

during the off-season. He indicated that he did experience high levels of physical discomfort while training or competing in swimming and that he just tries to take the pain and "grit his teeth". When he was 12 years old he did receive some training in visualization using cassette tapes provided by a previous coach.

Swimmer #3: The third swimmer was a 15 year old female with eight years of competitive swimming experience. As a National Qualifier, her best swimming events were the 400m individual medley, 200m individual medley, 200m butterfly, and the 100m butterfly. During the competitive season she trained approximately 18 hours per week (including weights) with no training during the off-season. She indicated that she did experience high levels of physical discomfort while training or competing in swimming. When asked how she dealt with the physical discomfort experienced while swimming, she said " Sometimes I think of how I've felt in past swims and that I'll improve if I work harder in sets. other times I listen to music in my head and get the feel for the tune". She had never received any formal training in mental skills to assist in athletic performance.

Swimmer #4: The fourth swimmer was a 16 year old female with two years of competitive swimming experience. Her best swimming events were the 100m breaststroke, and the 200m breaststroke. During the competitive swimming she trained approximately 18 hours per week (including weights) with no training during the off-season. She indicated that she did experience high

levels of physical discomfort while training or competing in swimming. When experiencing the physical discomfort she usually tells herself " that it will all be worth it in the end and the pain will benefit me". She had never received psychological training in mental skills to assist in athletic performance.

Experimental Design

Due to the individual nature of pain tolerance adaptation and the unique individuality of the pain tolerance program, a single subject research design was employed for this study. Single subject design is particularly well suited to research on behavior modification and is widely employed in counselling and psychotherapy (Borg and Gall, 1989). Single subject research is often criticized for its lack of internal and external validity. It is criticized for its lack of internal validity because it has few subjects and therefore no control group for comparison with a treatment group. Critics ask how it is possible to be sure that the intervention is responsible for any changes during the study. To most effectively deal with the issue of internal validity the multiple baseline across individuals design was utilized. The multiple baseline across individuals design consists of each subject participating in the same intervention program, testing procedures, and completing the same measures. However, the difference is that each subject begins the intervention program at a different time within the study. In the present study, each subject began the mental skills training program for pain one week

after the previous subject (see Table 1).

External validity is concerned with the application of the study results to the greater population. Critics of single subject research state that since only a few subjects are utilized it is impossible to generalize the information to the general population. It is true that it is difficult to generalize to the general population from only four subjects. However, the main purpose of the study is not to generalize but to ascertain the specific mental skill requirements for specific athletes. For a sport psychology consultant the main concern is not how effective a mental skills program is for all athletes but rather how effective the program is for certain athletes. However, multiple baseline across subjects targets a common skill across several learners, staggers instruction to allow for rate differences, and it permits sport researchers to validate program effectiveness with several athletes, thereby enhancing the generality of the findings (Cuvo, 1979 [cited in Tawney and Gast, 1984]). It is safe to assume that a mental skills program that is effective for one athlete will most likely be effective for an athlete who is of similar gender, age, sport, experience level, and personality type etc.

Measures

Critical Swimming Velocity. Critical swimming velocity, based on the concept of critical power (CP) termed by Monod and Sherrer (1965), is an established and accepted method for assessing endurance performance in competitive swimmers (Smith, 1992). Jenkins and Quigley (1990) reported that

CP provides a simple and inexpensive means of assessing the exercise intensity which can be maintained continuously for up to 30 minutes at near maximal lactate steady-state. Critical swimming velocity is defined as the swimming velocity that can be maintained without exhaustion over a long period of time. Critical swimming velocity is expressed as the slope of a straight line between swimming distance and swim time for various swimming distances performed all-out from 50m up to 1500m. (Smith, 1992).

Specifically, critical swimming velocity was tested four times, conducted over eight sessions, and was consistent with the protocol suggested by Smith (1992). During the first part of each test swimmers were instructed to swim 1200m freestyle as fast as possible at a relatively even pace. After the 1200m swim and a four minute recovery period, a push 50m "flat out" freestyle sprint was conducted. Times for the 1200m and the 50m swims were recorded. The second part was conducted two days later using a 600m freestyle and a 200m freestyle in place of the 1200m and 50m freestyle swims. This is done because, according to the protocol (Smith, 1992), a time for each of 50m, 200m, 600m, and 1200m swims is required to arrive at a most accurate measurement of critical swimming velocity. The results from the four critical swimming velocity tests were then compared to the 13 heart rate test swims to help determine performance improvement.

Heart-Rate Test Swims

The heart rate test swim is a difficult test set in which the swimmers are asked to swim as fast as possible on each interval while maintaining a heart rate of over 180 beats per minute throughout the set. Swimmers swam various distances of freestyle on an interval time of 1 minute 30 seconds per 100m. The heart rate set is outlined below:

Distance	Interval Time
50m	45 sec
50m	45 sec
100m	90 sec
150m	135 sec
100m	90 sec
100m	90 sec
50m	45 sec

The basic heart rate set is 600m, however, the test swim consisted of having swimmers repeat the heart rate set 4 times for a total of 2400 metres. Heart rate and swim time were recorded immediately after each interval (ie. 50m, 100m, 150m). Total time of all of the swims was calculated and then compared to the target time derived from the critical swimming velocity. A successful test swim was considered any swim that was completed at or above anaerobic threshold based on the previously determined critical swimming velocity. A swimmer who had a critical swimming velocity of 1.2m per second would need a swim time at/or lower than 33 minutes, 20 seconds (2400metres/1.2 metres per second) for the heart rate swim test to be considered successful. Critical swimming velocity was

assessed during the 2nd, 6th, 10th, and 13th weeks of the study which allowed the anaerobic threshold standard to be adjusted throughout the study.

Perceived Discomfort Intensity. Perceived discomfort intensity was measured through the use of a numerical rating scale, called the Ratings of Perceived Discomfort scale, with descriptive terms at and between the extremes (Thorn and Williams, 1989). The scale consisted of evenly spread demarcations ranging from 0 to 100 on a vertical line. The descriptive anchors *no discomfort, just noticeable discomfort, moderate discomfort,* and *excruciating discomfort* were used to correspond to pain levels of 0, 10, 50, and 100, respectively. There is no anchor at 90 to correspond with the anchor at 10 because the scale only measures physical discomfort from the anchor of 10 through to the anchor of 100. The 0 anchor is not an indication of discomfort but rather of no discomfort.

Swimmers were asked to report their pain levels at the completion of the 2400m heart rate test swims. Numerical rating scales have been shown to be valid measures of pain intensity based on their consistency with other pain assessment measures (Jensen, Karoly and Braver, 1986).

Profile of Mood States. The Profile of Mood States (POMS) inventory, developed by McNair, Lorr, and Droppleman (1971), is a list of sixty-five mood adjectives that are thought to encompass the total mood structure of an individual. The inventory was derived through factor analysis and measures six identifiable mood/affect states: Tension-Anxiety; Depression-Dejection; Anger-Hostility;

Vigor-Activity; Fatigue-Inertia; and Confusion-Bewilderment. The POMS inventory has been extensively used in a variety of athletic situations including diagnostic assessment (Morgan, 1979; Morgan, Brown, Raglin, O'Connor, & Ellickson, 1987), comparisons of athletes with non-athletes (Fuchs & Zaichkowsky, 1983; Porter, 1985), and assessing the acute effects of exercise and sport participation on mood (Berger & Owen, 1988;). Terry (1995) did a thorough review on the efficacy of mood state profiling with elite performers. Grove & Praprevessis (1992) found the shortened version of POMS developed by Schacham (1983), which includes a scale for self-esteem related affect, to be useful in the sport setting. In the present study the longer 65-item scale was used because of its extensive use in previous studies and its availability. The POMS inventory was administered ten minutes prior to the beginning of every heart rate test swim.

While there is some difficulty with using POMS to predict athletic success (Renger, 1993), the purpose of using POMS in this study was simply to assess the athletes' state of mental health prior to a swim test.

Reported Method of Coping with Pain. Subjects completed an open-ended question at the completion of each heart rate test swim to determine how they coped with the discomfort and whether they utilized the skills learned from the mental skills program for pain management. Responses were classified by two independent raters into one of four categories: (a) relaxation, (b) attention diversion, (c) self-instruction, and (d) negative attributional patterning. When the

raters failed to independently agree on the category, they together decided on the most appropriate category.

Heart Rate. Heart rate was monitored during the heart rate test swims after each 100m and 150m interval. It was measured using a Treffene heart rate monitor designed specifically to measure the heart rate of competitive swimmers. The purpose of recording heart rate was to ensure that sufficient effort was given by the swimmers during the heart rate test swims to induce a high level of physical discomfort and/or pain. Swimmers were told that they needed to maintain a minimum heart rate of 180 beats per minute throughout the test swims which is consistent with the average anaerobic threshold level heart rate on most trained endurance athletes.

Testing Procedures

Since the major emphasis of this study was to examine the effectiveness of a cognitive-behavioral program in improving tolerance of athletic pain associated with swimming at or above anaerobic threshold the testing procedures reflected that purpose. First, the heart rate test swim was completed prior to, during and after the mental skills training and once per week for 13 weeks (see Table 1). Second, swimmers were assessed using the endurance-orientated protocol, suggested by Smith (1992), to determine critical swimming velocity. Third, subjects received 6-9 hours of mental skills training based on a cognitive-behavioral pain tolerance program for athletes developed by Whitmarsh (1992).

Table 1

Single Subject Multiple Baseline Research Design

Subject	Week #1	Week #2	Week #3	Week #4	Week #5	Week #6	Week #7
Swimmer #1	**Swim**	Swim	Swim	Mental Training	Mental Training	Mental Training	Mental Training
Male	Testing	Testing	Testing	Swim Testing	Swim Testing	Swim Testing	Swim Testing
Swimmer #2	Swim	Swim	Swim	Swim	Mental Training	Mental Training	Mental Training
Male	Testing	Testing	Testing	Testing	Swim Testing	Swim Testing	Swim Testing
Swimmer #3	Swim	Swim	Swim	Swim	Swim	Mental Training	Mental Training
Female	Testing	Testing	Testing	Testing	Testing	Swim Testing	Swim Testing
Swimmer #4	Swim	Swim	Swim	Swim	Swim	Swim	Mental Training
Female	Testing	Testing	Testing	Testing	Testing	Testing	Swim Testing

Subject	Week #8	Week #9	Week #10	Week #11	Week #12	Week #13
Swimmer #1	**Mental Training**	Mental Training	Swim	Swim	Swim	Swim
Male	Swim Testing	Swim Testing	Testing	Testing	Testing	Testing
Swimmer #2	Mental Training	Mental Training	Mental Training	Swim	Swim	Swim
Male	Swim Testing	Swim Testing	Swim Testing	Testing	Testing	Testing
Swimmer #3	Mental Training	Mental Training	Mental Training	Mental Training	Swim	Swim
Female	Swim Testing	Swim Testing	Swim Testing	Swim Testing	Testing	Testing
Swimmer #4	Mental Training	Mental Training	Mental Training	Mental Training	Mental Training	Swim
Male	Swim Testing	Swim Testing	Swim Testing	Swim Testing	Swim Testing	Testing

Based on a review of literature and knowledge gained from Study #1, it was hypothesized that 1) a cognitive-behavioral training program will improve athletic pain tolerance as evidenced by subjective pain ratings, 2) swimmers able to enhance their ability to tolerate high levels of physical discomfort through mental skills utilization should see a corresponding improvement in times on the swimming tests, and 3) mood levels, as measured by the longer version of the Profile of Mood States, will be related to critical swimming velocity and performance on the heart rate test swims.

Mental Skills Training

The Cognitive-Behavioral Pain Management Program for Athletes (Whitmarsh, 1992) is a program based on stress inoculation training (SIT) and is an adaptation of programs designed by Turk, Meichenbaum, and Genest (1983) and Meichenbaum (1985). The adaptations were made in order to make SIT more relevant for the competitive swimming environment and acute discomfort tolerance. This sport related SIT program consists of the same three phases as the earlier SIT programs, namely, education and conceptualization, skills acquisition, and consolidation and application.

The training was conducted through the use of four different workbooks in which swimmers received information, practical examples, and helpful exercises to complete. The first workbook provided information on pain perception and the physiological/psychological connection of pain based on the gate-control theory of

pain (Melzack and Wall, 1988). Swimmers were taught to view physical discomfort as a four stage process and to become more self-aware of the effects that physical discomfort and/or pain can have on their athletic performance. The four stages of athletic pain include: preparing for the discomfort, confronting the discomfort, coping with the discomfort, and reinforcing/reflecting on successful performances. The second and third workbooks consisted of mental skills acquisition training which is often the most effective phase of the program (Whitmarsh and Alderman, 1993). In these workbooks, subjects received coping skills training in three areas: relaxation and controlled breathing based on Benson (1975, 1984), imagery, external diversion, and internal diversion. As well, swimmers were taught a systematic method of applying self-coaching strategies to deal with the four stages of pain: Finally, in the fourth workbook, swimmers were given the opportunity to apply the learned techniques in a variety of different swimming specific and non-swimming specific exercises.

Along with the four workbooks, mental skills training was conducted through the use of 12 individual counselling sessions over a 6 week period. While the mental skills program was essentially the same for each subject slight adjustments were made to cater more effectively to the individual needs of the participants. Due to subject familiarity with each other prior to the start of the study, treatment effectiveness was dependent on subject cooperation not to disclose information concerning the type of mental skills training that they were

receiving during the training phase of the study. Upon completion of the six-week mental skills program, swimmers were encouraged to continue to use and practice the mental skills whenever possible.

Results

The data for each treatment phase (pre-mental skills training, mental skills training, and post-mental skills training) were analysed using descriptive statistics, correlational statistics, and visual inspection of the data consistent with single subject research. Descriptive results for heart rate test swims, ratings of perceived discomfort, and Total Mood Disturbance (TMD) of the POMS profiles can be seen in Table 2.

Table 2

Descriptive results for heart rate test swims (n=13), ratings of perceived discomfort (n=13), and Total Mood Disturbance (POMS) (n=13).

Subject	Measure	Mean	S.D.	Range
Swimmer #1	Heart Rate Test Swim	1.403	.0265	1.371 to 1.453
	Ratings of Perceived Discomfort	78.769	4.422	71 to 85
	Total Mood Disturbance (POMS)	18.538	10.580	0 to 38
Swimmer #2	Heart Rate Test Swim	1.393	.0194	1.346 to 1.424
	Ratings of Perceived Discomfort	75.538	4.396	65 to 81
	Total Mood Disturbance (POMS)	17.846	12.271	2 to 41
Swimmer #3	Heart Rate Test Swim	1.424	.0288	1.361 to 1.461
	Ratings of Perceived Discomfort	79.461	7.621	60 to 92
	Total Mood Disturbance (POMS)	42.846	27.343	-1 to 86
Swimmer #4	Heart Rate Test Swim	1.302	.0155	1.263 to 1.328
	Ratings of Perceived Discomfort	81.153	4.605	72 to 88
	Total Mood Disturbance (POMS)	-12	7.103	-25 to -1

Heart Rate Test Swims

Swimmer #1 Swimmer #1 showed an improvement in swim times on the heart rate test swims from pre-training to post-training (see Figure 6). During the pre-training phase the average metres/second of the two baseline swims was 1.392 m/s. This was improved to 1.405 m/s during the training phase and was held at 1.405 m/s during the post-training phase.

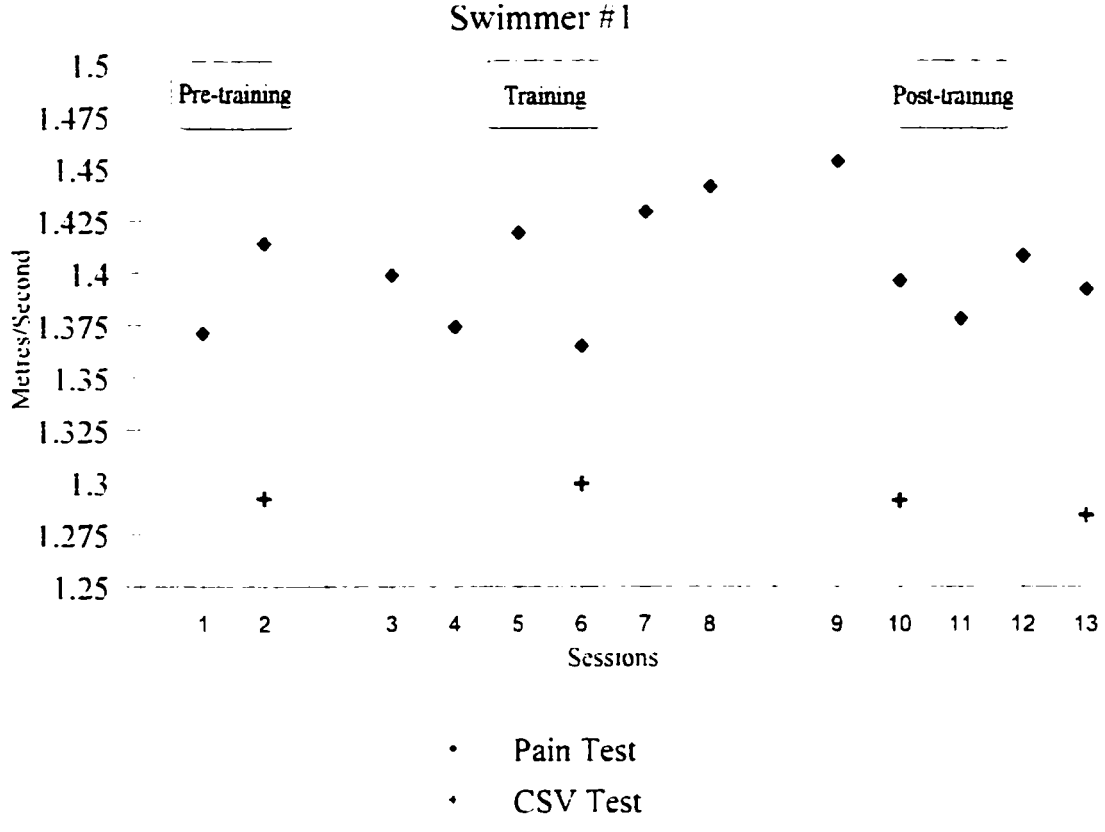

Figure 6: Heart rate test swims and critical swimming velocity results for Swimmer #1.

This change in performance equates with a 1% improvement which would be

equivalent of a 10 second improvement of a 1500 metre distance swim. This 10 seconds would most certainly be important from the perspective of a coach and a highly trained athlete.

Critical swimming velocity (CSV) showed a decline over the last two CSV tests conducted during the 10th and 13th week of the study. This was as a consequence of the heavy training associated with this phase of the season as well as the heavy weight training demands of that month. This makes the results from the heart rate test swims even more significant. In other words, when the swim training and weight training was the most demanding, swimmer #1 was able to use mental strategies to help overcome the physical discomfort and improve his performance on the heart rate test swims even though his critical swimming velocity scores had decreased.

Swimmer #2 Swimmer #2 showed a slight improvement in swim times on the heart rate test swims from pre-training to post-training (see Figure 7). During the pre-training phase the average metres/second of the two baseline swims was 1.390m/s. This was improved slightly to 1.396 m/s during the training phase and dropped to 1.392 during the post-training phase. This change in performance equates with a .4% improvement which would be equivalent of a 5 second improvement in a 1500 metre distance swim. While a 5 second improvement would be welcome for an elite competitive swimmer, it is very difficult to assume that the mental skills played a significant role except to say that he reported that

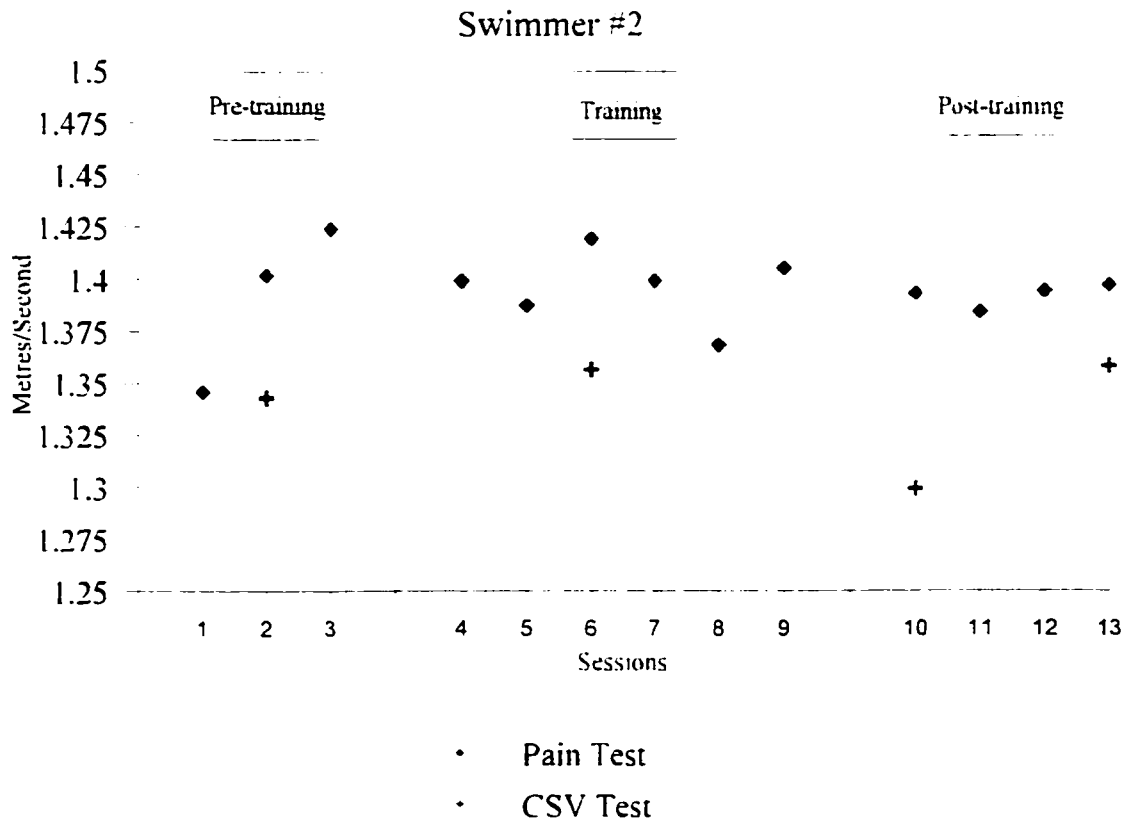

Figure 7. Heart rate test swims and critical swimming velocity results for Swimmer #2.

the mental skills helped him to maintain heart rate swim times while the rest of his training performances were decreasing. Critical swimming velocity (CSV) showed an increase from pre-training into the training phase. From the training phase into the post-training phase there was a sharp decline in CSV in the 10th week with a solid recovery in the 13th week. Swimmer #2 was a very tired athlete who was also having life challenges that made it difficult to get sufficient sleep or to commit fully to the heavy training program. The erratic times in CSV do provide some support for the mental skills program since he was able to maintain his heart rate

wim times while he could not maintain consistent CSV times.

Swimmer #3 Swimmer #3 had a significant improvement in swim times on the heart rate test swims from pre-training to post-training (see Figure 8). During the pre-training phase the average metres/second of the two baseline swims was 1.402 m/s. This was improved to 1.435 m/s during the training phase and was

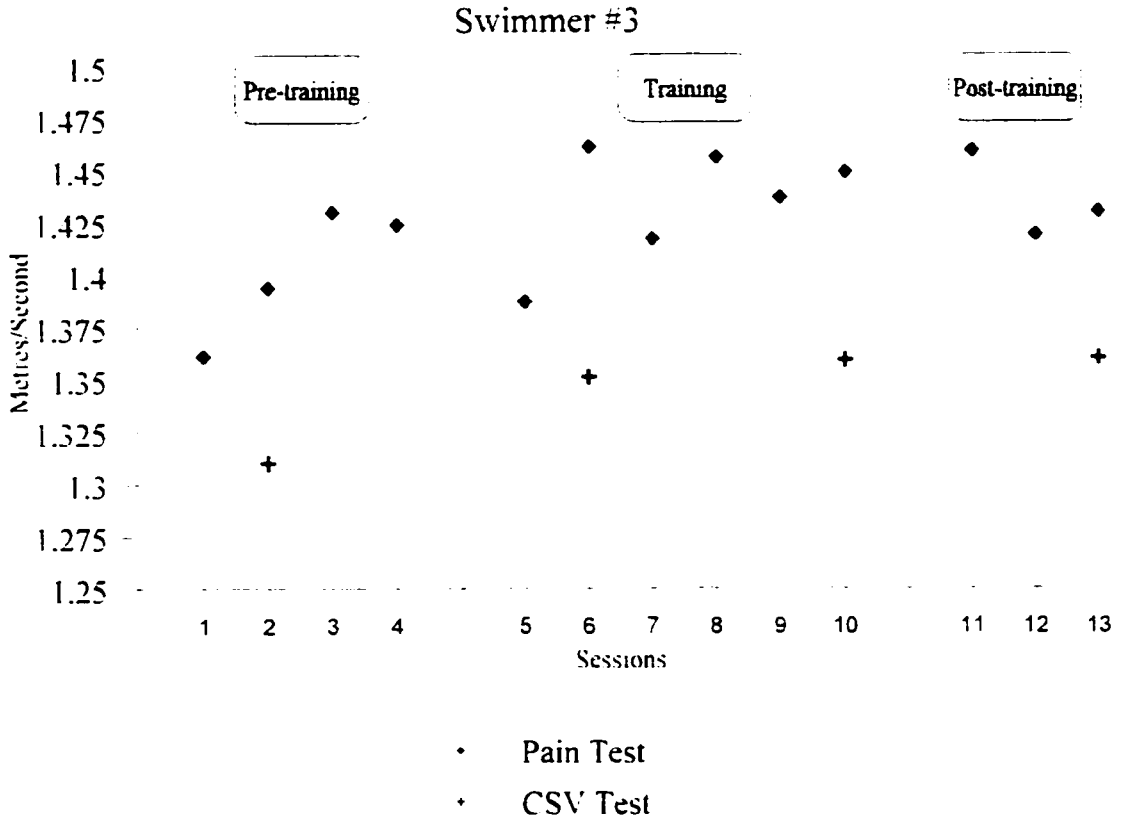

Figure 8: Heart rate test swims and critical swimming velocity results for Swimmer #3.

slightly increased to 1.436 m/s during the post-training phase. This change in

performance equates with a 2.5% improvement which would be equivalent of a 25 second improvement in a 1500 metre distance swim. Visual inspection of the data would indicate obvious clinical significance in terms of competitive swimming. For an elite, nationally qualified swimmer a 25 second improvement would not be expected during the fourth macrocyle in which the physical demands of the training is at the heaviest. In this case, the swimmer acknowledged that the mental skills program was largely responsible for her dramatic improvements on the difficult test set.

Critical swimming velocity (CSV) showed a improvement from the 2nd week to the 6th week of the testing schedule. From the 6th week until the 13th week the CSV scores held relatively constant with a slight increase during the final weeks. Swimmer #3 indicated that she also used the mental skills during the CSV test which is understandable considering her confidence in the mental skills program. The CSV results provide evidence that the mental skills were effective in improving both the heart rate test swim results and the CSV scores. Once again, considering the physical demands of the swim training, these results are promising since she was able to improve her swimming at a time when many athletes are most tired and physically sore.

Swimmer #4 Swimmer #4 showed little improvement in swim times on the heart rate test swims from pre-training to post-training (see Figure 9). During the pre-training phase the average metres/second of the two baseline swims

was 1.296m/s. This was improved to 1.307 m/s during the training phase and was held at 1.303 m/s during the post-training phase. This change in performance equates with a .8% improvement which would be equivalent of a 10 second

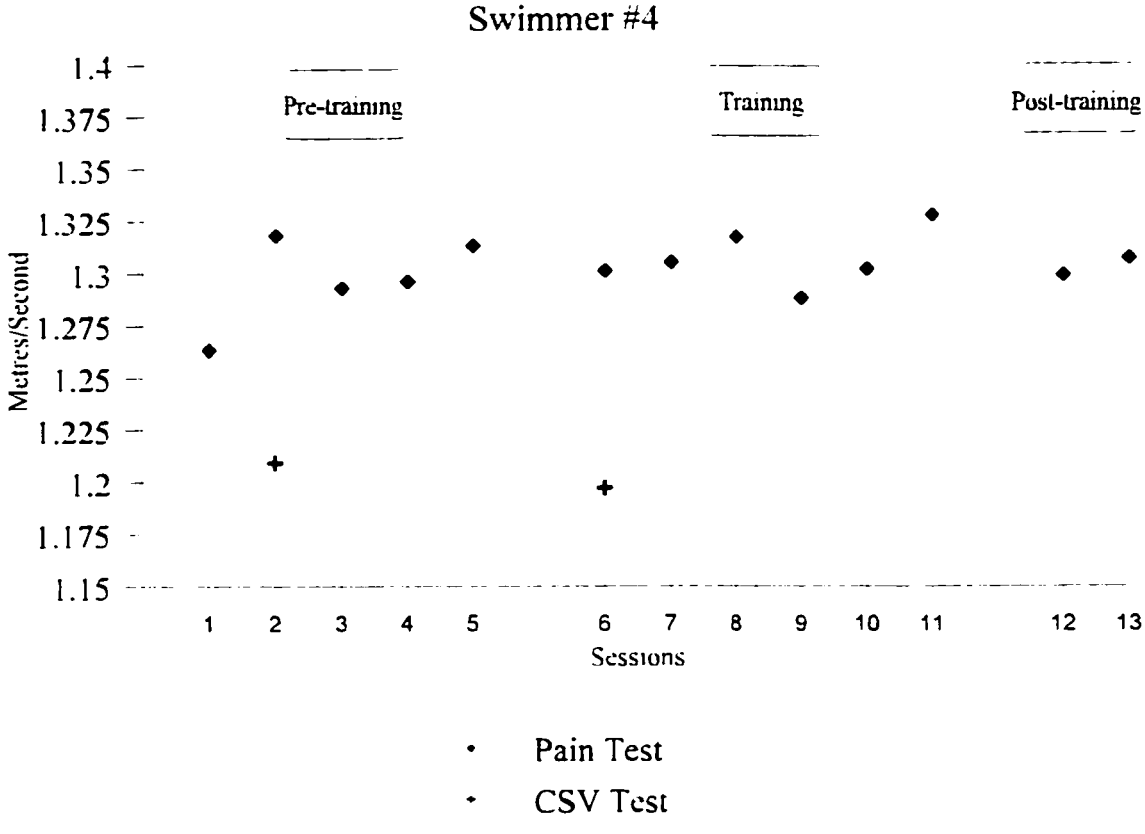

Figure 9: Heart rate test swims and critical swimming velocity results for Swimmer #4.

improvement in a 1500 metre distance swim.

Swimmer #4 was a good swimmer but started her competitive swimming career much later (13 years old) than most other competitive swimmers. Her lack

of experience in competitive swimming would place her in the novice swimmer category even though she is much older than most "novice" swimmers. Novice competitive swimmers often see dramatic improvements in stroke efficiency and race time. On the contrary, experienced, elite swimmers will see improvements come slowly through persistent effort and diligent practice. Therefore, the heart rate test swim results for Swimmer #4 cannot be considered clinically significant because of her inexperience in competitive swimming and the likelihood that she would have improved with or without the mental skills program.

Swimmer #4 was tested for CVS on the 2nd and 6th weeks of the study. For reasons that were not controllable, she was unable to establish CSV scores on the 10th and 13th weeks of the study. The first two CSV scores indicate that she was unable to maintain CSV during the heavy time of the season. However, with only two assessments it is difficult to provide a complete and accurate statement of results for this subject.

Perceived Pain Intensity

Pain is different for every person and while a particular event may cause excruciating pain for one person it will be only noticeable to another. One person with a facial cut will find it extremely painful whereas another person will hardly notice it. Pain in the competitive swimming environment is no different. Each competitive athlete will perceive pain differently depending upon a number of factors such as: swimming experience, psychological outlook, level of physical

fitness, training program, and life experiences. Since pain and the tolerance of it is individual in nature, it is not appropriate to make comparisons between athletes on their perceived pain level. Even if it was possible to know what the "actual" pain level was, each athlete would provide a different rating of the pain and its effects. Pain measurement must rely on self-report and evaluation and trust that the person is telling the truth. Analysis of the pain ratings in this study compared each athlete on individual perceived pain ratings for the 13 heart rate test swims.

Perceived pain ratings were compared with the heart rate test swims to determine if there was a relationship between pain level and swimming performance. None of the correlations were significant but some relationship trends were identified. Swimmer #1 showed the strongest correlation ($r = -.469$) which indicates a negative relationship between swimming performance and perceived pain. This makes intuitive sense since more physical effort is likely if the pain were to be reduced. Swimmer #3 also demonstrated a similar relationship with perceived pain and swimming performance ($r = -.318$). Swimmer #2 and #4 showed almost no relationship, positive or negative, with perceived pain and swimming performance. It is interesting to note that the two athletes that were most successful in improving heart rate swim times demonstrated the strongest relationship between performance and perceived pain.

This finding is contrary to the results of Study #1 in which a positive relationship was found between swimming performance and perceived pain by

those swimmers that were successful in improving critical swimming velocity. It is possible that the longer intervention program in Study #2 may have helped those swimmers to more effectively lower their perceived pain intensity while increasing their physical exertion level. An alternative explanation is that the subjects learned to focus on the sensory qualities of pain which could result in a lowered perception of the detrimental effects of pain even though pain intensity remains high. However, further research may provide better insight into the interesting relationship between perceived pain intensity and athletic performance.

Profile of Mood States

Profile of mood states was used to assess whether or not mood levels were relatively consistent or inconsistent from one swim test to the next. By adding up the six confirmed scales of POMS, it is possible to arrive at a Total Mood Disturbance Score (TMD). The TMD score was used to determine overall mood level. Each of the swimmers evidence considerable variance in TMD scores over the 13 weeks with Swimmer #4 having the least variance (SD = 7.104) and Swimmer #3 having the most variance (SD = 27.343). Pearson moment correlation analyses indicated a negative relationship with TMD scores and swimming performance on the heart rate test swims with three of the swimmers. This is expected since the lower the TMD score the more vigor and less fatigue that the swimmer has prior to swimming. Swimmer #2 demonstrated a significant relationship of .-503 ($p<.10$) whereas Swimmer #3 showed virtually no

relationship between overall mood levels and swimming performance. It is interesting to note, however, that Swimmer #2 had a strong negative relationship between her TMD scores and ratings of perceived discomfort (r = -.408).

POMS scores were also analysed to identify if the classic "iceberg" profile was evident prior to any of the heart rate swim tests. Morgan (1980) and Morgan, Brown, Raglin, O'Connor, and Ellickson (1987) labelled a POMS profile that was low on the negative factors of tension, depression, confusion, anger, and fatigue but high on the positive state of vigor as an Iceberg Profile. Morgan and associates looked at wrestlers, rowers and runners and found that in over 85% of the studies the iceberg profile was identified in elite athletes. In this study, Swimmers #1, #3 and #4 demonstrated an iceberg profile 5, 6 and 13 times, respectively. Having an iceberg profile did not make any significant difference to the overall heart rate swim times.

Reported Method of Coping with Pain

The qualitative data from the open-ended question was categorized into one of five categories: (a) relaxation, (b) attention diversion, (c) self-coaching, (d) physical adjustments, and (e) negative attribution patterning. Negative attribution patterning is a negative reaction to physical discomfort in which swimmers make irrational statements about the severity of the discomfort and lose control of their performance.

From the 52 heart rate swim tests, 77 statements were made by the

swimmers about how they attempted to endure the accompanying pain. Of the 77 statements. 81% of them were made during the training and/or post-training phases. This is most likely because during the pre-training phase the swimmers had little idea of how to tolerate the pain other than to say " I tried to push through". Broken down into the five categories: 30% of the responses stated using relaxation. 24% attention diversion. 19% self-coaching. 17% physical adjustments. and 10% negative attribution patterning.

Discussion

The purpose of the study was to examine a mental skills program designed to improve athletic pain tolerance in competitive swimmers. Pain tolerance was measured through the use of an aerobically based swim test called the heart rate set. Critical swimming velocity (Smith. 1992) was assessed during the study to compare with swimming velocities from the heart rate set. Since the heart rate swim test placed subjects into a state of physical discomfort and/or pain. it was assumed that an increase in swimming velocity would see a corresponding increase in the pain level and the need for increased pain tolerance.

Pain tolerance is an individual skill and each athlete will have different levels of pain tolerance under different situations (Whitmarsh and Alderman. 1993). Each of the four subjects showed an increase in swimming velocity from the pre-training phase. into the training phase and finally into the post-training

phase. However, swimming velocity increases of clinical significance were evident with only two of the swimmers. Interestingly, the two swimmers with significant performance improvements were the two that had been most successful as competitive swimmers with one being a national qualifier. Similar results were found in research using the mental skills program for pain management (Whitmarsh and Hogg, 1996).

Ratings of perceived discomfort played a different role with each athlete. The swimmers that were successful in improving swimming velocity in the heart rate set demonstrated a negative relationship of perceived pain and swimming velocity. The unsuccessful swimmers demonstrated virtually no relationship with perceived pain and swimming velocity. This provides an indication that the successful subjects were able to more effectively control the debilitating effects of the perceived pain while improving swimming performance. This facilitates performance improvement by allowing athletes to increase their effort level after they have sufficiently managed the corresponding pain level. This is not consistent with other research conducted using the mental skills program for pain management (Whitmarsh and Hogg, 1996) and further investigation is required.

One of the challenges that becomes most evident in this study is that of conducting intervention research within the field setting. Studies conducted in the safe confines of the laboratory or classroom allow for much greater control of the numerous variables that can affect the data. While it is valuable information to

know if an intervention package is effective in the laboratory it is most essential, for the applied sport psychology practitioner, to know that an intervention package will be effective in the actual sport setting. If an intervention program is only effective in the laboratory then what is its ultimate value in the sport setting? However, controlling all extraneous variables is not possible in the athletic setting.

In the present study, swimmers not only participated in this physically difficult study but also maintained their heavy swim training and weight training schedule. As a result, swimmers participated in the heart rate swim sets after heavy weight training or difficult swim training the day before. It is simply unrealistic to ask coaches and elite athletes to take 13 weeks or one full macrocycle off to participate in a physically demanding study. These difficulties must be taken into account when conducting field research particularly research that requires heavy psychological and physiological commitment on the part of the athletes during the training/competitive season.

This research provides support that a mental skills pain management program may improve athletic pain tolerance among some athletes. However, all athletes are different in the way they respond to training and instruction and need to be treated as such. It became clear from this study that there are two significant areas that must be addressed to make the mental skills pain program more effective. First, mental skills intervention programs for pain tolerance must take a closer look at individual differences between athletes. Developing individual

programs to cater to personality characteristics may prove to beneficial. This would require developing an intensive personality profile based on personal interviews and various personality inventories such as Cattell's Sixteen Personality Factors Questionnaire (16PF) or Minnesota Multiphasic Personality Inventory (MMPI). A personality characteristic such as hardiness would be worth investigating since Goss (1994) found that hardy swimmers experienced fewer mood disturbances, had lower feelings of fatigue with higher feelings of vigor, and possessed more adaptive coping behaviors.

Second, it seems necessary to take a step back from the intervention approach and re-evaluate the role that pain and the tolerance of pain plays in swimming performance. A phenomenological research method would be valuable for assessing process variables such as pain perception. Pain perception is a complex concept and could contain rich data as to how the athlete perceives and deals with or fails to deal with it. A phenomenological research method could tap into to the essence and meaning which people ascribe to the phenomenon as they experience it. Knowledge gained from this type of study could then be used to make appropriate changes to a mental skills pain management program for future interventions.

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CHAPTER 4

Competitive Swimming and Athletic Pain Perception

The athlete's capacity to tolerate pain is among the most important features of sporting success (Anshel and Russell, 1994). However, pain is experienced differently in various sports and in a unique way by different athletes. The perception of pain is dependent upon physiological, psychological, environmental, and situational factors. Whitmarsh and Hogg (1997) concluded that for mental skills training to be effective in altering athletic pain tolerance it is essential that the trainer have a good understanding of how athletes perceive pain. Comprehending how a competitive swimmer perceives pain, understanding the training and competitive environments, and being aware of the physiological and psychological dimensions of pain perception, allows the coach or mental skills trainer to individualize the mental skills program and increase the chances that the program will help the swimmer manage pain more effectively.

Pain tolerance goes beyond one's physiological condition and it is apparent that situational and social influences are highly relevant determinants of pain tolerance. An important objective of athletes is maintaining optimal effort and skilled performance while and after experiencing pain during the contest, and

following rehabilitation (Anshel and Russell, 1994). Athletes involved in aerobic training seem to have a lowered perception of pain during or following exercise. Vecchiet, Marini, Colozzi, and Ferolki (1984) conducted a study on muscular pain sensitivity. Using two sodium chloride (1 minute and 60 minutes post-exercise) injections into the vastus lateralis of the left quadriceps following a 30 minute stationary cycling session, they found that pain from the injection persisted longer after the second injection than the first injection subsequent to aerobic exercise. They concluded that previous aerobic exercise produces a hyperalgesic effect after exposure to a painful stimulus. Janal, Colt, Clark, and Glusman (1984) reported that running 6.3 miles at approximately 85% of maximal aerobic capacity reduced pain ratings following application of an ischemic pain stimulus in male subjects. An ischemic pain stimulus is a pain induction method that involves increasing pressure against the thumbnail with a small hammer. Koltyn, Garvin, Gardiner, and Nelson (1996) in a cycling study showed that pain threshold and pain ratings were significantly altered following exercise, but did not change significantly after quiet rest. Pain threshold increased significantly immediately following exercise and remained elevated for at least 15 minutes post-exercise. Along with the change in pain threshold, pain ratings were significantly lower in the exercise condition.

This study is a phenomenological examination of pain perception with competitive swimmers. It was felt that the area of pain perception is a complex

concept and could contain rich data as to how the athlete perceives and successfully deal with or fails to deal with pain. The pain experienced by swimmers is associated with heavy aerobic and anaerobic activity in training and competition. Knowledge from this type of study could then be used to further develop mental skills training packages designed to help competitive swimmers and other endurance athletes manage pain more effectively. The purpose of the study is to examine the ways in which competitive swimmers perceive pain and the role that pain tolerance plays in swimming performance.

Method

Multidimensional scaling and hierarchical cluster analysis were used to develop a graphic conceptual framework of the perceptions of pain in competitive swimming by elite swimmers. Specific research questions addressed in this study included: 1) What were the reported athletic pain experiences of competitive swimmers? 2) What were the themes or categories underlying their identified experiences?

Concept mapping is a structured conceptualization process which consists of four main components. First, statements were generated about pain in competitive swimming from elite swimmers through the use of a detailed interview. Second, redundant or ambiguous statements were removed to eventually arrive at a final set of 98 statements. Third, the interrelationships

between the statements were articulated by having a group of sorters organize the statements into sets containing a common theme. Multivariate statistical techniques were applied to this information to determine underlying categories. Finally, the concepts generated were depicted in the form of a spatial map which represents the ideas of interest.

Phase One: Generation of Statements

Participants. Five female competitive swimmers and four male competitive swimmers ranging in age from 18 to 22 years were interviewed. Participants were experienced swimmers (mean = 9.6 years) and competed at either a provincial (N=1) or national level (N=8) as determined by standardized qualifying times. Swimmers were recruited on a volunteer basis to participate in a structured interview lasting approximately one hour. Demographic data describing the nine interviewed swimmers are summarized in Table 3.

Procedure. Participants underwent structured interviews in which they were asked to respond to a series of 18 open ended questions. These questions were intended to address the first research question of exploring the athletic pain experiences of competitive swimmers. Questions were developed based on earlier research conducted by Whitmarsh and Hogg (1997) and on discussions with experienced swim coaches.

After each interview was completed, the specific statements were compiled

Table 3

Characteristics of Male and Female Competitive Swimmers Interviewed

Participant	Age	Gender	Competitive Swimming Experience	Best Swimming Events	Competitive Level
1	20	Female	10 years	200m Backstroke 100m Backstroke 200m Freestyle	Provincial
2	21	Female	10.5 years	100m Butterfly 200m Butterfly 50m Freestyle	National Qualifier
3	22	Male	6 years	100m Backstroke 50m Backstroke 100m Freestyle	National Qualifier
4	20	Male	11 years	400m Individual Medley 400m Freestyle 200m Butterfly	National Team
5	20	Female	8 years	100m Breaststroke 200m Individual Medley 400m Individual Medley	National Qualifier
6	18	Male	10 years	200m Butterfly 100m Butterfly 50m Butterfly	National Qualifier
7	20	Male	11 years	100m Butterfly 200m Butterfly 100m Breaststroke	National Qualifier
8	19	Female	10 years	100m Butterfly 200m Backstroke 200m Butterfly	National Qualifier
9	19	Female	10 years	200m Backstroke 100m Butterfly 200m Butterfly	National Qualifier

to formulate an original list of 397 statements generated by the 9 competitive swimmers. The next step consisted of putting the statements through four different editing periods in order to remove reference to gender, to correct some errors in

grammar and spelling, and to eliminate ambiguous and redundant statements. The process of compiling a final master list from the original list consisted of reviewing the statement list of the second swimmer and comparing to the statement list of the first swimmer. Any statements that had not been previously stated by the first swimmer were added to the new master list. Then, the third statement list was reviewed and new statements were added to the master list. This process continued until statements of all nine participants were reviewed. In this way, all redundant and ambiguous statements were removed. Through this process the original list of 397 statements was reduced to 98 statements.

The original list and the final master list was then evaluated independently by an experienced swim coach and a university graduate to see if the statements in the final master list captured the essence of the original statements so that no key ideas had been omitted. Having an experienced coach and university graduate, not associated with the study, helped to increase the validity of the editing process since they were able to make objective and unbiased decisions about statement selection and omission. Based on their recommendations, some of the statements were adjusted to more accurately reflect the essence of the original 397 statements. The final master list of statements can be seen in Table 4.

Table 4

Final Master List of Competitive Swimmer Statements

Number	Statement
1.	There is always some part of my body that will be sore.
2.	If I am doing a lot of training then pain will affect my performance.
3.	I try not to let any negative thoughts I have before I swim affect me.
4.	I try not to think about the pain until after I am done.
5.	There is no pain when I don't put any effort into my swimming.
6.	I experience more pain at the more important meets
7.	I push myself physically and mentally at important meets to do my best.
8.	If I do not have a specific mental goal in mind then the physical pain will get worse.
9.	If I know that I am behind then I won't push myself and the physical pain is less.
10.	If I am out in front I try a lot harder to stay ahead and I feel the physical pain more.
11.	I need to be focussed in sprinting to deal with the pain.
12.	I use my legs a lot during middle distance swims and by the time I am done I can hardly feel them.
13.	The pain interferes with my enjoyment of training camps. makes me feel like I can't go anymore. I get cranky, and I just want to quit.
14.	I experience mental pain trying to get myself psyched up for a workout or race.
15.	When I am sore or stiff I will take it easy until the physical pain is gone.
16.	The coach is a good motivator so I push myself and do not experience much mental pain.
17.	There is more physical pain in training.
18.	Negative thoughts like" should I stop?" or "can I keep going or not?" are always going through my head.
19.	I try to lengthen my stroke and lessen the frequency so that I am using the least amount of energy to cover a certain distance.
20.	The physical pain is the same whether I am winning or losing the race.
21.	I can handle the physical pain better when I am winning.
22.	I don't really notice the physical pain in sprints because the race is so short.
23.	The mental pain increases in longer races.
24.	Doing weights as part of my training produces the same level of pain as swimming.
25.	I can always talk to someone on the team about how I feel or get someone to help me stretch.
26.	I experience motivation when I know that I have worked hard.
27.	I stretch really well before I get in to swim.
28.	I try to enjoy being there and just to have fun and not worry about doing good or bad.
29.	I try to train hard so that I am in good shape.
30.	I eat the right foods so I'll have enough energy and then maybe will not experience as much physical pain.
31.	Every muscle feels sore and fatigued
32.	I start to feel the pain when I am getting tired.
33.	Motivating myself is mentally painful.
34.	Sometimes before I swim I'll still have physical pain from a previous practice
35.	The amount of physical pain in competition depends upon how mentally prepared or unprepared I am and how well I can keep my focus.
36.	Sometimes the pain is intermittent.
37.	I try to be mentally and physically prepared for every meet and race.

Table 4 (continued)

Number	Statement
38.	Sometimes I just want to get the set over with so I'll push myself harder so I can finish faster which will make the physical pain worse.
39.	When I am ahead. I am in a state of flow and I don't notice the pain.
40.	When I start the race I 'm focussed on my start and I can keep focussed for the first couple of lengths.
41.	Pain in sprinting is mostly mental.
42.	I experience similar pain in other sporting activities because I always put in my best effort.
43.	I experience anxiety wondering when practice will end and I can stop.
44.	I experience frustration/anger if I have to keep swimming even when I am in pain.
45.	I use specific words like smooth to keep my stroke smooth and flowing.
46.	It helps to know that other people are going through the same thing.
47.	I don't get tired mentally unless I am sick and then I just feel like giving up.
48.	It feels like you can't move your arms one more time around.
49.	If pain doesn't hit until near the end I feed off it- I think" I'm almost done let's see how much I can make this hurt".
50.	Before I swim I feel good because I enjoy swimming and I get excited about it.
51.	I can't commit myself to hurting (physically) as much in practice as I do in competition.
52.	I go into complete body collapse and have problems walking when I'm done a race.
53.	When I feel pain my stroke is the first thing to go (change).
54.	In the middle when I start hurting (physically) its really hard to keep going because that is when I hurt the most.
55.	I never experience mental or physical pain before a race.
56.	I enjoy swimming and pain just happens to be a part of it and I accept that.
57.	I use a lot of visualization before the race so when I get to the race there is not any unexpected feelings and I can focus on my race.
58.	I experience physical pain when I push my body beyond the comfort zone.
59.	My mental frame of mind going into a race is important and the more important a meet the more important a positive frame of mind.
60.	When I am losing it's not only the physical pain that gets to me but it's also the mental pain of losing.
61	I think about the stroke and usually I focus on the clock and my times.
62.	If I start hurting too early in a race I start wondering whether or not I'll be able to finish so I have to slow down and pace myself.
63.	I feel physical pain while I'm training but after I'm done the pain doesn't last.
64.	The physical pain from swimming the race will last longer after the race is over because I put all the energy and strength I have into the race.
65.	The physical and mental pain are related because when I physically start to hurt the mental pain gets worse too.
66.	I get angry when I don't make set times.
67.	Relaxation training was helpful because it helped me relax and it lessened the mental pain.
68.	There is lots of mental pain because I work so hard to get a win or be in a certain position.
69.	Sometimes I train better when I'm sore.
70.	During high season at training camps I hurt all the time.
71.	At the big meets I know what it took me to get there and I usually know where I stand so it is not as mentally painful.
72.	I usually think about the pain too much and I tell myself to take it easy or else I am going to die.

Table 4 (continued)

Number	Statement
73.	If I sleep wrong the night before it can affect me both physically and mentally.
74.	The pain in sprints is a sharper pain and I'm trying to go as fast as I can.
75.	I have got goals to work for and I force myself to push through the pain and I am willing to take more pain.
76.	I usually try to lighten the atmosphere by joking around so I can relax more and then I will be able to deal with the pain better.
77.	In races, I feel pain in certain areas depending upon which parts of my body I work more
78.	I experience pain before, during, and after swimming.
79.	In training, I go hard and I push until I am done the sets and until I have nothing left to give - my whole body hurts.
80.	When I race I try to have a certain strategy and there will be times in a race when my legs will hurt so I will concentrate on my arms more or vice versa.
81.	Sometimes I just do not want pain so I will swim slower and stay in my comfort zone and not push myself as hard as I can.
82.	Sometimes it helps to increase my arm speed and keep the rhythm of the stroke.
83.	If I do not feel like swimming on a particular day the pain affects me more.
84.	I do feel pain in other sports but mostly its a direct pain in specific areas.
85.	I sometimes feel like I can't take anymore and I just want to cry
86.	I get nervous before competitions.
87.	I like to use distraction techniques such as concentrate on my stroke, sing songs, add numbers, think about what I would rather be doing, or think about someone I hate and pretend they are experiencing the pain.
88.	I give myself positive reinforcement and tell myself to keep going and that I can do it.
89.	At this level, it is really up to the athlete whether or not she will use the strategies to help tolerate pain.
90.	I find it hard to breathe.
91.	I get an overall feeling of deadness while racing, all my energy is gone and I can't move without pain.
92.	A negative attitude and low motivation will always make the pain seem worse.
93.	Generally, if I am leading the race the pain seems almost irrelevant; just happy that I am winning.
94.	I sometimes give up and convince myself that my pain is worse than it actually is - as if pain will somehow justify swimming slow or losing.
95.	Pain is part of the sport and some pain is good and it pushes you to get past it and advance to a higher level.
96.	You never enjoy the pain while you are experiencing it, but the rewards you get are worth it.
97.	I am tolerant of the pain if I am in a good mood when I am experiencing it.
98.	When I am in a bad mood and experience pain, I get angry and pouty and very testy and I tend to perform worse.

Phase 2: Structuring of Statements

The second phase involved three distinct tasks, the rating of statements by

competitive swimmers, the sorting of statements by theme into categories and then analyzing the categories using the concept mapping procedure. The rating task was completed by eight competitive swimmers different from the original swimmers who were interviewed to create the final master list of 98 statements. The purpose of the rating task was to determine if the experience of pain in swimming, as indicated by the nine interviewed swimmers, was similar to the pain experienced by other competitive swimmers. The raters were either provincial or national level swimmers, included 5 males and 3 females, and ranged in age from 13 to 18 years with a mean age of 15.4 years. Raters were asked to rate each statement, based on their own experience as a competitive swimmer, using a 5-point likert scale asking how strongly they agreed with the statements. Descriptors were provided for each point and ranged from 1 = do not agree at all, to 5 = completely agree.

The sorting task was completed by ten people and included 1 swim coach, 2 university varsity coaches, 1 elite athlete, and 7 university graduates. Six men and four females completed the sorts. The ages of the sorters ranged from 21 to 38 years and the average of the sorters was 28.4 years. Using index cards with one statement on each card, sorters were instructed to categorize the 98 statements into themes that made sense to them based on similarity of content and the meaning of the statements. Final sorting results can be seen in Appendix E (pp. 217-220). Sorters were instructed that each statement could only be placed into one pile and

that there could not be one pile of 98 statements or 98 piles with one statement each. Sorters were told that the procedure would take approximately 45 minutes to complete.

Data Analysis The data analysis was conducted and concept maps produced using the Concept System computer software designed by Trochim (1989) to implement the concept mapping procedure. Individual matrices, also termed binary symmetric similarity matrices, were computed for the sorted items. The individual sort matrices were then aggregated to obtain a combined group similarity matrix. The data from the group similarity matrix were then subjected to a nonmetric multidimensional scaling (MDS) procedure with a two-dimensional solution. In concept mapping, the multidimensional scaling analysis creates a map of points which represent the set of statements based on a similarity matrix which resulted from the sorting task (Trochim, 1997).

Typically, when multidimensional scaling analysis is conducted, the analyst can choose the number of dimensions that the set of points can be displayed in. An analyst could ask for any number of solutions from 1 to N-1 dimensions. If a one-dimensional solution is requested, all of the points will be arrayed along a single line. A two-dimensional solution places all the points into a bivariate distribution which is suitable for plotting on a X-Y graph. However, most researchers have found that it is difficult to graph and interpret solutions which are higher than three-dimensional easily (Trochim, 1997). Kruskal and Wish (1978)

stated that when MDS configuration is designed primarily as the foundations on which to display clustering results, then a two-dimensional configuration is far more useful than one involving 3 or more dimensions.

The analysis created a two-dimensional point map representing an X-Y coordinate for each statement. This is based on the criterion that statements piled together most often are located closer together, whereas those sorted less frequently together are sorted further apart. A final stress value was then computed for the two-dimensional solution of the MDS analysis. The stress value is a numerical index of the stability of the MDS solution and ranges from zero (perfectly stable) to one (perfectly unstable) (Daughtry and Kunkel, 1993).

The data from the MDS similarity matrix was then subjected to a hierarchical cluster analysis to group sorted items into internally consistent clusters. In this process, the cluster solution is superimposed on the MDS point plot. Cluster analysis is well suited for direct measures of proximity such as MDS matrices (Borgen and Barnett, 1987). The Concept System computer software designed by Trochim (1989) uses Ward's (1963) minimum variance method to identify the maximum degree of distinctiveness between clusters. Following the statistical analysis and based on the inspection of the grouped items the initial 19-cluster solution was examined which averaged about five statements in each cluster. Then, successively lower cluster solutions were explored with the goal to maintain the integrity of the MDS results and arrive at a final cluster solution that

preserved the detail and yielded substantively interpretable clusters (Trochim, Cook, Seltze, 1994).

Results

Multidimensional Scaling

The MDS procedure resulted in a final stress value of .313 for a two-dimensional solution. This stress value represents a reasonably stable solution since the stress value is an index of stability and ranges from zero (perfectly stable) to one (perfectly unstable) and indicates the total variance that accounts for error. Knish (1994) in a study exploring the beliefs of chronic low back pain sufferers obtained a final stress value of .27 for a two-dimensional solution. Williamson (1997) accepted final stress values of .29 and .32 respectively for a two-dimensional solution in her study on the impact of acute myocardial infarction on the quality of life of patients and their partners.

The two-dimensional point map of the 98 competitive swimmer statements is presented in Figure 10. Each statement produced by the swimmers is represented by a dot or "point" with the number identifying the statement beside it. The placements of the points is derived from the MDS solution which spatially represents a two-dimensional matrix of proximities. The distance between the points represents the frequency with which the pain perception statements were sorted together by the sorters. Points that are relatively close together represent

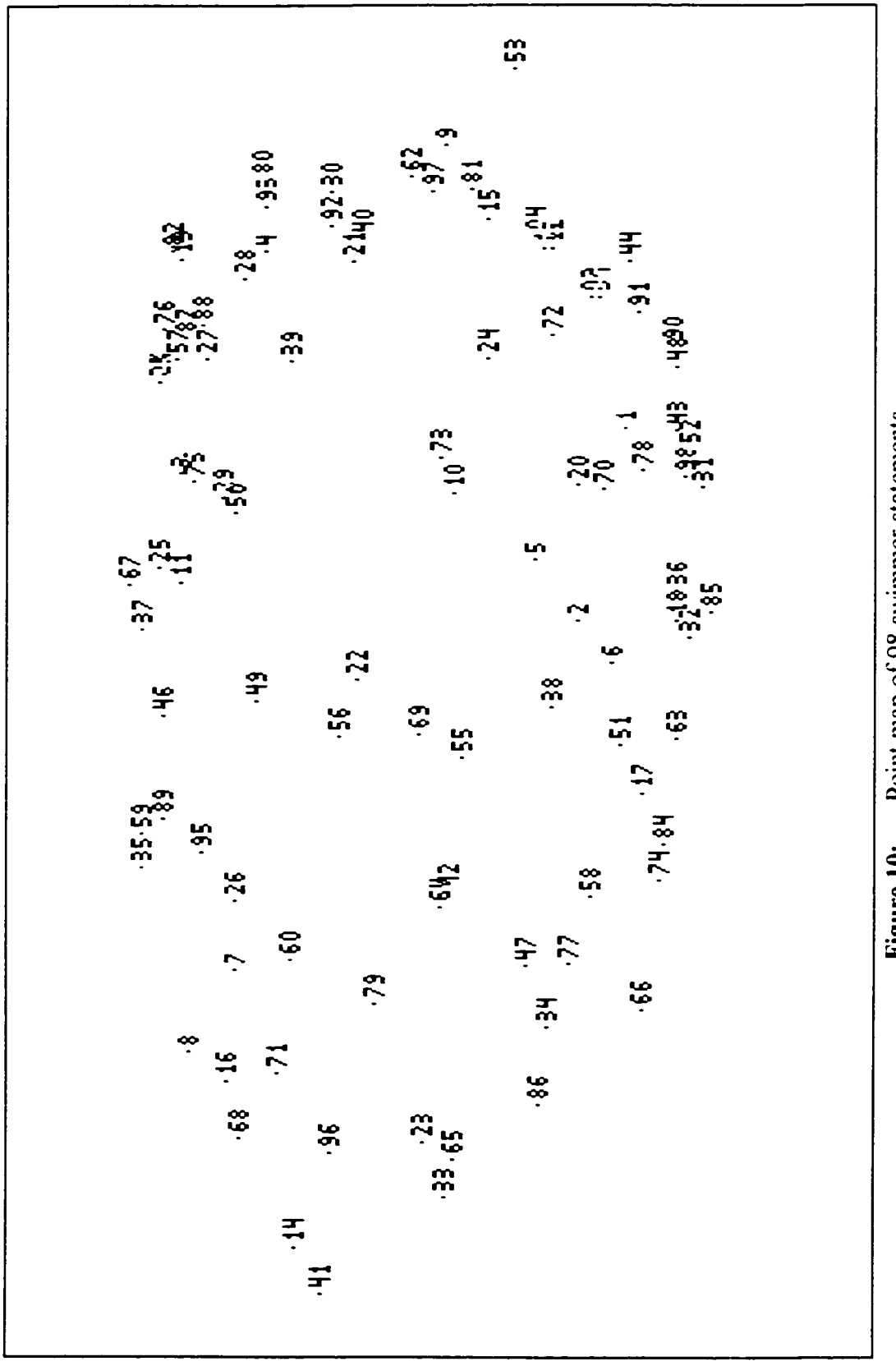

Figure 10: Point map of 98 swimmer statements.

items that were placed together by the sorters more frequently than items represented by points more distant from each other. For example, at the top of the point map (see Figure 10), statement #37 (I try to be mentally and physically prepared for every meet and race.) and #67 (Relaxation training was helpful because it helped me relax and it lessened the mental pain.) were located close together, as expected given their conceptual similarity. Statements that lack conceptual similarity are far apart on the point map such as statement #53 on the far right (When I feel pain my stroke is the first thing to go (change) and statement #41 on the far left (Pain in sprinting is mostly mental.)

Cluster Analysis

The second quantitative analysis in the concept mapping process is the hierarchical cluster analysis. The purpose is to group individual statements on the map, using Ward's (1963) minimum variance clustering technique, into clusters which reflect similar concepts.

The cluster analysis partitioned the MDS configuration for the competitive swimmers' point map into a nineteen cluster solution (one fifth of the total number of statements). There is no simple mathematical criterion for selecting the number of clusters for the final concept map. Trochim (1989) suggests that all cluster solutions from 20 to 3 clusters be initially examined. Furthermore, he suggests that all cluster solutions be considered suggestive and some may need adjustments based on visual inspection. He also maintains that the mathematical basis for the

multidimensional scaling is stronger than that of the cluster analysis and therefore more weight should be given to the multidimensional scaling. Trochim, Cook, and Seltze (1994) indicate that discretion in examining different cluster solution is a must to ensure that the concept map is neither too fragmented or too general making it difficult to interpret.

Keeping in line with the strength of the multidimensional scaling as opposed to the cluster analysis, the computer program provides a bridging index for each point and an average bridging index for each concept. The bridging index is calculated as the weighted average of the distances between the item and all the other items contained in the multidimensional solution found on the concept map (Trochim, 1994 (cited in Knish, 1994)). In other words, the index is to help determine whether an item is a good representation of the space it occupies or whether it is located as a compromise by the MDS algorithm. The bridging index is represented by a number between 1 and 0. A higher value indicates that an item is more likely a "bridge" item having been sorted with many other statements from different locations on the map. The lower bridging index values indicate that the item was sorted primarily with the statements that are located close to it on the point map. In general, the lower the bridging, the more central the statement is for the meaning of the cluster.

In the present study, careful examination was made of the initial 19-solution cluster solution along with an examination of successively lower (15, 12, 10, 9, 8,

7, 5, 3) cluster solutions to arrive at a final cluster solution. A judgement was made for each cluster solution to determine if the merger seemed reasonable and allowed for labeling and interpretation of the concept solution.

The 19-cluster solution was far too fragmented making it difficult to interpret. Next, successive lower cluster solutions were examined. The 3-cluster solution was extremely general and clusters contained more than one theme. Themes of coping strategies, mental attitude and description of pain were included in one cluster. It was recognized that a more sensible partition of the clusters was required. Fifteen, twelve, and ten cluster solutions seemed to also be too fragmented even though much improved from the 19-cluster solution. It was evident, based on systematic analysis of the different cluster solutions (19, 15, 12, 10, and 3) that the most appropriate cluster solution would be somewhere between 9 and 3 clusters.

As the number of clusters decreased the right side of the concept map began to take shape and distinct, interpretable clusters formed. For example, the 6-cluster solution combined two concepts, evident in the 7-cluster solution, into the common concept theme of description of pain while maintaining the bridging index. The bridging index of the two clusters were .08 and .20 respectively while the combined bridging index was .13. The experience was similar with two clusters being combined to form the common theme cluster of experience and consequence of pain. However, the 6-cluster solution did pose some problems.

The themes of recognition of mental pain and acknowledgment of pain were combined in the 6-cluster solution. These themes are related but distinct and having them as part of the same cluster makes it virtually impossible to interpret with any degree of accuracy. In order for the MDS solution to separate those two themes it was necessary to go to the 10-cluster solution which made other aspects of the concept map too fragmented. Therefore, it was finally decided based on the MDS solutions, themes within the clusters, and the bridging indexes that a 6-cluster solution with the 6th cluster split into two would be most appropriate. Therefore, the final concept map (see Figure 11) is a 6-cluster MDS solution with a manual split of the 6th cluster into two themes (mental pain and acknowledgment of pain) resulting in a 7-cluster solution map.

Each of the 7 clusters represent major themes that came out of the 9 structured interviews with competitive swimmers and their perception of pain in swimming. Statements in each of the 7 clusters as well as the bridging index and ratings for each statement can be seen in Table 5.

Cluster #1 - Description of Pain. Cluster #1 was located on the bottom right side of the concept map and contained 18% of the items in this solution. The statements were related to the way that pain makes them feel while swimming and how they would describe the pain. Pain was described in many different ways but with the common suggestion of it being debilitating. Descriptions included pain as being sore and fatigued (#31), hard to breathe (#90), overall deadness while racing

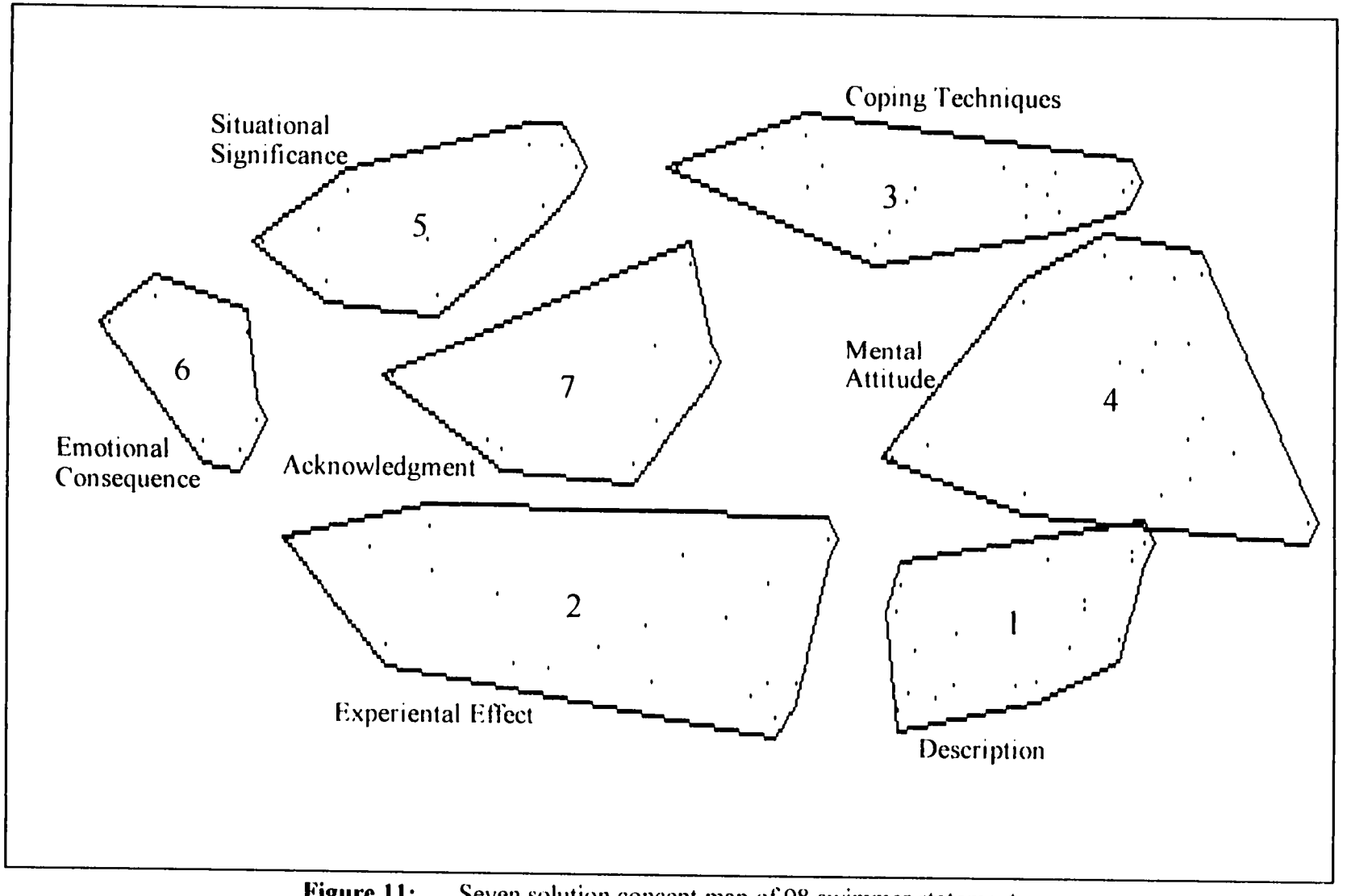

Figure 11: Seven solution concept map of 98 swimmer statements.

#91), the middle of the race hurts the most (#54), can't move arms around one more time (#48), and going into complete body collapse and having problems walking when finished racing (#52). This cluster attained the second highest average bridging index value of .13. The average rating of importance for this cluster is the lowest of the seven clusters with 2.69. This is most likely related to the individualized way of describing pain. While most swimmers recognize that pain exists each swimmer describes it in a different way and the raters may also not describe pain in the same way as the interviewed swimmers.

Cluster #2 - Experiential Effect. Cluster #2 is adjacent to Cluster #1 on the bottom of the concept map and contains 19% of the 98 statements. While some of the statements seemed similar to the ones within Cluster #1 there is a distinction between them that requires them to be in separate clusters. The statements in Cluster #2 are descriptive like the ones in Cluster #1 but the focus of most of the statements is on the experience of pain and the consequences that pain has on swimming performance. Differences in pain with or without effort (#5), pain in competition and/or practice (#51), feeling pain when tired (#32), pain when beyond the comfort zone (#58), and the bodily location of the pain (#77) are statements that are descriptive but specifically descriptive about personal experience and the consequence of pain on performance. The ratings of importance showed an average of 3.28 for this cluster. This is a higher rating than Cluster #1 because the description of pain is more individual in nature while the

experience and consequence of pain is more universal.

Cluster #3 - Coping Techniques. Cluster #3 is located at the top right of the concept map and contains 18% of the 98 statements. Coping methods used by competitive swimmers to deal with pain are varied and well-utilized. This is supported by the strength of the average rating of importance of 3.69 which was the second highest rating given of the seven clusters. The bridging index was the lowest of the seven clusters (.12) and indicates that these statements had been sorted together most of the time. Two of the items had a bridging index value of .00 such as using specific words like "smooth" to keep my stroke smooth and flowing (#45), and think about the stroke and usually focus on the clock and my times (#61). The other statements were all different types of coping methods that swimmers preferred to use to deal with the pain and they ranged from psychological methods to physical preparation strategies.

Cluster 4 - Mental Attitude. Competitive swimmers and other endurance athletes often discuss the role of mental attitude in sport performance and particularly in relation to pain tolerance. Cluster #4 confirms that it is an area of concern for competitive swimmers with thoughts about trying not to think about the pain (#4), just trying to have fun (#28), irrelevance of pain when leading a race (#93), being in a state of flow (#39), detrimental effects of a negative attitude (#92), and importance of being in a good mood (#97). Cluster #4 contains 18% of the 98 statements and is located on the right side of the concept map between

Table 5

Cluster Items, Bridging Values, and Ratings for Concept Map Of Competitive Swimmers Perceptions of Pain In Swimming.

Statements (#)	Bridging Index	Ratings
Cluster #1: *Description*		
There is always some part of my body that will be sore. (#1)	0.11	2.13
I experience pain before, during, and after swimming. (#78)	0.05	2.5
The physical pain is the same whether I am winning or losing the race. (#20)	0.12	3.13
During high season at training camps I hurt all the time. (#70)	0.11	3.75
Every muscle feels sore and fatigued. (#31)	0.06	2
I go into complete body collapse and have problems walking when I'm done the race. (#52)	0.04	2.25
When I'm in a bad mood and experience pain, I get angry and pouty and very testy and I tend to perform worse. (#98)	0.14	3.13
I experience anxiety wondering when practice will end and I can stop. (#43)	0.12	2.38
It feels like you can't move your arms one more time around. (#48)	0.04	3.88
I find it hard to breathe. (#90)	0.01	3.13
I use my legs a lot during middle distance swims and by the time I am done I can hardly feel them. (#12)	0.24	3.13
The pain interferes with my enjoyment of training camps, makes me feel like I can't go anymore, I get cranky and just want to quit. (#13)	0.29	2.63
I sometimes give up and convince myself that my pain is worse than it actually is - as if pain will somehow justify swimming slow or losing. (#94)	0.24	3.13
I usually think about the pain too much and I tell myself to take it easy or else I am going to die. (#72)	0.18	2.25
I experience frustration/anger if I have to keep swimming even when I am in pain. (#44)	0.22	2.5
I get an overall feeling of deadness while racing, all my energy is gone and I can't move without pain. (#91)	0.1	2.63
In the middle when I start hurting (physically) its really hard to keep going because that is when I hurt the most. (#54)	0.14	3.13

If I do feel like swimming on a particular day the pain affects me more. (#83)	0.16	3.88
Cluster Average	**0.13**	**2.86**
Cluster #2: *Experiential Effect*		
If I am doing a lot of training then pain will affect my performance. (#2)	0.13	3
I experience more pain at the more important meets. (#6)	0.15	1.5
Sometimes I just want to get the set over with so I'll push myself harder so I can finish faster which will make the physical pain worse. (#38)	0.27	3
There is no pain when I don't put any effort into my effort into my swimming. (#5)	0.24	2.63
There is more physical pain in training. (#17)	0.18	3.38
I can't commit myself to hurting (physically) as much in practice as I do in competition. (#51)	0.25	3
I feel physical pain while I am training but after I'm done the pain doesn't last. (#63)	0.14	3.38
The pain in sprints is a sharper pain and I am trying to go as fast as I can. (#74)	0.38	3.63
I do feel pain in other sports but mostly its a direct pain in specific areas. (#84)	0.27	3.38
Negative thoughts like "should I stop?" or "can I keep going or not?" are always going through my head. (#18)	0.26	2.38
Sometimes the pain is intermittent. (#36)	0.13	3.25
I start to feel the pain when I am getting tired. (#32)	0.09	4
I sometimes feel like I can't take anymore and I just want to cry. (#85)	0.27	3
Sometimes before I swim I'll still have physical pain from a previous practice. (#34)	0.6	4.13
I don't get tired mentally unless I am sick and then I just feel like giving up. (#47)	0.53	2.63
I get nervous before competitions. (#86)	1	3.63
I experience physical pain when I push my body beyond the comfort zone. (#58)	0.36	4.75
In races. I feel pain in certain areas depending upon which parts of my body I work more. (#77)	0.48	4.25
I get angry when I don't make the set times. (#66)	0.7	3.5
Cluster Average	**0.34**	**3.28**

Cluster #3: *Coping Strategies*		
I try not to let any negative thought I have before I swim affect me. (#3)	0.12	4.63
I have got goals to work for and I force myself to push through the pain and I am willing to take more pain. (#75)	0.1	4.13
I try to train hard so that I am in good shape. (#29)	0.16	3.88
Before I can swim I feel good because I enjoy swimming. (#50)	0.19	3.88
I need to be focussed in sprinting to deal with the pain. (#11)	0.24	2.75
I can always talk to someone on the team about how I feel or get someone to help me stretch. (#25)	0.14	4.25
I try to be mentally and physically prepared for every meet and race. (#37)	0.18	4.38
Relaxation training was helpful because it helped me relax and it lessened the mental pain. (#67)	0.21	3.75
It helps to know that other people are going through the same thing. (#46)	0.29	3.25
I try to lengthen my stroke and lessen the frequency so that I am using the least amount of energy to cover a certain distance. (#19)	0.07	3.5
Sometimes it helps to increase my arm speed and keep the rhythm of the stroke. (#82)	0.13	3.75
I stretch really well before I get in to swim. (#27)	0.07	3.75
I give myself positive reinforcement and tell myself to keep going and that I can do it. (#88)	0.06	4.13
I use specific words like "smooth" to keep my stroke smooth and flowing. (#45)	0	2.25
I think about the stroke and usually focus on the clock and my times. (#61)	0	3.63
I use a lot of visualization before the race so when I get to the race there is not any unexpected feelings and I can focus on my race. (#57)	0.02	3.5
I like to use distraction techniques such as concentrate on my stroke, sings songs, add numbers, think about what I would rather be doing, or think about someone I hate and pretend they are experiencing the pain. (#87)	0.07	3.88
I usually try to lighten the atmosphere by joking around so I can relax more and then I will be able to deal with the pain better. (#76)	0.07	3.13
Cluster Average	**0.12**	**3.69**
Cluster #4: *Mental Attitude*		
I try not to think about the pain until after I am done. (#4)	0.27	3.75

I try to enjoy being there and just to have fun and not worry about doing good or bad. (#28)	0.19	2.13
When I race I try to have a certain strategy and there be times in a race when my legs will hurt so I will concentrate on my arms more or vice versa. (#80)	0.29	3.75
Generally, if I am leading the race the pain seems almost irrelevant; just happy that I am winning. (#93)	0.21	3.38
When I am ahead, I am in a state of flow and I don't notice the pain. (#39)	0.18	3.13
I can handle the physical pain when I am winning. (#21)	0.25	3.75
When I start the race I am focussed on my start and I can keep focussed for the first couple of lengths. (#40)	0.34	3.63
I eat the right foods so I'll have energy and then maybe will not experience as much physical pain. (#30)	0.4	3
A negative attitude and low motivation will always make the pain seem worse. (#92)	0.4	4.5
If I know that I am behind then I won't push myself and the physical pain is less. (#9)	0.31	1.63
If I start hurting too early in a race I start wondering whether or not I'll be able to finish so I have to slow down and pace myself. (#62)	0.26	2.38
I am tolerant of the pain if I am in a good mood when I am experiencing it. (#97)	0.37	4.13
When I am sore or stiff I will take it easy until the physical pain is gone. (#15)	0.26	2
Sometimes I just do not want pain so I will swim slower and stay in my comfort zone and not push myself as hard as I can. (#81)	0.3	2.88
When I feel pain my stroke is the first thing to go (change). (#53)	0.42	3.38
If I am out in front I try a lot harder to stay ahead and I the physical pain is less. (#10)	0.23	3
If I sleep wrong the night before it can affect me both physically and mentally. (#73)	0.3	4.25
Doing weights as part of my training produces the same level of pain as swimming. (#24)	0.28	2.88
Cluster Average	**0.29**	**3.19**
Cluster #5: *Situational Significance*		
I push myself physically and mentally at important meets to do my best. (#7)	0.39	4.63
I experience motivation when I know that I have worked hard. (#26)	0.35	4.63

Pain is part of the sport and some pain is good and it pushes you to get past it and advance to a higher level. (#95)	0.31	4.75
If I do not have a specific mental goal in mind then the physical pain will get worse. (#8)	0.46	2.13
The coach is a good motivator so I push myself and do not experience much mental pain. (#16)	0.38	4.38
There is lots of mental pain because I work so hard to get a win or be in a certain position. (#68)	0.36	2.63
When I am losing it's not only the physical pain that gets to me but it's also the mental pain of losing. (#60)	0.49	2.63
At the big meets I know what it took me to get there and I usually know where I stand so it is not as mentally painful. (#71)	0.54	3.5
The amount of physical pain in competition depends upon how mentally prepared or unprepared I am and how well I can keep my focus. (#35)	0.27	3.63
My mental frame of mind going into a race is important and the more important a meet the more important a positive frame of mind. (#59)	0.29	4.13
At this level, it is really up to the athlete whether or not she will use the strategies to help tolerate pain. (#89)	0.22	4.63
Cluster Average	**0.37**	**3.78**
Cluster #6: *Emotional Consequence*		
I experience mental pain trying to get myself psyched up for a workout or race. (#14)	0.38	1.5
Pain in sprinting is mostly mental. (#41)	0.37	3.13
You never enjoy the pain while you are experiencing it, but the rewards you get are worth it. (#96)	0.8	4.63
The mental pain increases in longer races. (#23)	0.51	3.5
Motivating myself is mentally painful. (#33)	0.52	1.88
The physical and mental pain are related because when I physically start to hurt the mental pain gets worse too. (#65)	0.59	3.88
Cluster Average	**0.53**	**3.08**
Cluster #7: *Pain Acknowledgment*		
I don't really notice the pain in sprints because the race is so short. (#22)	0.29	3.63
I enjoy swimming and pain just happens to be a part of it and I accept that. (#56)	0.27	4.13

If pain doesn't hit until near the end I feed off it - I think "I'm almost done let's see how much I can make this hurt". (#49)	0.31	3.88
I experience similar pain in other sporting activities because I always put in my best effort. (#42)	0.4	3
The physical pain from swimming the race will last longer after the race is over because I put all the energy and strength I have into the race. (#64)	0.45	3.13
In training, I go hard and push until I am done the sets and until I have nothing left to give - my whole body hurts. (#79)	0.51	3.75
I never experience mental or physical pain before a race. (#55)	0.36	2.25
Sometimes I train better when I am sore. (#69)	0.28	3.13
Cluster Average	**0.36**	**3.36**

Cluster #3 and Cluster #1. This location indicates a strong relationship between the themes of description of pain, coping methods of pain, and mental attitude towards pain.

Cluster #5 - Event Significance. Situational significance refers to the significance of the training sessions or the competitions. A competition may be significant to almost every swimmer such as a provincial or national championship or a competition may hold personal significance to a particular swimmer for any number of reasons. Swimmers indicated that they push physically and mentally at more important meets (#7), there is lots of mental pain when working hard to get a win (#68), they know what it took to get to big meets (#71), and the more important the meet the more important a positive frame of mind (#59). Statements in this cluster account for 11% of all statements and the rating of importance was the highest of all the clusters of 3.78. This indicates that most swimmers feel that

the significance of the situation plays a critical role in determining the amount and consequences of pain.

Cluster #6 - Emotional Consequence. Competitive swimmers not only experience physical pain in swimming but mental pain is also experienced. This is confirmed by this cluster in which all but one of the statements has "mental pain" as a core aspect of the statement. This cluster has the least number of statements and accounts for only 6% of the total 98 statements. This could be explained by a lack of knowledge of the mental aspects of sport by competitive swimmers. Pain in sprinting is mostly mental (#41), the mental pain increases in longer races (#23), motivating myself is mentally painful (#33), and the strong relationship between physical and mental pain (#65) are statements that represent this cluster. While Cluster #6 has the least number of statements, it is interesting to note that it has the highest average bridging index of the seven clusters with .53. This indicates that the recognition of mental pain is both a distinct theme of swimming pain experience and a universal theme intertwined within the other six themes. Interesting to note that statement #96 (You never enjoy the pain while you are experiencing it, but the rewards you get are worth it) has a very high bridging index of .80 indicating its universal appeal supported by the very high importance rating of 4.63.

Cluster #7 - Pain Acknowledgment. Cluster #7 is the final cluster and is located in the center of the concept map. This cluster contains statements that

acknowledge that pain exists in the sport such as: I enjoy swimming and pain just happens to be a part of it and I accept that (#56), I experience similar pain in other sporting activities because I always put in my best effort (#42), and sometimes I train better when I am sore (#69). The average bridging index for Cluster #7 was .28 and the average importance rating was 3.36.

Discussion

Competitive swimmers are placed in situations requiring high levels of pain tolerance whether it be in training, small swim meets, or in major competitions. Swimmers interviewed in this study generated 397 statements and almost every one of those statements indicated that pain was an integral part of the competitive swimming environment. The majority of the statements were similar in content, attitude, and flavor indicating the universality of the pain experience in competitive swimming. The seven major areas of the pain experience included: description of pain, experiential effect of pain, coping techniques, importance of mental attitude, the interaction of situational significance, the emotional consequences of pain, and acknowledgment of pain in competitive swimming.

Competitive swimmers seem to describe pain in many different and unique ways. Competitive swimmers define pain in swimming by describing the physical location, intensity level, limiting factors, and external comparisons. However, the uniqueness of pain description by the swimmers does not take away from the

commonality of the detrimental consequences of pain. Competitive swimmers agree that pain limits performance, takes away from the enjoyment of the sport, hampers training, is a necessary part of the sport, is universally experienced, and the development of effective coping methods are essential for effective pain management. The qualitative interviews confirm that an effective, tailor-made mental skills training package for managing pain in competitive swimming is desirable and necessary.

Coping techniques were utilized by all of the interviewed swimmers to varying degrees and was rated as one of the most important aspects of the pain experience in competitive swimming. Some of the techniques included physical adjustments and manipulations such as stretching but most of the techniques were cognitive-behavioral in nature. Regardless of the techniques, it was evident that swimmers experienced mental pain along with physical pain and that mental attitude played a significant role in the coping of both types of pain. Evidently, the emotional consequences of pain was a thread that was intertwined within each of the seven major themes of swimming pain as evidenced by the high bridging index.

The situation also played a significant role in the intensity and effects of the pain as evident by the high agreement rating among the raters. Generally, swimmers indicated that the more important the meet the less they experienced physical pain and usually mental pain. Training was where swimmers thought

about the pain the most, experienced it most often and found it mentally challenging to stay motivated enough to push through it. This is a challenge for swim coaches because competitive swimmers spend much more time in training than in competition. Elite swimmers could spend as much as 24 hours per week training in the pool, swim over 100,000 metres per week, and commit to 4-6 hours per week of additional training in activities such as weight training or flexibility enhancement. If competitive swimmers are going to achieve optimal management of the pain in swimming then they are going to have to learn to manage pain most effectively in training.

The parallel-processing model posits that a pain schema is formed which represents both the sensory and emotional aspects of the pain experience (Leventhal and Everhart, 1980). Fernandez and Milburn (1994) state that it is important to recognize that overall, sensory and affective pain are distinguishable features of the pain experience and should be assessed separately. In the current study, 39% of the statements represented the sensory qualities of pain and 61% of the interview-generated statements spoke about the emotional consequences of the pain experience. In fact, not only were the emotional consequences of pain a common thread between all of the themes it was established as its own unique theme. Further breakdown reveals that 60% (36.6% of the 98 statements) of the emotional statements were negative in nature and 40% (24.4% of the 98 statements) were positive emotional statements. This indicates that when a

competitive swimmer describes the emotional aspects of pain they will usually describe it as negative and debilitative. It is important to note that even though pain is usually hurtful and unpleasant, swimmers can make a decision to react positively or negatively to the pain.

The pain schema causes the stimulus to be perceived in a way consistent with the structure of the schema and would bias the interpretation and perception of the noxious stimulation (Taylor and Crocker, 1981 (cited in Dar and Leventhal, 1993)). In other words, competitive swimmers who describe the pain in negative, emotional ways would likely have a pain schema that is primarily negative and focused on the emotional consequences of pain. The parallel-processing model posits that a competitive swimmer could change their negative pain schema to be one that is more positive and focused on the sensory qualities of the pain experience. This change in the pain schema would allow the swimmer to interpret the pain stimulus in a manner that would diminish the debilitating effects of the pain and decrease perceive pain. Competitive swimmers would need to have this pointed out to them and be taught how to re-program their pain schema with appropriate mental skills.

Athletes involved in aerobic training seem to have lowered perception of pain during or following exercise. Competitive swimmers are highly trained, aerobic athletes with most of their training being at 85% of maximal aerobic capacity or higher. The swimmers in this study had an average of 9.6 years of

competitive experience and all, except one of them, competed at the national level. Based upon the initial list of 397 statements and the final master list of 98 statements about pain, it seems that competitive swimmers are definitely aware of the pain during swimming and perceive it's effects to be largely debilitative in training and competitive performance. Previous studies on aerobic training and pain perception (Janal et al., 1984; Koltyn et al., 1996; Vecchiet et al., 1984) assessed pain perception following aerobic exercise using a non-sport related pain stimulus. Further examination is required to determine if aerobic training plays a role in decreasing pain perception of exercise-induced pain during the training episode. Nielens and Plaghki (1994) found 72% of female patients and 33% of the male patients had a positive trend toward pain enhancement during a gradational cycloergometer test. Brewer, Raalte, and Linder (1990) found that pain did not affect performance of a weight lifting task but did significantly hamper performance of a complex putting task. While it was not a focus of this study, it would seem that a competitive swimmer, like the golfer, would become more attuned to the exercise-induced pain while swimming and not less attuned.

The information gained from an experiential examination of pain perception with competitive swimmers can be useful for swimmers, coaches and sport psychologists. Pain tolerance goes beyond just physiological conditioning but it is apparent that situational, cognitive, and social influences are relevant determinants of pain perception. Understanding that competitive swimmers acknowledge high

levels of pain in swimming, knowing how they describe the pain experience and consequence, and appreciating how situational variables play an interactive role in pain intensity can help swimmers and coaches to modify training and seasonal planning protocols to be most effective. Identifying the importance of coping methods and determining which methods are most effective assists the sport psychologist in developing an effective, individualized mental skills training program. It is imperative that a thorough understanding of pain in swimming is achieved to assist the competitive swimmer most effectively.

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CHAPTER 5

Discussion and Conclusions

The present three study investigation was guided by personal experience as an elite triathlete, the preoccupation with pain by competitive swimmers as expressed to me over the years while functioning as a swim coach, and by the lack of research literature designed to increase pain tolerance of the injury free athlete in a psychological attempt to improve performance. Single subject methodology was used to examine the effectiveness of a cognitive-behavioral pain management program for athletes (Whitmarsh, 1992; Whitmarsh and Alderman, 1993) with competitive swimmers in the training environment. The results from the first two studies indicated that while the mental skills training did help some of the swimmers improve their performance on the swimming tests and pain tolerance indicators, most of the swimmers did not improve with sufficient magnitude. The third study was designed to re-evaluate the role that pain and the tolerance of pain plays in swimming performance. A phenomenological research method was utilized to gain a greater understanding of pain perception with competitive swimmers. Interview data was analyzed using the concept mapping methodology which resulted in the development of a concept map that included seven pain

perception themes. In this chapter, the results of the studies are reviewed and discussed, implications are presented and recommendations are made for future research.

Review and Discussion

Pain tolerance is an individual skill and each athlete will have different levels of pain tolerance under different situations (Whitmarsh and Alderman, 1993). As expected, not all of the subjects improved their critical swimming velocity from pretreatment to posttreatment. In study #2, four subjects showed an increase in swimming velocity from the pre-training phase, into the training phase and finally into the post-training phase. However, swimming velocity increases of clinical significance were evident with only two of the swimmers. Interestingly, those athletes who did improve their critical swimming velocity were the most skilled and experienced swimmers.

Ratings of perceived discomfort played a different role with each athlete. Swimmers who improved their critical swimming velocity reported an increase in perceived pain from pretreatment to posttreatment, whereas the non-successful subjects reported the opposite. This indicates that highly skilled, experienced swimmers did not lessen the pain but were able to more effectively control the debilitating effects of the perceived pain. Contrary to the first study, those swimmers, in the second study, who were successful in improving swimming

velocity in the heart rate set demonstrated a negative relationship with perceived pain and swimming velocity. The unsuccessful swimmers demonstrated virtually no relationship with perceived pain and swimming velocity. It is possible that swimmers successful in improving performance on the heart rate test swims were able to effectively lower the perceived pain intensity while maintaining a high effort level. Further research may help to explain these differences.

Swimmers also perceive pain differently depending upon the situation. Swimmers indicated, in the third study, that situational significance played an important part in the perception of pain. While some swimmers indicated that there was more pain in competition, the overwhelming response was that pain perception was more acute in training because of the length and relative boredom of the training environment. Most swimmers found that during competition many other factors came into effect that diminished the acuity of the pain. Not only did swimmers indicate a difference in pain intensity between the training and competitive environments, many swimmers expressed that the significance of the swim meet played a crucial role in pain perception. Statements such as, "At the big meets I know what it took me to get there and I usually know where I stand so it is not as mentally painful" and "My mental frame of mind going into a race is important and the more important and meet the more important a positive frame of mind" were common among the 397 original statements.

Heil (1995) stated that an athlete's survival in his or her sport is often

dependent upon a successful outcome. When faced with a painful situation, competitive swimmers will make one of two choices: (1) stop or slow down, or (2) use coping skills to tolerate the pain. Swimmers that choose to use coping skills to manage pain facilitate performance improvement by allowing an increase in effort level even with a corresponding increase in perceived pain. This supports previous research (Pen and Fisher, 1994; Spink and Longhurst, 1986; Tajet-Foxell and Rose, 1995) with pain tolerance and the use of mental skills strategies. Swimmers unable to use mental skills effectively must choose to decrease the pain by stopping or slowing down resulting in performance decrement as evidenced by one swimmer when he stated "Sometimes I do not want pain so I will swim slower and stay in my comfort zone and not push myself as hard as I can". Confirmation of the importance of mental skills in swimming was given in the third study with two of the seven swimming pain themes focused on mental aspects: coping techniques and the recognition of mental pain.

Swimmers who were successful in improving critical swimming velocity and performance on the swimming tests indicated a higher belief in the effectiveness of the mental skills program for pain management. This is an important finding because it is possible that these athletes would have improved regardless of the type of mental training they received. In other words, did they improve their critical swimming velocity because of the cognitive-behavioral pain management program or because they were led to believe that it would be of

benefit for them? An alternate, positive explanation is that those athletes that indicated a higher belief in the mental skills program chose to apply it more effectively and practice the skills more diligently than those swimmers with a lower belief in the mental skills. The role of personal belief and self-efficacy has been shown to be an influential factor in the efficacy of a cognitive-behavioral intervention for pain management (Weinberg, Jackson, and Gould, 1979; Weinberg, Gould, Yukelson, and Jackson, 1981; Williams and Kinney, 1991). Dolce, Crocker, Moletteire, and Doleys (1986) found that while attentional focus, cognitive appraisal and fear arousal can influence pain, the ability to cope with pain can be greatly enhanced by elevating people's sense of coping self-efficacy.

Implications

The implications that arise out of this investigation are twofold. First, there are a some issues that must be considered when conducting mental skills intervention research within the actual sport or field setting. Second, this three-study investigation has provided information that has direct implications for future mental skills training packages designed to improve athletic pain tolerance.

Research Implications

In employing intervention studies, sport psychologists and researchers interested in helping athletes achieve athletic success need to be aware of the

important difference between clinical and statistical significance and not automatically disregard sport data simply because it did not achieve statistical significance. In the case of competitive swimming, a winning performance can be determined by 1/100 of a second, therefore, even a slight improvement in critical swimming velocity can be clinically significant. Those interested in helping athletes achieve athletic success need to find out from coaches and athletes what would be a significant improvement within their respective sport and then use that information as the guideline for determining efficacy of a mental skills training protocol.

Studies conducted in the safe confines of the laboratory or classroom allow for much greater control of the numerous variables that can affect the data. While it is valuable information to know if an intervention package is effective in the laboratory it is most essential, for the applied sport psychology practitioner, to know that an intervention package will be effective in the actual sport setting. If an intervention program is only effective in the laboratory then what is its ultimate value for the athlete and his or her coach? The challenge is that it is very difficult to control all the extraneous variables in a field setting in the same way that you can control them in the laboratory.

In the present investigation, swimmers not only participated in physically difficult studies but also maintained their heavy swim training and weight training schedule. Coach compliance, while initially agreed to, is not a guarantee and

coaches often change their minds as to when the researcher and practitioner can meet with athletes, test athletes, and in some cases they will determine how long the study is able to run. Coaches find it difficult to balance the needs of the researcher to control extraneous variables and the needs of the athlete to execute an individualized, optimum training program. For example, swimmers in study #2 occasionally participated in the heart rate swim sets after heavy weight training or difficult swim training the day before. The head coach understood that this may adversely affect the performance of the swimmers on the heart rate set, but felt it was necessary to not change the swimmers training program While desirable, it is simply unrealistic to ask coaches and elite athletes to take 13 weeks or one full macrocycle off to participate in a physically demanding study. These difficulties must be taken into account when conducting field research and particularly research that requires a heavy psychological and physiological commitment on the part of the athlete during the training/competitive season.

Mental Skills Training Implications

The cognitive-behavioral pain management program for athletes (Whitmarsh, 1992) was most beneficial for those swimmers who competed at a higher level and had more experience as a competitive swimmer. The implication is that experienced and skilled athletes recognize that pain is debilitating and plays a significant role in their swimming success. Almost all of the interviewed

athletes, except one, in study #3 competed at a national level and they generated 397 statements about pain in swimming during their interviews. Every one of these swimmers indicated that pain is part of competitive swimming and spoke about the importance of being able to manage the pain effectively as a prerequisite for optimal performance. It is possible that inexperienced swimmers with low technical or physical ability have never been in a situation where pain is the major limiting factor on performance. In other words, biomechanical concerns, physical conditioning, lack of coaching, tactical errors, and stroke technique may play an equal or more significant role in the performance of a novice or developing swimmer. However, with elite swimmers who follow the same kind of training programs, share similar physiological and technical attributes, and receive equivalent coaching, the significance of high pain tolerance is much more acute. For the elite athlete, self-awareness of how much pain can be psychologically controlled for and for how long and to what effect is a significant psychological skill and a key factor in athletic success (Hogg, 1992).

It also became quite obvious that those swimmers that improved their swimming performances from pretreatment to posttreatment utilized the mental skills most often during the swim tests. Athletes must understand that being trained in mental skills to improve pain tolerance does not automatically correspond with pain tolerance improvement. Many of the athletes in the investigation indicated that they had received prior training in the use of mental

skills and that they found the mental skills to be ineffective in improving their swimming performances. It is possible that while they received training in mental skills they chose not to practice them or to apply them in a consistent, structured manner. In this present investigation, those athletes who were most successful in improving performance on the swimming tests were the athletes who spent the most time practicing the new mental skills and chose to utilize them most often during the swimming tests. Athletes and coaches must understand that there is a significant difference between just learning new mental skills and actually applying the mental skills while swimming.

Mental skills programs must meet the needs of the athletes and be individualized to be effective. A mental skills program for pain tolerance in competitive swimming should be focused on the seven major areas of the pain experience including: description of pain, experiential effect of pain, coping techniques, importance of mental attitude, the interaction of situational significance, the emotional consequences of pain, and acknowledgment of pain in competitive swimming. A sport psychologist or coach should find out how each athlete feels about each of the seven areas of the pain experience and then design a unique program of mental skills. This will help to ensure that the athlete gets the most out of the mental skills program.

The parallel-processing model posits that a pain schema is formed which represents both the sensory and emotional aspects of the pain experience

(Fernandez and Milburn, 1994; Leventhal and Everhart, 1980). In the current study, the majority of the interview-generated statements referred to the emotional consequences of the pain experience as opposed to the sensory qualities of the pain. Competitive swimmers who describe the pain in negative, emotional ways would likely have a pain schema that is primarily negative and focused on the emotional consequences of pain. The parallel-processing model posits that a competitive swimmer should change their negative pain schema to one that is more positive and focused on the sensory qualities of the pain experience. Swimmers can accomplish this by developing a consistent pattern of positive, sensory based attitudes and statements rather than focusing on the negative consequences of pain. This change allows the swimmer to interpret the pain stimulus in a manner that diminishes the debilitating effects of the perceived pain. Athletes should not be instructed to eliminate the pain but rather to learn to manage the pain more effectively. The only way to eliminate the pain altogether is to stop or slow down the activity. Swimmers desiring optimal performances will find that focusing on the sensory qualities of the pain experience will help them to tolerate high levels of pain and not to eliminate the pain.

Future Research

The present investigation provides evidence that cognitive-behavioral techniques can be effective in improving athletic pain tolerance of competitive

swimmers. Beside the implications for research and mental skills training, two suggestions for future research are advanced to strengthen the mental skills training protocols and to further our understanding of the pain experience in competitive swimming and other endurance sports.

Competitive swimmers are highly trained, aerobic athletes with most of their training being at 85% of maximal aerobic capacity or higher. Based upon the results of the first two studies, the initial list of 397 statements from study #3, and the final master list of 98 statements about pain, it seems that competitive swimmers are definitely aware of the specific pain associated with swimming and perceive it's effects to be largely debilitative. Previous studies on aerobic training and pain perception (Janal et al., 1984; Koltyn et al., 1996; Vecchiet et al., 1984) assessed pain perception following aerobic exercise using a non-sport related pain stimulus. Further examination is required to determine if aerobic training plays a role in decreasing pain perception of exercise-induced pain during the training episode. Nielens and Plaghki (1994) found 72% of female patients and 33% of the male patients indicated an increase in pain intensity during a gradational cycloergometer test. Brewer, Raalte, and Linder (1990) found that pain did not affect performance of a weight lifting task but did significantly hamper performance of a complex putting task. It would seem that a competitive swimmer, or any aerobic-based athlete, would become more attuned to the exercise-induced pain while swimming rather than less attuned. In other words,

the increased body awareness of an elite athlete, like a competitive swimmer, would most likely increase their sensitivity to pain. This would make them more perceptive of slight increases or decreases in pain intensity while swimming as opposed to becoming less perceptive of the pain while swimming.

This research provides support that a mental skills pain management program may improve athletic pain tolerance among some athletes. However, all athletes are different in the way they respond to training and instruction and need to be treated as such. It became clear from this investigation that mental skills intervention programs for pain tolerance must take a closer look at individual differences between athletes. Developing mental skills programs to cater to the unique personality characteristics of individual athletes may prove to beneficial. This would require developing an intensive personality profile based on personal interviews and the use of reliable and acceptable tests (eg. CSAI-2). A personality characteristic such as hardiness might also be worth investigating since Goss (1994) found that hardy swimmers experienced fewer mood disturbances, had lower feelings of fatigue with higher feelings of vigor, and possessed more adaptive coping behaviors. This concern for individualization combined with a mental skills program that focuses on the seven major pain themes would make for an interesting and beneficial research project.

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APPENDIX A

Pain Management Program

COGNITIVE-BEHAVIORAL PAIN MANAGEMENT PROGRAM FOR ATHLETES

by

Blair Whitmarsh (1992)

INITIAL PHASE

A Situational and Cognitive-Affective Analysis.

Questions for the Coach to ask the athlete:

1. What does you pain feel like? Describe it?
2. When does your pain occur?
3. Is the pain during competition continuous or intermittent?
4. What actions make the pain worse?
5. What things are you unable to do in training or competition due to pain?
6. What do you do to relieve pain?
7. Are you confident in your methods for controlling pain?

SECOND PHASE

Education and Conceptualization.

Educate the athlete on pain perception and the physiological/psychological connection based on Melzack and Wall's (1965) Gate-Control Theory of Pain.

Encourage athlete to view pain as a series of four stages: preparing for the pain, confronting the pain, coping with critical moments, and reinforcing and\or reflecting on successful performances.

THIRD PHASE

Skill Acquisition and Consolidation

Encourage appropriate and successful implementation of athletes' existing coping skills.

Arrange acquisition of any essential coping skills that may be missing.

Encourage athlete to feel confident that the coping skills acquired will work in an aversive situation.

Skills:

1. **Cue-Controlled Relaxation and Controlled Breathing.**

   Reduces pain by:

   A. Reducing muscle tension.
   B. Diverting attentional focus.
   C. Reducing anxiety.

   Use the Relaxation Response and Niedeffer's "Centering".

   Helps athletes know if they are tense or relaxed in training or competition.

   Reduces anxiety and tension which acts to close the pain gate and reduce discomfort.(Gate-Control Theory)

2. **Cognitive Coping Skills Training.**

   Train athletes in these skills:

   (A) Imaginative Inattention

   ignoring the pain by engaging in imagery which is incompatible with the pain experience. ie. going to the beach.

(B) Imaginative Transformation of Pain

acknowledging the noxious sensations, but interpreting them as trivial or unreal.

(C) Imaginative Transformation of Context

acknowledging the noxious sensations, but transforming the setting or contest. ie. picturing oneself as " James Bond " having been shot in the limb.

(D) Attention-Diversion (external)

focussing attention on physical characteristics of the environment. ie. looking at the clouds or counting telephone poles.

(E) Attention-Diversion (internal)

focussing attention on self-generated thoughts. ie. doing mental arithmetic, making lists of favorite songs or mentally building a house from scratch.

(F) Association

focussing on internal physiological characteristics such as heart and breathing rates while reminding oneself to "stay cool" and "relax".

(G) Somatization

focussing on the part of the body receiving the intense stimulation, but in a detached manner. ie. analyzing the intense stimulation and sensations as if to write a biology report.

3. Self-Instructional Training

Four Parts:

1. Prepare for Intense Stimulation Before it is too Strong.

(A) What is it I have to do? (view the situation as a problem you can handle)
(B) Just think about what I have to do. (focus on what the situation requires)
(C) Think of the strategies I can use to help cope. (review

cognitive coping skills)

(D) Don't worry; it won't help anyway. (use anxiety and worry as a reminder to focus on the task)

(E) Remember my past experiences in pain control. (reassurance about the ability to use cognitive strategies)

2. Confronting and Handling the Situation.

(A) I can handle this aversive situation. (view the situation as a challenge to tackle)

(B) Just relax, breathe deeply and use one of the strategies. (use cognitive coping skills)

(C) Don't think about the pain. (focus attention on the task at hand)

(D) Remember, I can switch to other cognitive strategies if necessary. (if current strategy is not working then consider switching)

3. Coping with Thoughts and Feelings at Critical Moments.

(A) When I feel pain, keep focussing on what I have to do.

(B) Don't try to eliminate pain totally, just keep it manageable.

(C) I knew pain sensations would arise, just keep them under control.

(D) Remember, I know a lot of pain control strategies.

(E) If I feel terrible, I must relax and focus on things under my control.

4. Self Reflection and Positive Self-Statements.

(A) I knew I could handle it! I am doing well.

(B) I did it! I know I will control my pain the next time it happens.

FINAL PHASE

Application

(A) Encourage athletes to experiment with the various cognitive skills of pain control in training.
(B) Encourage athletes to choose 1 or 2 cognitive pain control methods that are most effective for them.
(C) Allow the athletes plenty of opportunities to practice the effective cognitive pain control strategies.
(D) Provide the athlete with success experiences in controlling pain.
(E) The athlete who is successful in controlling pain with cognitive methods will have a higher level of self-efficacy.
(F) The higher the level of self-efficacy, the more likely the athlete will choose to use a cognitive pain control method in future aversive situations.

References

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Turk, Dennis C., Meichenbaum, Donald., Genest, Myles. (1983) Pain and Behavioral Medicine. New York: Guildford Press.

APPENDIX B

Pain Management Program

Module I

Self-Awareness and Pain Perception

INTRODUCTION

Throughout life people are confronted with many situations in which the ability to tolerate pain is extremely important. Individuals undergoing major surgery, suffering from terminal illness and women in labor must cope with intense pain. The ability to tolerate high levels of pain, however, is also beneficial in the area of athletics. The athlete who has a high level of pain tolerance is, in most situations, expected to achieve a higher level of performance than the athlete with a low level of pain tolerance. Thus, coping with high levels of pain is often a part of the price of athletic success.

Not all athletes are equal in their ability to tolerate pain, however, pain tolerance is probably a learned skill and may be the most important psychological skill an athlete can develop. Bill Koch, silver medalist at the 1976 Olympics in the 30km cross country skiing race, felt that 90 percents of his success could be attributed to his ability to tolerate pain and Greg Lemond, three time winner of the Tour de France (considered by many to be the most gruelling race in sport) has said "...the best climbers are those one who can stand the most pain... in pro cycling everything hurts, but you just ride through it".

What exactly is the mental skills pain management program? It is the learning, practicing and application of mental and psychological skills to assist athletes in coping with higher levels of pain thereby resulting in improved performance. The pain management program involves knowledge and instruction in

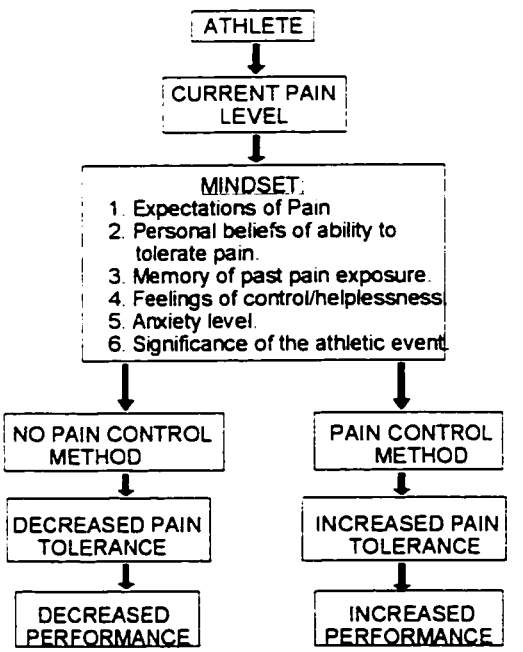
* Self-Awareness Enhancement
* Education on Pain Perception
* Stages of Pain
* Relaxation Training
* Pain Coping Skills
* Self-Coaching
* Application

As you work through the different modules you must remember that going through the pain management program is exactly like your physical training program. This means that for you to get the most out the pain management program, you must practice the skills and knowledge that you receive everyday or at least every other day. Many coaches and athletes maintain that peak performance is 90 percent mental which stresses the importance of learning and practicing mental skills on a consistent and regular basis.

SELF-AWARENESS

Everyone has heard it said "You are what you eat !". It is true that the nutritional habits of some athletes can play a limiting or beneficial role in their athletic performance. However, even more than food, what an athlete thinks about can have a dramatic impact on performance. In other words, negative attitudes, negative expectations, and negative behaviors will ultimately lead to diminished performance.On the other hand, positive attitudes, positive expectations and improved behaviors will lead to an improved performance. Therefore, a more appropriate phrase for the athlete to remember is "You do what you think !".

In the past, it was believed that pain tolerance was an skill that people were born with and that there was no way that anybody could improve their ability to tolerate high levels of physical discomfort. However, research has shown that how a person thinks about pain and the way they choose to deal with the pain can have a tremendous impact on the their ability to tolerate the pain. In other words, the mental mindset of an athlete will determine whether or not an athlete will choose a pain control method or not (see below). Athletes using various pain control methods such as relaxation, imagery and/or self-coaching are able to tolerate higher levels of pain and achieve greater levels of performance.



(Blair Whitmarsh 1990)

EXAMINING MY MINDSET

TASK 1: Describe how you currently see yourself as an athlete by focussing only on the positive. Use simple cue words to describe yourself.

TASK 2: Clearly identify what you experience to be negative thoughts and influences that affect your swimming performance, no matter how insignificant they may seem.

TASK 3: Now put in order of importance those thoughts, feelings, behaviors that you need and want to improve upon or change. Recognizing and listing them will be a good start towards changing them.

PAIN PERCEPTION

It is important for every athlete to carefully think about how pain and their pain coping ability affects their training and competitions. Please complete the following questions and remember to think carefully about each question before answering them.

1. Are you aware of any pain while you are swimming?

2. What does the pain feel like? Describe it in detail.

3. How often and when does your pain occur?

4. Is the pain experienced during training and competitions different in any way?

5. Is the pain during competition intermittent or continuous?

6. What actions make the pain worse?

7. What things are you unable to do in training or competition due to the pain?

8. What do you do to relieve pain while swimming?

APPENDIX B

Pain Management Program

Module II

Relaxation Training

RELAXATION TRAINING

Being able to relax while experiencing pain enables you to bring your physical, mental and emotional processes under self-control. Many athletes have been unable to perform because they were unable to bring the pain they were experiencing under self-control. Relaxation reduces pain in three major ways; 1) it reduces muscle tension, 2) allows people to focus on something besides the pain, and 3) reduces anxiety. In addition to being physically relaxed, relaxation helps to create a feeling of emotional calmness. Thus we can use relaxation exercises as a way to decrease tension and reduce the discomfort and/or pain.

RELAXATION

1. Reduces muscle tension.

2. Changes focus of attention.

3. Reduces anxiety.

As mentioned, relaxation is the easing of tension. Relaxing your mind is easing the tension in your mind by blocking out negative or bad thoughts. This is extremely important because a change in our mental state can and usually does cause a change in our bodily state. If our minds are relaxed then it is highly likely that our bodies will also be relaxed which will decrease the amount of pain experienced.

One of the advantages of relaxation training is that anyone can learn how to relax and anyone can learn how to use relaxation to enhance their performance. One of the most simple yet effective relaxation methods is the Relaxation Response developed by Dr. Herbert Benson. It is called the Relaxation Response because following the method will cause your body to enter into a state of relaxation. This relaxation method can be mastered with just a few minutes of practice each day and can be used not only before and after swimming but also during a difficult swim set or race.

THE RELAXATION RESPONSE

Relaxation Response

Refers to the capacity of the body to enter a special state characterized by lowered heart rate, decreased rate of breathing, lowered blood pressure, slower brain waves, and an overall reduction of the speed of metabolism. In addition, the changes produced by this Response counteract the uncomfortable feelings of pain.

The Relaxation Response can help athletes tolerate higher levels of pain, however, medical and psychological research has shown that those who develop and regularly use the Relaxation Response effectively can:

- **Relieve headaches.**
- **Reduce heart pain and perhaps eliminate the need for heart surgery.**
- **Reduce blood pressure control hypertension.**
- **Enhance creativity, especially when experiencing a "mental block".**
- **Overcome sleep disorders.**
- **Prevent hyperventilation attacks.**
- **Help alleviate backaches.**
- **Enhance the therapy of cancer.**
- **Control panic attacks.**
- **Lower cholesterol levels**
- **Alleviate the symptoms of anxiety that include nausea, vomiting, diarrhea, constipation, short temper, and inability to get along with others.**
- **Reduce overall stress and achieve greater inner peace and emotional balance.**

THE RELAXATION RESPONSE

The Relaxation Response can be done at home, in the car, riding the bus, sitting at school, swimming in a race, in fact, a relaxed state can be achieved anywhere and at any time of day. However, when initially learning the Relaxation Response there are four basic elements that must be present at all times for the Response to be effective. Once the Response is well learned then only two elements are necessary: an object to dwell on and a passive attitude.

THE FOUR BASIC ELEMENTS

A QUIET ENVIRONMENT

One must "turn off" not only mental distractions, but also distraction around you.

AN OBJECT TO DWELL ON

This object may be a word or sound repetition; gazing at a symbol or concentrating on a particular feeling. When distracting thoughts do occur, one can return to this repetition of the word or sound to help eliminate other thoughts.

A PASSIVE ATTITUDE

It is the emptying of all negative thoughts and distractions from one's mind. *A passive attitude appears to be the most essential factor in eliciting the Relaxation Response. A person should not be concerned with how well he or she is doing the Response.*

A COMFORTABLE POSITION

One should be in a comfortable position that will allow an individual to remain in the same position for at least twenty minutes without going asleep. Usually a sitting position is recommended.

HOW TO ELICIT THE RELAXATION RESPONSE

STEP ONE: Pick a brief phrase or word that reflects your personality or sport.

Since a most crucial part of any Relaxation Response technique is to use a word or phrase to meditate on, it is important to pick a word that has a special meaning to you. If the word or phrase is special to you then it is more likely that you will get more deeply involved in the Relaxation Response technique. You will look forward to practicing it, and you will do it more consistently.

It is important to take a few things into consideration when choosing an appropriate word or phrase. First, the word or phrase must be easy to pronounce and remember. Second, the words should be short enough to say silently as you exhale a breath. Examples of some words may include: one, out, in, strength, right, left, easy etc.

STEP TWO: Choose a comfortable position.

The position must be comfortable enough that it can be maintained for relatively long periods of time, but uncomfortable enough so that you won't fall asleep.

STEP THREE: Close your eyes.

Avoid squinting or squeezing your eyes. Close the easily and naturally. The act should be effortless.

STEP FOUR: Relax your muscles.

Starting with your feet and progressing up to your calves, thighs, and abdomen, relax the various muscle groups in your body.

Loosen up your head, neck, and shoulders by gently rolling your head around and shrugging your shoulders slightly. As for your arms and hands, stretch and then relax them, and then let them drape naturally into your lap. Avoid grasping your knees or legs or holding your hands tightly together.

STEP FIVE: Become aware of your breathing, and start using your focus word or phrase.

Breathe slowly and naturally, without forcing your rhythm. At this point, start repeating silently the word or phrase you have chosen as your mental device on each outbreath. For example, if you use the word strength, slowly breathe in and then out. As your breath is going out, say strength silently to yourself.

If you have been unable to find a mental device to repeat, you can elicit the Relaxation Response without saying any words to yourself at all. Instead, as you breathe in, focus your awareness on the expansion of your abdomen, and then on its contraction as you exhale. Visualize your abdomen as if it were a balloon that slowly fills and then slowly empties.

Remember, though, that the more you tailor the relaxation technique to your own personality or sport, the more likely it is that you will continue to use it regularly and get the full benefits of the Relaxation Response.

STEP SIX: Maintain a passive attitude.

Along with the repeated word or phrase, a passive attitude is the other most crucial aspect of eliciting the Relaxation Response. As you sit quietly, repeating your personal word or phrase, thoughts will inevitably begin to bombard your mind. You may even see mental images or patterns that distract you from you chosen word or phrase.

But remember: They don't matter. These lapses are natural and they happen to everyone who practices the Relaxation Response technique. The key to dealing with these interruptions is learning to respond to them in a casual, unconcerned way. Do not try to force or concentrate them out of your mind.

If distracting thoughts come into your mind, simply adopt a passive attitude. In other words, do not fight the distraction. When you become aware of it, simply say to yourself, " Oh, well," and slip gently back into the repetition of your word or phrase. Even if the distracting thoughts occur the entire time you are meditating, that's all right. They are natural.

In the same way, if you are distracted by an itch or tight clothing, go ahead and scratch or rearrange your clothes so that you are more comfortable as you continue with our chosen focus words. Through regular practice, you can learn to disregard the aggressive, unsettling thoughts that push their way into your consciousness - including the bothersome thoughts about how well you are practicing the technique and whether it is working.

Remember, passive does not mean that you do not train hard or try to win an important race. A passive attitude refers to your mental outlook and not your physical effort. It is possible for you to be in a state of relaxed awareness in which you are aggressive enough to achieve swimming success.

STEP SEVEN: Continue for a set period of time.

Practice the technique for only ten to twenty minutes. But don't time your session with an alarm or kitchen timer. This would startle you or make you anticipate the sound. Instead keep a watch or clock in plain sight, and sneak a peek now and then when you think about the time. If ten to twenty minutes have not passed, close your eyes again and return to the repetition until the full time has elapsed.

Once the session is over, sit quietly but keep your eyes closed for a full minute or two. Stop repeating the word or phrase you have been using. Allow regular thoughts to enter your mind once again. Finally, open your eyes slowly and sit quietly for another full minute or two. If you stand up immediately you may feel dizzy. The dizziness is not dangerous, but there is no need to experience it. As you elicit the Relaxation Response by slowly going into it, so should you return to your everyday state in a slow, gradual manner.

STEP EIGHT: Practice the technique twice daily.

Just as it takes much practice to develop physical skills it also takes practice to effectively elicit psychological skills such as the Relaxation Response. You should practice the method twice a day. Most people do so before breakfast and before dinner. The exact time that you schedule your sessions is up to you, but the method seems to work best on an empty stomach.

THE RELAXATION RESPONSE AND SWIMMING

Some sports fit well with the Relaxation Response techniques, especially the aerobic activities like running, rowing, swimming and cycling. The athletic endeavors involve a rhythmic, smooth, repetitive kind of exercise that can enhance rather than detract from you ability to achieve a focussed, passive frame of mind. Here's how the Relaxation Response works best with swimming.

1. **Do your usual stretching and warm-up exercises before you begin using the Relaxation Response.**

2. **As you swim, keep your eyes open. Although the standard Relaxation Response technique requires you to shut your eyes to avoid distractions, you have to see where you are going when you are combining this type of relaxation with swimming.**

3. **Become aware of your breathing. After you fall into a regular pattern breathing, focus your attention on the in-and-out rhythm of your breathing. As you inhale, say to yourself silently,"in". When you exhale, think, "out". In effect, this becomes your mental device or focus word in the same way that you use your personal phrase with the standard Relaxation Response technique. If this rhythm is uncomfortable for you - for instance, if your breathing is too fast or too slow - you can focus on something else. For example, you can become aware of your arms entering or pulling through the water. That is, you could silently alternate saying, "One...two...one...two" or "right...left...right...left".**

4. **Maintain a passive attitude. Just as you do with the standard Relaxation Response techniques, gently disregard disruptive thoughts. Simply think to yourself, " Oh well," and slip back into your repetitive focus word. Remember that passive is not the same as "wimpy" or "soft".**

5. **When you complete your swim set or workout, return to your normal after-workout routine.**

APPENDIX B

Pain Management Program

Module III

Mental Coping Skills

MENTAL SKILLS FOR COPING WITH PAIN

A person's thoughts, expectations and ideas can have a great effect on the way he/she feels and behaves. A person with a faulty mindset can lead to feelings of nervousness, worry, pain and ultimately, failure. On the other hand, an accurate mindset will cause a person to relax, feel confident and decrease the pain. In this section, you will be taught four different mental coping skills that will assist you in handling the pain you experience in your sport. A brief explanation of each skill will be followed by some exercises to help you learn them more effectively. Try to become familiar with the four methods by practicing them during your swim workouts.

MENTAL COPING SKILLS

IMAGERY

Using imagery to ignore the pain. This is accomplished by imagining something that brings you pleasure. For example, you could imagine going to a beautiful beach in Hawaii.

FOCUS OF ATTENTION
(internal)

This way of focussing your attention has you make up your own thoughts that are not related to swimming. For example you could do math in your head, make a mental list of your favourite songs, count backwards from 1000 by 7's, or design a new house from scratch in your head.

FOCUS OF ATTENTION
(external)

Instead of thinking of the pain it is often helpful to change what you are thinking about and focus your attention on physical characteristics of the environment. For example you could look at the tiles on the bottom of the pool, count the number of lengths swam and/or count the number of arm strokes you take.

FOCUS ON PHYSICAL

This method is the one most used by elite level athletes. In this method you think about and focus on your own physical body. For example, you would concentrate on your heart rate and/or breathing rate while reminding yourself to "stay cool" and "relax". This method is similar to the Relaxation Response in Module II.

IMAGERY

Using imagery to ignore the pain. This is accomplished by imagining something that brings you pleasure. For example, you could imagine going to a beautiful beach in Hawaii.

Exercise 1: Write down in detail the scene that you will imagine in all pain situations.

FOCUS OF ATTENTION
(external)

Instead of thinking of the pain it is often helpful to change what you are thinking about and focus your attention on physical characteristics of the environment. For example, you could look at the tiles on the bottom of the pool, count the number of lengths swam and or count the number of arm strokes you take.

Exercise 2: Write down the method that you will choose to use when in swimming situations involving some pain.

FOCUS OF ATTENTION
(internal)

This way of focussing your attention has you make up your own thoughts that are not related to swimming. For example, you could do math in your head, count backwards from 1000 by 7's, make a mental list of your favourite songs or design a new house from scratch in your head.

Exercise 3: Write down the thoughts, in detail, that you will choose to use when in swimming situations involving pain. If, for example, you are going to list your favourite songs, write down the list of songs.

APPLICATION

Exercise 1: **Using a timer and sitting at home, try each one of the four mental skills for 4 minutes each. Close your eyes on all of them except for Focus of Attention (external). After you have tried 4 minutes of each one (total time 16 minutes) then answer the following questions.**

1. Which two methods were the easiest to concentrate on for the full 4 minutes?

2. Which two methods were the most difficult to concentrate on for the full 4 minutes?

3. Is there any ways in which the methods could be improved to help you more specifically? If there is then make sure you make the adjustments before practicing the next time.

Exercise 2: **Over the next two weeks, try using each one the mental skills for pain during difficult training sets. After you have been able to try each once at least once then answer the following questions.**

1. Which two methods were the easiest to concentrate on for the full 4 minutes?

2. Which two methods were the most difficult to concentrate on for the full 4 minutes?

SELF-COACHING

Once you begin a training set or a race you are for the most part unable to hear any instructions from the coach. As a result, many athletes are unable to adapt to unexpected situations because they can not get the "answers" from their coach. The purpose of self-coaching is to train athletes to coach themselves through difficult training sets or races. Self-coaching involves talking to and convincing yourself that you can push through the pain and have a successful performance. Self-coaching helps you to use the Relaxation Response and the mental coping skills more effectively.

Every difficult swim can be broken into four stages. The self-coaching will be based on the four stages with positive statements associated with each stage. Remember, during each stage you must "talk to yourself" in a positive manner so that you will have a successful performance. The following pages will take you step-by-step through the four stages of pain and provide opportunity to create your own positive statements.

FOUR STAGES OF PAIN

1. ***Preparing for the pain.***

2. ***Confronting the discomfort.***

3. ***Coping with critical moments.***

4. ***Reinforcing/reflecting on successful performances.***

SELF-INSTRUCTIONAL TRAINING

PREPARATION

1. *Do not think that you are helpless. Develop a coping plan.*

Examples of things you can say to yourself:

- *I can deal with this task. Let me actively prepare.*
- *I must just think about what I can do to deal with this. I will think about a plan for future events.*

Add here any others that you can think of that will help you to stop a helpless attitude.

2. *Keep a positive attitude: Stop negative thoughts and redirect your attention to positive ideas.*

Some self-statements you could use:

- Stop worrying. Worrying won't help anything.
- What are some of the things I can do instead?
- I am feeling anxious - that's natural. But that's no reason to give up. Let me just breathe deeply and relax.

Add other things you can say that may help you to keep positive:

CONFRONTATION

1. *Make use of general coping strategies such as the Relaxation Response and the mental coping skills. Switch strategies as necessary, and use self-statements to direct your attention to as many or as few coping strategies as you need.*

Some statement examples:

- All right, I'm feeling some pain. That lets me know that I should take some slow, deep breaths as I relax more, and switch from the mental strategy I was using to another one.
- STOP these negative thoughts. Let me just concentrate on one of the mental coping skills to do something positive.

Add examples here:

2. *RIMS: Relaxation, Imagery, Mental Skills. Remind yourself of the advantages of using coping techniques.*

Things you may say to yourself:

- This discomfort is getting to me. Wait! Remember RIMA: Relaxation, Imagery, and Mental Skills. OK; let me Relax and develop a good Image.
- Relax. Just breathe deeply and relax.
- Concentrate fully on breathing and relaxation.
- I won't think about my pain. I will focus my attention on remembering details of the movie I saw last night.

Take a few minutes here to review some of the strategies that were covered in Module II and Module III. Then add here any other self-coaching statements that you might use to call these to mind. Develop your own versions of images, relaxation, mental activities, and so on.

Add your own examples here:

CRITICAL MOMENTS

1. *Be realistic in expecting some pain, but don't exaggerate the pain. Keep them manageable.*

Some examples of what to say:

- When I feel a lot of pain, I should just pause and then focus again on a strategy for dealing with it.
* I won't attempt to eliminate the pain totally. I just need to keep it manageable.
* I knew the pain sensations would rise. But I can keep them under control.

Add some other things you might say to yourself:

2. *When you find yourself giving way to unpleasant thoughts or feelings, make an effort to STOP them. Substitute positive self-coaching to get you back on the right track.*

The following are some statements to use in this regard:

- Things are going pretty badly. I can't take anymore - no, wait - just pause. I shouldn't make things worse than they really are. I'll review my coping strategies to see what I can switch to.
- My pain feels terrible. Things are falling apart. No, I'll stop thinking that. Relax!! I will focus my attention on something else. That's better, I'm regaining control. Just a slow deep breath ... Good.
* I can't get my mind off the pain. I'll have to stop. NO! Wait a minute! I planned for this. Stop the negative thoughts. Let me use a strategy, and I'll get over this difficult time. OK, let me relax, relax, breathe slowly and deeply.

Add some other statements to help you remain positive through the pain:

REFLECTION

1. *At first you may notice only a little change in your ability to tolerate pain, but remember you are learning a new skill which will take practice. You deserve a pat on the back from yourself for having tried. If you've brought the pain under control even a little bit, you deserve to feel proud.*

For example:

* I knew I could handle the pain! I'm doing pretty well.
* I did it! I know how I will control my pain the next time it happens.

Add other examples of your own here:

ONCE AGAIN, REMEMBER THAT THE KEY IS TO *RECOGNIZE* NEGATIVE THOUGHTS AND FEELINGS, TO *INTERRUPT* THEM WITH POSITIVE SELF-COACHING, AND TO USE THE SELF-COACHING TO GUIDE YOU IN THE USE OF *COPING STRATEGIES.*

APPENDIX B

Pain Management Program

Module IV

Application

APPLICATION

Over the past few week you have been taught a number of different skills to help you tolerate pain while swimming. It is now important that you do not let your new knowledge "slip away" by not practicing the skills on a regular basis. As stated earlier, for you to get the most out of the pain management program you must practice the skills and knowledge that you receive everyday or at least every other day. Many coaches and athletes maintain that peak performance is 90 percent mental which stresses the importance of learning and practicing mental skills on a consistent and regular basis.

The following pages will provide you with a few exercises that you can go through to help you practice and perfect some of the skills. While you are going through the exercises choose two skills that you will use most often (for example you could choose the Relaxation Response, Imagery and/or Self-Coaching). Please go through all of the exercises listed in the following pages.

CONSISTENT
DAILY PRACTICE

EQUALS

CONSISTENT
DAILY BEHAVIOR

Ice Water Task

You will need a timer to complete this task. Place your hand into a bucket of very cold water filled with plenty of ice. You will experience some pain, however, the pain is not damaging and is instantly relieved by removing your hand from the water. As you experience the pain, try to use one or two of the skills from Module 2 and/or Module 3 to tolerate the pain. Try holding your hand there for one minute, then two minutes, then three minutes and so on. It is important to replenish the ice and change hands in between practice trials. Practice as much as possible and try to hold your hand in the water for as long as possible. Write down comments in the space provided after each trial.

Trial #1:

Trial #2:

Trial #3:

Trial #4:

Trial #5:

Phantom Chair Task

You will also need a timer for this task. This task requires you to put your back up against a wall and slide down the wall until your thighs are parallel with the floor. It would be the exact same position as sitting in a chair except that there is no chair below you. You will feel a burning pain in your thighs as you try to hold the position. Like the ice water task, try to hold the position for one minute, then two minutes, then three minutes and so on. After each trial take at least a fifteen minute break. You may even want to only do one trial each day. While you are experiencing the burning pain try to use one of the mental skills to help to handle it more effectively. Write down your comments in the space provided.

Trial #1:

Trial #2:

Trial #3:

Trial #4:

Trial #5:

Swimming Task

Pick two of the mental skills that you feel most comfortable with (ex. Relaxation Response, Imagery, Self-Coaching) and utilize them during a difficult training set. When you are doing a difficult training set choose the mental skill that you will use and try to do it throughout the swim. The more you practice the skill in a training set the more likely you will be able to use the skill effectively in competition. Write down any comments you have about using the skills while swimming.

APPENDIX C

Study #1

POMS PROFILE SHEET

Name:_____ Date:_____

T Score	FACTOR						T Score
	Ten	Dep	Ang	Vig	Fat	Con	
80+	35-6	47	32+			28	80+
79	34	46				27	79
78		45	31				78
77	33	44	30		28	26	77
76	32	43	29	32			76
75		43			27	25	75
74	31	41	28	31			74
73	30	40	27	30	26	24	73
72	29	38-9	26		25	23	72
71		37		29			71
70	28	36	25	28	24	22	70
69	27	35	24		23		69
68		34	23	27		21	68
67	26	33			22		67
66	25	32	22	26	21	20	66
65	24	31	21	25			65
64		30	20		20	19	64
63	23	28-9		24	19	18	63
62	22	27	19	23			62
61		26	18		18	17	61
60	21	25	17	22	17		60
59	20	24		21		16	59
58	19	23	16		16		58
57		22	15	20	15	15	57
56	18	21	14				56
55	17	20		19	14	14	55
54	16	19	13	18	13		54
53		17-8	12			13	53
52	15	16	11	17	12	12	52
51	14	15	10	16	11		51
50		14				11	50
49	13	13	9	15	10		49
48	12	12	8	14	9	10	48
47	11	11	7				47
46		10		13	8	9	46
45	10	9	6		7		45
44		7-8	5	12		8	44
43	9	6		11	6	7	43
42	8	5	4				42
41	7	4	3	10	5	6	41
40	6	3	2	9	4		40
39		2	1			5	39
38	5	1		8	3		38
37	4	0	0	7	2	4	37
36							36
35	3			6	1	3	35
34	2				0		34
33	1			5		2	33
32				4		1	32
31	0						31
30				3		0	30
T Score	_____	_____	_____	_____	_____	_____	T Score
Raw Score	_____ Ten	_____ Dep	_____ Ang	_____ Vig	_____ Fat	_____ Con	Raw Score

McNair, Lorr, and Droppleman (1971)

RECORD SHEET

TEST #:____

	Lane 1	Lane 2	Lane 3	Lane 4	Lane 5	Lane 6
50m						
100m						
150m						
200m						
250m						
300m						
350m						
400m						
450m						
500m						
550m						
600m						
H.R.						
Lactate						
POMS						
RPD						
50m						
100m						
150m						
200m						
H.R.						

APPENDIX D

Study #2

Abstract

Investigation of a Cognitive-Behavioral Pain Management Program for Competitive Swimmers

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This study was a field examination of a cognitive-behavioral pain management program for competitive swimmers (Whitmarsh, 1993). The study involved two female and two male swimmers (M=16.25) at a provincial/national level and utilized a multiple baseline single-subject research design. Subjects were involved in a series of heart rate test swims which were designed to place the swimmer in a situation of extreme physical discomfort once per week for 13 weeks. Subjects also received approximately 9 hours of psychological training spread over 12 individual counselling sessions accompanied by a self-administered psychological workbook. Supplemental data was also collected during the study to include perceived pain level, profile of mood states (POMS), psychological tool utilization, heart rate and critical swimming velocity. The results indicate that two of the swimmers improved their heart rate test times in a clinically significant manner. This is extremely encouraging when considering the physiological and psychological demands of the 13 week study and the study corresponding with the most physically demanding time of the competitive swim season. It is also evident from the study that cognitive-behavioral programs need to be individually tailored to meet the needs of the individual athlete.

Measures

Critical Swimming Velocity. Critical swimming velocity (CSV) is defined as the swimming velocity that can be maintained without exhaustion over a long period of time (Smith, 1992). CSV was assessed during the 2nd, 6th, 10th, and 13th weeks of the study which allowed the anaerobic threshold standard to be adjusted throughout the study.

Heart-Rate Test Swims

The basic heart rate set is 600m and swimmers went through the heart rate set 4 times for a total of 2400 metres. Swimmers swam various distances of freestyle on an interval time of 1 minute 30 seconds per 100m. The heart rate test swim is a difficult test set in which swimmers swim as fast as possible on each interval while maintaining a heart rate of over 180 beats per minute, consistent with the average anaerobic threshold level heart rate on most trained endurance athletes, throughout the set.

Perceived Discomfort Intensity. Measured through the use of a numerical rating scale, the Ratings of Perceived Discomfort scale, with descriptive terms at and between the extremes (Thorn and Williams, 1989). The scale consisted of evenly spread demarcations ranging from 0 to 100. The descriptive anchors *no discomfort, just*

noticeable discomfort, moderate discomfort, and *excruciating discomfort* were used to correspond to pain levels of 0, 10, 50, and 100.

Profile of Mood States. The Profile of Mood States (POMS) inventory, developed by McNair, Lorr, and Droppleman (1971), is a list of sixty-five mood adjectives that are thought to encompass the total mood structure of an individual. The inventory measures six identifiable mood/affect states: Tension-Anxiety; Depression-Dejection; Anger-Hostility; Vigor-Activity; Fatigue-Inertia; and Confusion-Bewilderment. The POMS inventory was administered at the beginning of every heart rate test swim.

Post-Swim Questionnaire. Subjects completed an open-ended question at the completion of each heart rate test swim asking how they coped with the physical discomfort.

Heart Rate. Heart rate was monitored during the heart rate test swims after each 100m and 150m interval. It was measured using a Treffene heart rate monitor designed specifically to measure the heart rate of competitive swimmers.

Procedures

Purpose: To examine the effectiveness of a cognitive-behavioral program in improving tolerance of pain in competitive swimming.

Procedure:

1. The heart rate test swim was completed prior to, during and after the mental skills training and once per week for 13 weeks.

2. Critical swimming velocity, an endurance-orientated swimming protocol, was assessed during the 2nd, 6th, 10th, and 13th weeks of the study. Heart rate test swim results were compared to the critical swimming velocity results.

3. Subjects received 6-9 hours of mental skills training based on a cognitive-behavioral pain tolerance program for athletes developed by Whitmarsh (1992) (see sheet describing mental skills program in detail).

4. A number of other measures were recorded prior to, during and after the heart rate test swims including perceived discomfort, Profile of Mood States (POMS), mental skill utilization, and heart rate (see sheet describing measures in detail).

Mental Skills Training

- **The Cognitive-Behavioral Pain Management Program for Athletes (Whitmarsh, 1992) is a program based on stress inoculation training (SIT) and adaptations of programs by Turk, Meichenbaum, and Genest (1983) and Meichenbaum (1985). The adaptations were made in order to make SIT more relevant for the competitive swimming environment and acute discomfort tolerance.**

- **Training was conducted through he use of four workbooks in which swimmers received information, practical examples, and helpful exercises to complete.**

  ***Workbooks*:**

  5. **Provided information on pain perception and the physiological/psychological connection of pain based on the gate-control theory of pain (Melzack and Wall, 1988). Swimmers were taught to view physical discomfort as a four stage process (1.Preparation, 2.Confrontation, 3.Coping, 4.Reflection) and to become more self-aware of the effects that physical discomfort can have on athletic performance.**

  2. **The first part of the skills acquisition training. Skills acquisition training is considered to be the most effective phase of the program (Whitmarsh and Alderman, 1993).**

Swimmers received coping skills training in relaxation and controlled breathing based on Benson (1975, 1984).

3. **The second part of the skills acquisition training which consisted of imagery, external diversion, and internal diversion. Swimmers were also taught a systematic method of applying self-coaching strategies to deal with the four stages of pain.**

4. **The final application workbook gave swimmers the opportunity to apply the learned techniques in a variety of different swimming specific and non-swimming specific exercises.**

☞ **Mental skills training was conducted through 12 individual counselling sessions over a 6 week period. While the mental skills program was essentially the same for each subject slight adjustments were made to cater more effectively to individual needs. Swimmers were encouraged to use and practice the mental skills whenever possible.**

Major Findings

- **All of the subjects increased swimming velocity from pre-training phase, into the training phase and finally into the post-training phase. However, clinical significance was evident with only two of the swimmers.**

- **Swimmers most successful in improving swimming velocity demonstrated a negative (non-significant) relationship with perceived pain and swimming velocity.**

- **The classic "iceberg" profile on the POMS test occurred 44% of the time, however, it did not make any significant difference to the overall heart rate swim times.**

- **Mental skills utilized during the heart rate test swims included relaxation (30%), attention diversion (24%), self-coaching (19%), physical adjustments (17%), and negative attribution patterning (10%).**

Final Observations

- **Sport psychologists and researchers need to be aware of the important difference between clinical and statistical significance. Sport data must be examined in light of the specific sport.**

- **Athletes should try to control the debilitating effects of perceived pain and not try to eliminate the pain altogether.**

- **An intervention package is only valuable if it is effective in the sport setting and not just the laboratory. However, controlling all extraneous variables is not possible in the sport setting.**

- **Swimmers in this study not only participated in this physically difficult study but also maintained their heavy swim training and weight training schedule. It is unrealistic to ask coaches and elite athletes to take 13 weeks off (or one full macro) to participate in a physically demanding study. These difficulties must be taken into account when conducting field research with elite athletes during the training/competitive season.**

☞ **Two significant areas must be addressed to make the mental skills pain program more effective.**

5. **Mental skills intervention programs for pain tolerance must take a closer look at individual differences. This would require developing an intensive personality profile based on personal interviews and personality inventories.**

6. **It may be necessary to re-evaluate the role that pain and the tolerance of pain plays in swimming performance. A phenomenological research method within a qualitative framework would be valuable for assessing process variables such as pain perception.**

HEART RATE TEST# ______________________ **DATE:** ______________________

NAME	DIST	TIME (secs)	H.R.	NAME	DIST	TIME (secs)	H.R.
	50				50		
	50				50		
	100				100		
	150				150		
	50				50		
	100				100		
	100				100		
	600				**600**		
	50				50		
	50				50		
	100				100		
	150				150		
	50				50		
	100				100		
	100				100		
	600				**600**		
	50				50		
	50				50		
	100				100		
	150				150		
	50				50		
	100				100		
	100				100		
	600				**600**		
	50				50		
	50				50		
	100				100		
	150				150		
	50				50		
	100				100		
	100				100		
	600				**600**		
	2400				**2400**		
	CSV				**CSV**		
	RPD				**RPD**		
	POMS				**POMS**		

APPENDIX E

Study #3

Pain Statements - Rating Sheet

The following statements have been made by competitive swimmers about the role of pain in competitive swimming. Please indicate how strongly you agree with each statement by rating each statement using the scale below. The rating must only consist of whole numbers and each of the five different ratings must have been used at least once.

1 = do not agree at all
2 = slightly agree
3 = moderately agree
4 = strongly agree
5 = completely agree

1. _____There is always some part of my body that will be sore.
2. _____If I am doing a lot of training then pain will affect my performance.
3. _____I try not to let any negative thoughts I have before I swim affect me.
4. _____I try not to think about the pain until after I am done.
5. _____There is no pain when I don't put any effort into my swimming.
6. _____I experience more pain at the more important meets
7. _____I push myself physically and mentally at important meets to do my best.
8. _____If I do not have a specific mental goal in mind then the physical pain will get worse.
9. _____If I know that I am behind then I won't push myself and the physical pain is less.
10. _____If I am out in front I try a lot harder to stay ahead and I feel the physical pain more.
11. _____I need to be focussed in sprinting to deal with the pain.
12. _____I use my legs a lot during middle distance swims and by the time I am done I can hardly feel them.
13. _____The pain interferes with my enjoyment of training camps, makes me feel like I can't go anymore, I get cranky, and I just want to quit.
14. _____I experience mental pain trying to get myself psyched up for a workout or race.

15. _____When I am sore or stiff I will take it easy until the physical pain is gone.
16. _____The coach is a good motivator so I push myself and do not experience much mental pain.
17. _____There is more physical pain in training.
18. _____Negative thoughts like" should I stop?" or "can I keep going or not?" are always going through my head.
19. _____I try to lengthen my stroke and lessen the frequency so that I am using the least amount of energy to cover a certain distance.
20. _____The physical pain is the same whether I am winning or losing the race.
21. _____I can handle the physical pain better when I am winning.
22. _____I don't really notice the physical pain in sprints because the race is so short.
23. _____The mental pain increases in longer races.
24. _____Doing weights as part of my training produces the same level of pain as swimming.
25. _____I can always talk to someone on the team about how I feel or get someone to help me stretch.
26. _____I experience motivation when I know that I have worked hard.
27. _____I stretch really well before I get in to swim.
28. _____I try to enjoy being there and just to have fun and not worry about doing good or bad.
29. _____I try to train hard so that I am in good shape.
30. _____I eat the right foods so I'll have enough energy and then maybe will not experience as much physical pain.
31. _____Every muscle feels sore and fatigued
32. _____I start to feel the pain when I am getting tired.
33. _____Motivating myself is mentally painful.
34. _____Sometimes before I swim I'll still have physical pain from a previous practice
35. _____The amount of physical pain in competition depends upon how mentally prepared or unprepared I am and how well I can keep my focus.
36. _____Sometimes the pain is intermittent.
37. I try to be mentally and physically prepared for every meet and race.
38. _____Sometimes I just want to get the set over with so I'll push myself harder so I can finish faster which will make the physical pain worse.

39. _____When I am ahead, I am in a state of flow and I don't notice the pain.
40. _____When I start the race I 'm focussed on my start and I can keep focussed for the first couple of lengths.
41. _____Pain in sprinting is mostly mental.
42. _____I experience similar pain in other sporting activities because I always put in my best effort.
43. _____I experience anxiety wondering when practice will end and I can stop.
44. _____I experience frustration/anger if I have to keep swimming even when I am in pain.
45. _____I use specific words like smooth to keep my stroke smooth and flowing.
46. _____It helps to know that other people are going through the same thing.
47. _____I don't get tired mentally unless I am sick and then I just feel like giving up.
48. _____It feels like you can't move your arms one more time around.
49. _____If pain doesn't hit until near the end I feed off it- I think" I'm almost done let's see how much I can make this hurt".
50. _____Before I swim I feel good because I enjoy swimming and I get excited about it.
51. _____I can't commit myself to hurting (physically) as much in practice as I do in competition.
52. _____I go into complete body collapse and have problems walking when I'm done a race.
53. _____When I feel pain my stroke is the first thing to go (change).
54. _____In the middle when I start hurting (physically) its really hard to keep going because that is when I hurt the most.
55. _____I never experience mental or physical pain before a race.
56. _____I enjoy swimming and pain just happens to be a part of it and I accept that.
57. _____I use a lot of visualization before the race so when I get to the race there is not any unexpected feelings and I can focus on my race.
58. _____I experience physical pain when I push my body beyond the comfort zone.
59. _____My mental frame of mind going into a race is important and the more important a meet the more important a positive frame of mind.

60. _____When I am losing it's not only the physical pain that gets to me but it's also the mental pain of losing.
61. _____I think about the stroke and usually I focus on the clock and my times.
62. _____If I start hurting too early in a race I start wondering whether or not I'll be able to finish so I have to slow down and pace myself.
63. _____I feel physical pain while I'm training but after I'm done the pain doesn't last.
64. _____The physical pain from swimming the race will last longer after the race is over because I put all the energy and strength I have into the race.
65. _____The physical and mental pain are related because when I physically start to hurt the mental pain gets worse too.
66. _____I get angry when I don't make set times.

67. _____Relaxation training was helpful because it helped me relax and it lessened the mental pain.
68. _____There is lots of mental pain because I work so hard to get a win or be in a certain position.
69. _____Sometimes I train better when I'm sore.
70. _____During high season at training camps I hurt all the time.
71. _____At the big meets I know what it took me to get there and I usually know where I stand so it is not as mentally painful.
72. _____I usually think about the pain too much and I tell myself to take it easy or else I am going to die.
73. _____If I sleep wrong the night before it can affect me both physically and mentally.
74. _____The pain in sprints is a sharper pain and I'm trying to go as fast as I can.
75. _____I have got goals to work for and I force myself to push through the pain and I am willing to take more pain.
76. _____I usually try to lighten the atmosphere by joking around so I can relax more and then I will be able to deal with the pain better.
77. _____In races, I feel pain in certain areas depending upon which parts of my body I work more
78. _____I experience pain before, during, and after swimming.

79. _____In training, I go hard and I push until I am done the sets and until I have nothing left to give - my whole body hurts.
80. _____When I race I try to have a certain strategy and there will be times in a race when my legs will hurt so I will concentrate on my arms more or vice versa.
81. _____Sometimes I just do not want pain so I will swim slower and stay in my comfort zone and not push myself as hard as I can.
82. _____Sometimes it helps to increase my arm speed and keep the rhythm of the stroke.
83. _____If I do not feel like swimming on a particular day the pain affects me more.
84. _____I do feel pain in other sports but mostly its a direct pain in specific areas.
85. _____I sometimes feel like I can't take anymore and I just want to cry
86. _____I get nervous before competitions.
87. _____I like to use distraction techniques such as concentrate on my stroke, sing songs, add numbers, think about what I would rather be doing, or think about someone I hate and pretend they are experiencing the pain.
88. _____I give myself positive reinforcement and tell myself to keep going and that I can do it.
89. _____At this level, it is really up to the athlete whether or not she will use the strategies to help tolerate pain.
90. _____I find it hard to breathe.
91. _____I get an overall feeling of deadness while racing, all my energy is gone and I can't move without pain.
92. _____A negative attitude and low motivation will always make the pain seem worse.
93. _____Generally, if I am leading the race the pain seems almost irrelevant; just happy that I am winning.
94. _____I sometimes give up and convince myself that my pain is worse than it actually is - as if pain will somehow justify swimming slow or losing.
95. _____Pain is part of the sport and some pain is good and it pushes you to get past it and advance to a higher level.
96. _____You never enjoy the pain while you are experiencing it, but the rewards you get are worth it.

97. _____I am tolerant of the pain if I am in a good mood when I am experiencing it.
98. _____When I am in a bad mood and experience pain, I get angry and pouty and very testy and I tend to perform worse.

Total Combined Statements

1. I always experience physical pain.
2. I think pain is inevitable.
3. There is always some part of my body that will be sore.
4. It is a good pain.
5. I know that I am training hard and that is good.
6. If I am doing a lot of training then pain will affect my performance.
7. If I am feeling run down then pain will affect my performance.
8. I hurt physically while I am swimming.
9. I hurt physically after swimming is done.
10. I try not to let any negative thoughts I have before I swim affect me.
11. I try not to think about the pain until after I am done.
12. In training there is more physical pain.
13. There is physical pain in competition.
14. There is mental pain in competition
15. Once the physical pain starts then it is continuous.
16. There is no pain when I don't put any effort into my swimming.
17. Sometimes I swim easier to get rid of the soreness faster.
18. When I am at a smaller meet (one that is not important) I won't mentally prepare and I won't push myself too hard.
19. I will not push myself hard as less important meets.
20. I experience more pain at the more important meets
21. I push myself physically and mentally at important meets to do my best.
22. I do not change my behavior in small sets.
23. In big sets I try to make my stroke longer and try to pace myself.
24. I push myself to keep going when the coach is standing at the end of the lane.
25. If I do not have a specific mental goal in mind then the physical pain will get worse.
26. If I know that I am behind then I won't push myself and the physical pain is less.
27. If I am out in front I try a lot harder to stay ahead and I feel the physical pain more.
28. The mental pain is less when I am ahead.
29. I feel the most pain on the last length of the race.
30. If I am mentally prepared it is easier to push through the pain.
31. The pain in sprinting only affects me in the half length.
32. I need to be focussed in sprinting to deal with the pain.
33. The middle distance swims are the hardest races.
34. I use my legs a lot during middle distance swims and by the time I am done I can hardly feel them.
35. I do not experience similar pain in other sports.
36. Pain interferes with my enjoyment of training camps. makes me feel like I can't go anymore. I get cranky, and I just want to quit.
37. I experience frustration when I am not making certain times that I know I should be.
38. I experience anger at the coach.
39. I am motivated if I do well in a race and then the pain is worth it.
40. I try to mentally break up sets so that they do not seem so big.
41. Sore and tired muscles.
42. Mental pain trying to get myself psyched up for a workout or race.
43. I am sore and tired and drained of energy from morning and evening workouts.
44. It is hard to stay awake in classes or get out of bed in the morning.
45. It is hard to stay motivated.
46. When I am sore or stiff I will take it easy until the physical pain is gone.

47. I am sore from the previous practice and it just continues on and on.
48. I mostly experience physical pain while I am swimming.
49. The coach is a good motivator so I do not experience much mental pain.
50. After I feel exhausted it is hard to be motivated to do any homework.
51. There is more physical pain in training.
52. The pain is more mental in competition.
53. If I am not physically prepared for a race then I wonder how I am going to be able to do good.
54. I hope that I will do good but I know I won't do my best.
55. I have to be mentally and physically prepared in order to have a good race.
56. If I am not physically prepared then it's harder on me mentally.
57. Once the pain starts in a race the pain is continuous and it gets progressively worse.
58. Lactic acid keeps building up and I can't get as much oxygen to my lungs as I want.
59. When I am trying to get in shape I constantly feel pain.
60. The pain is always there when I train progressively harder and harder.
61. I like to do well in less important meets but if I don't do well I don't worry about it.
62. I do not push myself physically as hard as less important meets.
63. I feel physical pain in competitions and some mental pain depending on how I am doing.
64. When I experience pain I slow down or don't try as hard.
65. I switch to one-arm fly when doing butterfly.
66. I am thinking " should I stop?" or "can I keep going or not?".
67. The negative thoughts are always going through my head.
68. I try to lengthen my stroke and lessen the frequency so that I am using the least amount of energy to cover a certain distance.
69. If I am having a bad day I can't get myself psyched up to swim which will make the physical pain that I experience.
70. The physical pain is the same whether I am winning or losing the race.
71. I can handle the physical pain better when I am winning.
72. If I am losing the mental pain I experience makes the physical pain worse.
73. I don't really notice the physical pain in sprints because the race is so short.
74. I notice the physical pain after I have finished the sprint.
75. I do not experience any mental pain because the sprint is so short and I don't really have a chance think about anything.
76. My muscle are more tired in longer races.
77. The mental pain increases in longer races.
78. I have more time to think and evaluate during longer races.
79. Doing weights as part of my training produces the same level of pain as swimming.
80. Leisure activities do not produce physical or mental pain in the same way as swimming.
81. I can always talk to someone on the team about how I feel or get someone to help me stretch.
82. Pain does not interfere with my ability to enjoy the sport of swimming.
83. The social aspect really helps in the enjoyment of the sport.
84. I experience happiness when I do well.
85. I experience depression if I am not doing well and I do not feel like being around anyone.
86. I experience indifference in small. less important meets.
87. I experience frustration when there is nothing that I can do about the pain until I have physically recovered from it.
88. I experience motivation when I know that I have worked hard.
89. I stretch really well before I get in to swim.
90. I try to enjoy being there and just to have fun and not worry about doing good or bad.
91. I do not dwell on bad performances so that lessens my mental stress.
92. I try to train hard so that I am in good shape.
93. I eat to have enough energy and then maybe will not experience as much physical pain.

94. I experience physical pain.
95. I experience mental pain.
96. Every muscle feels sore and fatigued
97. I just hurt everywhere.
98. I feel mentally fatigued.
99. I am tired and want to rest.
100. I start to feel the pain when I am getting tired.
101. I have to keep telling myself to keep going and force myself to swim.
102. Motivating myself is mentally painful.
103. Once I start to hurt really bad I slow down and don't push myself as hard as I know I can.
104. Sometimes before I swim I'll still have physical pain from a previous practice
105. I sometimes have negative mental thoughts because I know what I have to do and I know it is going to hurt.
106. My body is sore from the workout and I have to keep telling myself to keep going and try and ignore the pain.
107. After swimming it is mostly physical pain that I experience.
108. The physical and mental pain is an all-around feeling of fatigue.
109. I am mentally and physically drained.
110. The amount of physical pain in competition depends upon how mentally prepared or unprepared I am and how well I can keep my focus.
111. I get down on myself in a race when I am doing poorly and that usually makes the physical pain seem more intense than when I was doing well.
112. Sometimes when it starts the pain is continuous and it keeps getting worse.
113. Other times the pain is intermittent.
114. I will start to hurt mentally and physically in a race. but if I can regain my focus or concentrate on what I need to do then the pain will go away or I won't notice it anymore.
115. If I am mentally psyched up and prepared to swim I don't experience any pain.
116. If I had a bad day or had problems with a professor that will affect me mentally and I won't be able to deal with physical pain as well in training.
117. I try to be mentally and physically prepared for every meet and race.
118. In less important meets. if I am not ready. I don't worry about it so I won't experience any mental or physical pain.
119. At important meets. I'll push myself and work as hard as I can so there will be physical pain.
120. The extent to which I feel the pain depends on my mental state.
121. I tell myself to keep going and that I can do it and try to push myself through the pain.
122. I try to make my stroke smooth. and long as opposed to using my full strength and speed. If I'm not into swimming the pain is worse.
123. Sometimes I just want to get the set over with so I'll push myself harder so I can finish faster which will make the physical pain worse.
124. The biggest difference is pain between winning and losing is the mental pain. If I get behind I am really hard of myself mentally which affects my swimming performance even more.
125. When I am ahead. I am in a state of flow and I don't notice the pain.
126. If I am going to feel the race. I am going to feel it in the middle of the race.
127. I might lose my focus in the middle of the race and what I 'm supposed to be doing.
128. When I start the race I 'm focussed on my start anussed for the first couple of lengths.
129. Near the end of the race I'm concentrating on my finish.Pain in sprinting is mostly mental.
130. I am really hard on myself especially when I am falling behind usually do not notice the physical pain in sprints because the races are so short.
131. I usually concentrate on what I am doing rather than the physical pain.
132. I experience similar pain in other sporting activities because I always put in my best effort and I am going to it right and give full effort.

133. I hated swimming when I was coming back after an injury.
134. It hurt so much trying to get back into shape and recover from the injury.
135. I experience anxiety wondering when practice will end and I can stop.
136. I experience frustration/anger that I have to keep swimming oven when I am in pain.
137. I experience motivation when I feel pain after a practice I know I've worked hard and I feel good about
138. I use specific words like smooth to keep my stroke smooth and flowing.
139. I use "lengthen' to stretch out my stroke.
140. I tell myself to keep pushing and that I can do it.
141. The whole team would get together and we'd talk about how we were feeling and it helped to know that their were other people going through the same thing I was.
142. It's mostly physical pain that I feel.
143. I don't get tired mentally unless I am sick and then I just feel like giving up.
144. It feels like you can't move your arms one more time around.
145. You just want to stop but you push yourself through the pain until you're finished.
146. If I start hurting early in a race it's hard for me to keep focussed on what I want to do.
147. If pain doesn't hit until near the end I feed off it- I think" I'm almost done let's see how much I can make this hurt cause I'm almost there.
148. Before I swim I feel good because I enjoy swimming and I get excited about it.
149. While swimming. I physically hurt but it/s the exhaustion I experience after I'm done swimming that really affects me- because I'm trying to balance school and other commitments and it's difficult to do when I'm exhausted.
150. I can't commit myself to hurting (physically) as much in practice as I do in competition.
151. More physical pain in competition than training.
152. I go into complete body collapse and have problems walking when I'm done a race.
153. My legs are just that sore after a race.
154. I put everything I have to give (physically) into competition.
155. I always experience physical pain in competition.
156. Once the pain starts it's continuous and it's physically the same until the end.
157. The pain is mentally easier near the end because I know I'm almost done.
158. If I experience pain it depends how much energy I feel like putting in.
159. I can take it easy and not feel any physical pain or if I take a race or training seriously I'll feel physical pain.
160. It is easier to commit to hurting at more important meets. but the physical pain isn't any different.
161. I do not consciously change my stroke but it does change.
162. I shorten my stroke and slow down the frequency of it.
163. In terms of thoughts. I try to think about my stroke and keeping it the same because when I feel pain my stroke is the first thing to go (change).
164. When I think about how much I hurt the physical pain gets worse or if I think "I'm losing" it gets worse.
165. When I am in a winning situation is's easier to motivate myself to continue hurting because I know I'm doing better than anyone else.
166. If I win it's like I'm getting rewarded or compensated for the pain.
167. In the middle when I start hurting (physically) its really hard to keep going because that is when I hurt the most.
168. I never experience mental or physical pain before a race.
169. At the end of a race there is physical pain but I know that I am almost done so I can deal with it.
170. Mentally I am almost numb while swimming.
171. I feel the physical pain while I'm swimming. but it hits me harder at the end because I know I'm done and it is okay to hurt then.

172. The 400 IM is the most physicallyg used and the rhythm changes so much your muscles don't get into a pattern.
173. Doing fly usually doesn't cause me any pain.
174. When I am doing backstroke my chest hurts because I' trying to control my breathing instead of gasping for air so that when I switch to breast stroke I have the right breathing pattern.
175. When I switch from breast stroke to freestyle my knees hurt from doing whip kick and then I have to switch to flutter kick and it hurts.
176. I experience some physical pain in other activities but it's completely different pain from the pain I experience in swimming.
177. I do not commit myself to hurting as much as I do in swimming.
178. I don't enjoy the pain. but I accept it and I'm willing to put up with it.
179. I enjoy swimming and pain just happens to be a part of it and I accept that.
180. I experience acceptance - I know I'm going to feel pain so why worry about it.
181. I experience anger - when I've had enough and don't think I can take anymore I get mad and I just want out.
182. I experience motivation - if I'm ahead or close to somebody I push myself more because I know
183. If I know if I'm hurting that much then everybody else must be too and I see if I can put pressure on the person ahead of me by getting closer and closer.
184. I really don't do anything to lessen the physical pain while swimming.
185. I use a lot of visualization before the race so when I get to the race there is not any unexpected feelings and I can focus on my race.
186. I experience mental pain by trying to get myself to do things I don't want to.
187. I experience physical pain when I push my body beyond the comfort zone.
188. Physically you feel your muscles breaking down. they are getting tired and fatigued and don't want to do what you've been telling them to do.
189. Mentally you get upset and frustrated because you know you should do this and you want to do this but it hurts too much.
190. Depending on how well I can cope with the mental stress of trying to push myself past my pain tolerance limits.
191. I experience pain sometimes before training because mentally I know what I have to do and that it's going to hurt.
192. During and after it is mostly physical pain.
193. I usually don't experience any pain before a race.
194. I just try and push myself through the pain and you don't get hurt right away.
195. My muscles gradually tighten up and get sore.
196. All of sudden my muscles will just fail - it's immediate and it's so mentally painful because I'm trying to go as fast as I can in a race. but my body refuses to listen to me.
197. Once the pain starts it is continuous.
198. Sometimes workouts aren't hard as others or I don't notice the pain.
199. I am thinking about my stroke or some races and I am ready for (physically) and so I don't experience any pain.
200. My mental frame of mind going into a race is important and the more important a meet the more important a positive frame of mind.
201. At less important meets I won't experience as much physical pain because I don't care too much about the results.
202. I try not to think about the pain.
203. I try to concentrate on what I'm doing (or supposed to be doing).
204. If I'm feeling tough. I'll push myself through it and if I'm feeling like a wimp I start to think about the pain more.
205. If I get more aggressive when I'm feeling pain I can push myself harder and the pain is easier to deal with.

206. When I start thinking about the pain it gets worse.
207. When I am losing it's not only the physical pain that gets to me but it's also the mental pain of losing.
208. If I am winning it's easier to take the physical pain and I'm more mentally positive.
209. Usually my strokes start to fall apart near the end and then I get upset that I'm slowing down and getting fatigued and that I might not win.
210. On the last length of a sprint, my body starts to get fatigued and then mentally I start to wonder whether I'll win or lose.
211. In the IM my freestyle is the worst and its the last stroke and by the time I get to it I'm so tired and I wonder whether or not I'll win or lose.
212. I don't push myself as hard in other activities.
213. I have been doing it for so long that the pain is part of it.
214. When I hurt I know I have trained hard and then I feel good.
215. I get frustrated with myself.
216. I become angry sometimes when I am so fatigued and I don't want to swim anymore I get mad at the coach.
217. I think about the stroke and usually I focus on the clock and my times - at the 50m pt or 100m pt.
218. There is a physical pain that I consider a good pain.
219. My muscles are hurting but I know I'm getting stronger and that I'll benefit from the pain.
220. The pain I experience in swimming is mostly physical.
221. Sometimes after a race I almost can't walk because my legs are so sore.
222. If I start hurting too early in a race I start wondering whether or not I'll be able to finish so I have to slow down and pace myself.
223. During swimming I'll always feel physical pain and after I can still feel the pain and I'm tired.
224. I feel physical pain while I'm training but after I'm done the pain doesn't last.
225. I am more tired after a race than in pain.
226. The physical pain from swimming the race will last longer after the race is over because I put all the energy and strength I have into the race.
227. Once the pain starts it is continuous and it usually keeps getting worse from that point until the end.
228. Whether I'm training or competing I always experience physical pain to some extent.
229. At smaller meets I usually don't care as much how I do so I don't go all out and pain is less.
230. At the more important meets I experience more pain.
231. I'm more willing to tolerate more pain at important meets because I know I have to swim all out if I want to win or qualify for another important meet.
232. I slow down my stroke sometimes.
233. I try not to think about the pain and focus more on my stroke or breathing.
234. Thinking about the pain all the time makes it worse.
235. If I am last or no chance of catching someone then I can't tolerate the pain as well and I'll slow down and not even try.
236. If I'm ahead I don't think about the pain.
237. I can tolerate higher levels of pain while ahead so I don't really feel that much pain while I am swimming.
238. When I am close to the end I usually start to feel the physical pain.
239. If I am behind I start to think maybe I'm not going to be able to finish the last length.
240. The physical and mental pain are related because when I physically start to hurt the mental pain acts worse too.
241. Then.
242. If I think about the physical pain while sprinting it is usually right at the end - the last length in the 100m or the last 10m in the 50m.
243. I feel the physical pain more in middle distance just because it's a longer race and the physical

pain will make the mental pain worse.
244. I do feel pain in other activities and usually feel more pain because I'm using different muscle groups that I haven't been training.
245. Mentally, swimming is more painful because if I'm participating in other activities I'm doing it just for
246. I'm doing it just for fun.
247. If I am having a bad day in the pool (not making set times), I think to myself "why am I here? why have I been swimming for so long?"
248. I get frustrated when I am not swimming as good (or fast) as I can.
249. I get angry when I don't make set times.
250. If I am mentally prepared to swim then I can handle the pain better.
251. If I think of a song or something that can get my attention from the pain I can handle the pain better.
252. I have received relaxation training - tensing and relaxing my muscles and visualization.
253. Imagining the pool and what I'll do when I walk in and get ready for a race and then swimming the race.
254. The relaxation training was helpful because it helped me relax and it lessened the mental pain.
255. Lots of physical pain.
256. Some mornings I wake up I'm exhausted and I have to force myself to keep going.
257. There is lots of mental pain because I work so hard to get a win or be in a certain position.
258. If I don't make my goal then that hurts (mentally) a lot.
259. Physically, there is all around soreness and exhaustion.
260. Mentally, there is a lot of frustration because I never go into a race thinking "I can't do this", so if I do not get the outcome I want I think "Why didn't I get this?", or "What did I do wrong?"
261. Physical pain can really get to me.
262. Sometimes I train better when I'm sore.
263. When I am competing and I hurt it really gets to me - especially mentally because I have to change my strategy for the race because I'm sore and I know I shouldn't be doing that.
264. During high season at training camps I hurt all the time.
265. If I haven't been training very hard for awhile, I'll start to hurt while I'm swimming and after.
266. The physical pain is the same in training and competition, but in training I think it is okay to be sore.
267. The more I hurt the more that I am getting out of a practice(physically).
268. Physical pain in competition can throw me off because I like to be loose and relaxed before my races.
269. Mentally, competition is harder on me.
270. During a race once it starts to hurt it is continuous.
271. There are some workouts and meets where I've felt really loose and relaxed and it also depends on what stage in training that I am at.
272. If I am tapering I am probably feel fine during workouts.
273. I feel more pressure when the meet I am at could effect how I'll do at another meet or if I am trying to qualify for another meet.
274. It is more painful for me(physically and mentally) at the meets where I am trying to qualify for something.
275. At the big meets I know what it took me to get there and I usually know where I stand so it is not as mentally painful.
276. I usually think about the pain too much and I tell myself to take it easy or else I am going to die.
277. In the stroke itself, I really try to stretch it out and keep it long and smooth as opposed to quick.
278. If I sleep wrong the night before it can affect me both physically and mentally.
279. Just thinking about the pain or how I'm going to place in a meet can make the pain worse.
280. I find it much easier to keep going when I know I am leading.

281. When I am leading. I feel better. my stroke tends to stay together better.
282. There has been a few times when I have been behind that I feel good and can over take them.
283. It is very rare that I feel good enough to overtake someone as opposed to keeping going when I am in the lead.
284. The physical pain starts to get to me half-way or 3/4 of the way through the race (depending on the length of the event) then I start to worry and I slow down and it's really hard to keep going and I really have to tell myself what to do as opposed to just doing it.
285. The pain in sprints is a sharper pain and I'm trying to go as fast as I can.
286. It physically hurts a lot but it doesn't last very long once the race is over.
287. I can recover from sprints pretty fast.
288. Sometimes when I am done middle distance swims I find it hard to walk because my legs are sore.
289. It is hard to keep swimming when I get into the warm down pool.
290. The physical pain is worse in middle distance and it takes longer for me to recover compared to a sprint.
291. I experience some pain in other activities. but I do not work as hard at other activities as I do at swimming.
292. I force myself to push through the pain and I am willing to take more pain.
293. Since I have gotten older I find it harder to keep the good times coming in and it's a lot more frustrating.
294. At some meets I just want to go home because I am not swimming well.
295. What keeps me going is the social aspect - a lot of my best friends swim.
296. I also know I have still got a lot left. I've come this far I am going to keep going for it.
297. I experience frustration with my performance.
298. I experience desperation because sometimes I just do not know what to do anymore to improve my performance.
299. I usually try to lighten the atmosphere by joking around so I can relax more and then I will be able to deal
300. deal with the pain better.
301. Thinking about a song I like can help motivate me and sometimes if I get mad enough I can push through the pain to get the times I want.
302. There is physical pain and mental pain.
303. If I let it. the mental pain can make the physical pain worse.
304. When experiencing physical pain it can make it a lot harder mentally to keep going.
305. In training. I feel the pain everywhere - it is an all-out all around pain.
306. In races. I feel pain in certain areas depending on which parts of my body I work more.
307. The pain will change - it will move from my arms to my legs or vice versa.
308. If I let myself feel the pain then I start thinking " I can't finish" or " I am going to slow down to get into my comfort zone"
309. Sometimes I can push through it and I tell myself it doesn't hurt that much.
310. I experience pain before. during. and after swimming.
311. I experience the most pain (mentally and physically) while swimming.
312. Mentally I can hurt if I let myself down and physically I'll hurt during and after and sometimes before I swim.
313. I'll be physically sore from my last race or my last training session.
314. I go hard in training and push until I'm done the sets and until I have nothing left (physically) to give.
315. There is not much mental pain in training.
316. When I race I try to have a certain strategy and there will be times in a race when my legs will hurt so I'll concentrate on my arms more or vice versa.
317. In a race I'm more mentally exhausted too

318. The physical pain is felt more in certain areas.
319. Pain is usually intermittent. when I first start out I feel good and as the race goes on the pain starts to get worse (physically) but sometimes I'll get a second burst of energy and I won't feel any pain.
320. Sometimes I just don't want to have pain so I'll swim slower and stay in my comfort zone and not push myself as hard as I can.
321. If I know there is not much riding on a particular race I won't get really psyched up for it so I'll just go in and swim the race and there won't be much pain.
322. At more important meets I start wondering if I trained enough.
323. During a race if I think I haven't trained enough my mental pain will make the physical pain worse.
324. I try to lengthen out my stroke and calm down and relax and If my legs are tired I'll work more on my arms or vice versa.
325. Sometimes it also helps to increase my arm speed and keep the rhythm of the stroke.
326. If I slow my stroke down it sometimes makes the pain worse.
327. If I haven't trained enough and I know I'm not ready it makes it worse.
328. If I dont a race my whole mind set is different
329. If I know that I am winning then it makes the pain worth something.
330. If I am losing the pain is worth nothing and there is no use in exerting myself and increasing the pain because I am going to lose.
331. At the mid point of a race I start to feel physical pain and I know I've still got half a race to go so I have to push myself harder and I have to concentrate on picking it up and going hard until the end.
332. I don't really feel the pain while swimming sprints.
333. In sprints my mind is on doing fast arm repetitions and kicking hard because the race is so short and when I'm done the pain hits
334. I have trouble breathing and my legs ache at the end of a sprint.
335. About halfway through a middle distance race the pain starts (physically) and depending on how I am doing in the race I'll either be able to pushy it aside or I'll think about it more.
336. I feel pain in other sports but mostly it is a direct pain in specific areas.
337. When I swim I usually feel pain everywhere. it is a different type of pain.
338. I know that my pain will pay off for me and that I am working towards something I really want.
339. Sometimes the pain makes me feel good - I know I've workde hard and I'm getting better.
340. I experience anger and get mad at the coach for making me swim so much and I feel I don't think I can take anymore.
341. I sometimes feel like I can't go any more and I just want to cry.
342. I feel nervous before competitions.
343. I concentrate on my stroke to lessen the pain.
344. I sing songs to myself or add numbers.
345. or give myself positive reinforcement
346. I give myself positive reinforcement like tell myself to keep going and that I can do it.
347. Psychological training helped in understanding my pain and ways of dealing with it.
348. At this level it is really up to the athlete whether or not she will use the strategies to help tolerate pain.
349. I know what to do. but I do not use the strategies very often.
350. In the form of extreme fatigue. my legs and arms hurt and feel heavy.
351. I find it hard to breathe.
352. The pain depends upon the type of work being done.
353. Sometimes muscle soreness and fatigue. overall fatigue. problems breathing. numbness or sometimes just overall pain. everything hurts and tightens up.
354. Sometimes the pain get bad and then you either slowdown to avoid such pain or you push

through.

355. One way the pain inhibits your performance in another it helps.
356. Sometimes before you swim you are feeling really sore and tight from the night before.
357. Usually always I feel pain of some sort during my swim.
358. After the race/set I usually feel real tight, tired, sometimes dizzy and numb.
359. During training the pain I feel is mostly pain from soreness, tightness, just that your muscles are tight.
360. In some sets your body hurts, and you have problems breathing (hard short rest sets)
361. In competition, mainly at the end of the race, my whole body is in pain.
362. My legs feel numb, my arms feel like dead weight, I can't breathe in competition.
363. I get an overall feeling of deadness in competition, all my energy is gone and I can't move without pain.
364. Pain is usually intermittent as long as I am in shape.
365. The pain usually sets in near the end of the race, sometimes in the middle.
366. Off the turns there is also pain.
367. Sometimes I'll feel great in the water and won't hurt, other times your feel the pain.
368. There are times when you hurt so bad you can't feel anything.
369. At times little effort will be used so the pain is little if any.
370. At more important meets the pain is higher mainly because I try harder and I am tapered.
371. I know it is a big meet so I think it hurts more than I did my best and I did better than at not so important meets.
372. Sometimes I slow down my overall swimming but there are other times when I increase my effort and frequency to push beyond that level - depends on my mood and motivational level.
373. A negative attitude and low motivation will always make the pain seem worse.
374. If I tell myself the pain is bad then I believe it and then slowdown or whatever.
375. Generally if i am leading a race the pain seems almost irrelevant, I am just happy I am winning.
376. If I am behind in a race I sometimes give up and convince myself that my pain is worse than it actually is
377. I sometimes use pain as a way to justify swimming slow or losing.
378. Pain is the greatest at the end but in some events the pain sets in earlier.
379. When I swim sprints the pain doesn't usually set in till 80m (100m) or after the race (50m).
380. Sprint pain usually doesn't last long and is more in fatigue and not as much in the muscles.
381. I push myself the most in middle distance than in others so pain is greater.
382. These (200's) are the events when absolute pain is experienced and the total body is affected and I am dead when finished.
383. When I swim distance it is usually just to swim it so it is not always important to do well.
384. When I do swim distance I do not know how to swim it so I alter my pace depending on how much pain I experience and my muscles usually get tight.
385. I do not experience similar pain when performing other activities.
386. Besides problems breathing swimming generally leaves me with an overall feeling of fatigue and pain.
387. Other sports I just feel pain in specific areas such as quads in running or forearms in tennis.
388. Pain is part of swimming.
389. Some pain is good and it pushes you to get past it and advance to a higher level.
390. You never enjoy the pain while you are experiencing it, but the rewards you get are worth it.
391. Pain is only temporary but the gratification you receive lasts a long time.
392. If I am in a good mood when I experience the pain I am tolerant and am either happy or sad.
393. When I am in a bad mood and experience pain I get angry and poutty and very testy, then I tend to perform worse.
394. Sometimes I sing myself a song, think about other things I would rather be doing, thing about someone and pretend they are experiencing the pain.

395. Other times I concentrate on my stroke or counting the race/set.
396. I participated in a pain tolerance study consisting of a test set and using various techniques to battle the pain.
397. Some of the techniques were useful if you made the effort and others were very useless.

Categorization of Statements by Sorters

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Sort: Sorter #1

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Item/Pile		Item/Pile		Item/Pile		Item/Pile		Item/Pile		Item/Pile		Item/Pile	
1	7	15	8	29	11	43	7	57	12	71	10	85	6
2	11	16	14	30	11	44	7	58	7	72	2	86	6
3	2	17	13	31	6	45	12	59	12	73	11	87	12
4	2	18	2	32	6	46	14	60	16	74	1	88	12
5	13	19	12	33	5	47	5	61	12	75	9	89	9
6	10	20	16	34	11	48	6	62	8	76	12	90	7
7	10	21	16	35	12	49	15	63	13	77	13	91	6
8	15	22	1	36	6	50	11	64	4	78	7	92	8
9	16	23	5	37	12	51	13	65	5	79	13	93	16
10	16	24	3	38	15	52	7	66	2	80	12	94	8
11	1	25	14	39	16	53	8	67	11	81	8	95	9
12	7	26	2	40	2	54	7	68	5	82	12	96	9
13	6	27	12	41	5	55	11	69	13	83	15	97	7
14	5	28	9	42	3	56	9	70	7	84	3	98	7

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Sort: Sorter #2

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Item/Pile		Item/Pile		Item/Pile		Item/Pile		Item/Pile		Item/Pile		Item/Pile	
1	5	15	5	29	7	43	8	57	8	71	8	85	6
2	5	16	3	30	5	44	4	58	5	72	5	86	8
3	8	17	5	31	5	45	1	59	8	73	9	87	4
4	4	18	6	32	5	46	6	60	9	74	5	88	6
5	3	19	2	33	6	47	8	61	1	75	4	89	9
6	5	20	5	34	5	48	5	62	4	76	4	90	5
7	6	21	5	35	9	49	4	63	5	77	5	91	5
8	9	22	5	36	5	50	6	64	5	78	5	92	4
9	3	23	4	37	9	51	7	65	9	79	7	93	4
10	5	24	5	38	3	52	5	66	3	80	4	94	5
11	4	25	8	39	3	53	2	67	4	81	3	95	4
12	5	26	6	40	8	54	5	68	4	82	2	96	3
13	3	27	7	41	9	55	9	69	5	83	5	97	4
14	4	28	6	42	5	56	5	70	5	84	5	98	8

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Sort: Sorter#3

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Item/Pile		Item/Pile		Item/Pile		Item/Pile		Item/Pile		Item/Pile		Item/Pile	
1	25	15	15	29	17	43	19	57	2	71	9	85	19
2	18	16	16	30	16	44	19	58	18	72	4	86	2
3	2	17	17	31	15	45	13	59	3	73	3	87	2
4	14	18	6	32	18	46	5	60	24	74	11	88	13
5	8	19	4	33	1	47	20	61	13	75	13	89	12
6	9	20	24	34	25	48	20	62	4	76	2	90	19
7	13	21	24	35	12	49	4	63	15	77	10	91	20
8	3	22	1	36	11	50	2	64	23	78	25	92	6
9	4	23	1	37	2	51	22	65	12	79	25	93	24
10	24	24	23	38	4	52	19	66	6	80	4	94	14
11	13	25	17	39	24	53	4	67	13	81	4	95	8
12	4	26	4	40	2	54	24	68	21	82	4	96	14
13	7	27	17	41	1	55	1	69	25	83	6	97	14
14	1	28	2	42	23	56	8	70	25	84	25	98	14

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Sort: Sorter #4

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Item	Pile	Item	Pile	Item	Pile	Item	Pile	Item	Pile	Item	Pile	Item	Pile
1	4	15	2	29	1	43	2	57	1	71	8	85	2
2	9	16	3	30	1	44	2	58	8	72	2	86	2
3	1	17	9	31	4	45	1	59	1	73	1	87	1
4	1	18	2	32	5	46	1	60	6	74	5	88	1
5	2	19	1	33	6	47	2	61	1	75	1	89	1
6	8	20	4	34	4	48	2	62	2	76	1	90	2
7	8	21	3	35	1	49	7	63	9	77	5	91	2
8	1	22	3	36	5	50	3	64	8	78	4	92	2
9	2	23	6	37	1	51	2	65	6	79	8	93	3
10	8	24	5	38	8	52	8	66	6	80	7	94	2
11	1	25	1	39	3	53	2	67	1	81	2	95	7
12	8	26	7	40	1	54	2	68	6	82	7	96	3
13	2	27	1	41	6	55	3	69	7	83	2	97	3
14	6	28	3	42	8	56	7	70	4	84	5	98	2

****

Sort: Sorter #5

****

Item	Pile	Item	Pile	Item	Pile	Item	Pile	Item	Pile	Item	Pile	Item	Pile
1	6	15	7	29	7	43	2	57	7	71	7	85	2
2	1	16	8	30	7	44	4	58	4	72	9	86	2
3	7	17	1	31	6	45	7	59	8	73	4	87	7
4	7	18	2	32	4	46	3	60	8	74	5	88	7
5	8	19	7	33	8	47	6	61	7	75	7	89	3
6	4	20	4	34	6	48	5	62	7	76	7	90	5
7	3	21	7	35	8	49	3	63	4	77	6	91	5
8	9	22	3	36	5	50	7	64	6	78	6	92	7
9	7	23	8	37	7	51	2	65	8	79	6	93	7
10	9	24	7	38	9	52	5	66	2	80	7	94	4
11	7	25	7	39	3	53	5	67	7	81	7	95	3
12	7	26	3	40	7	54	9	68	8	82	7	96	3
13	3	27	7	41	8	55	3	69	1	83	9	97	7
14	8	28	7	42	4	56	3	70	6	84	4	98	4

****

Sort: Sorter #6

****

Item	Pile	Item	Pile	Item	Pile	Item	Pile	Item	Pile	Item	Pile	Item	Pile
1	8	15	9	29	5	43	5	57	1	71	13	85	13
2	5	16	6	30	8	44	7	58	9	72	9	86	1
3	1	17	5	31	8	45	3	59	1	73	1	87	6
4	9	18	7	32	8	46	6	60	2	74	4	88	6
5	9	19	3	33	13	47	13	61	3	75	6	89	6
6	12	20	2	34	5	48	8	62	2	76	6	90	8
7	12	21	2	35	1	49	2	63	5	77	9	91	8
8	6	22	4	36	8	50	1	64	9	78	8	92	13
9	2	23	13	37	1	51	5	65	9	79	5	93	2
10	2	24	5	38	9	52	8	66	7	80	9	94	9
11	4	25	6	39	2	53	3	67	6	81	9	95	11
12	8	26	6	40	2	54	9	68	13	82	3	96	11
13	5	27	1	41	4	55	1	69	5	83	9	97	11
14	13	28	11	42	10	56	11	70	5	84	10	98	7

****

Sort: Sorter #7

****

Item	Pile	Item	Pile	Item	Pile	Item	Pile	Item	Pile	Item	Pile	Item	Pile
1	3	15	2	29	14	43	14	57	2	71	1	85	10
2	14	16	1	30	2	44	9	58	6	72	8	86	15
3	9	17	6	31	10	45	2	59	4	73	16	87	2
4	8	18	9	32	6	46	2	60	1	74	7	88	2
5	3	19	2	33	1	47	1	61	2	75	2	89	3
6	6	20	6	34	16	48	10	62	2	76	2	90	10
7	4	21	9	35	4	49	2	63	6	77	6	91	10
8	4	22	7	36	5	50	15	64	5	78	6	92	9
9	9	23	1	37	4	51	14	65	4	79	14	93	2
10	9	24	13	38	6	52	10	66	11	80	2	94	2
11	7	25	8	39	2	53	2	67	4	81	2	95	3
12	10	26	11	40	15	54	5	68	1	82	2	96	3
13	2	27	2	41	7	55	8	69	14	83	9	97	12
14	1	28	2	42	13	56	3	70	14	84	13	98	12

****

Sort: Sorter #8

****

Item	Pile	Item	Pile	Item	Pile	Item	Pile	Item	Pile	Item	Pile	Item	Pile
1	1	15	1	29	2	43	1	57	2	71	3	85	1
2	1	16	2	30	3	44	1	58	3	72	1	86	3
3	2	17	1	31	1	45	2	59	2	73	1	87	3
4	3	18	1	32	1	46	3	60	2	74	1	88	2
5	1	19	2	33	1	47	1	61	2	75	2	89	2
6	1	20	1	34	3	48	1	62	1	76	3	90	1
7	2	21	2	35	2	49	2	63	1	77	3	91	1
8	3	22	2	36	1	50	2	64	2	78	1	92	2
9	1	23	1	37	2	51	1	65	1	79	2	93	2
10	3	24	1	38	1	52	1	66	1	80	3	94	1
11	3	25	2	39	2	53	1	67	3	81	1	95	2
12	1	26	2	40	1	54	1	68	2	82	2	96	3
13	1	27	2	41	3	55	1	69	2	83	1	97	1
14	3	28	3	42	2	56	2	70	1	84	1	98	1

****

Sort: Sorter #9

****

Item	Pile	Item	Pile	Item	Pile	Item	Pile	Item	Pile	Item	Pile	Item	Pile
1	4	15	4	29	6	43	5	57	11	71	3	85	5
2	8	16	3	30	12	44	5	58	8	72	12	86	5
3	10	17	8	31	4	45	11	59	10	73	12	87	11
4	13	18	5	32	12	46	2	60	13	74	6	88	13
5	12	19	11	33	3	47	3	61	11	75	3	89	1
6	13	20	6	34	8	48	4	62	13	76	11	90	4
7	13	21	13	35	9	49	3	63	4	77	13	91	13
8	3	22	13	36	12	50	5	64	7	78	12	92	9
9	13	23	3	37	9	51	8	65	3	79	8	93	13
10	13	24	8	38	6	52	7	66	5	80	13	94	12
11	6	25	2	39	13	53	4	67	11	81	8	95	6
12	4	26	8	40	13	54	13	68	3	82	11	96	6
13	5	27	8	41	3	55	12	69	8	83	5	97	5
14	3	28	13	42	8	56	12	70	8	84	6	98	5

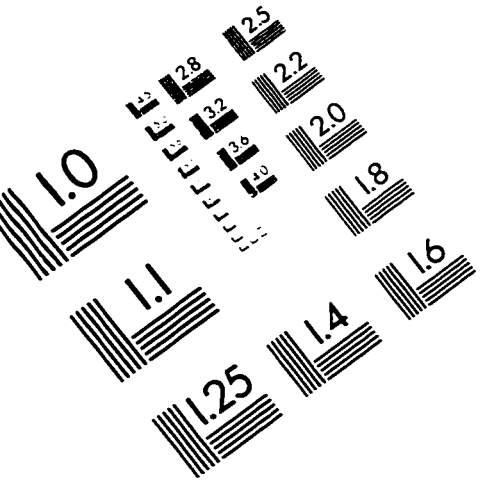
****

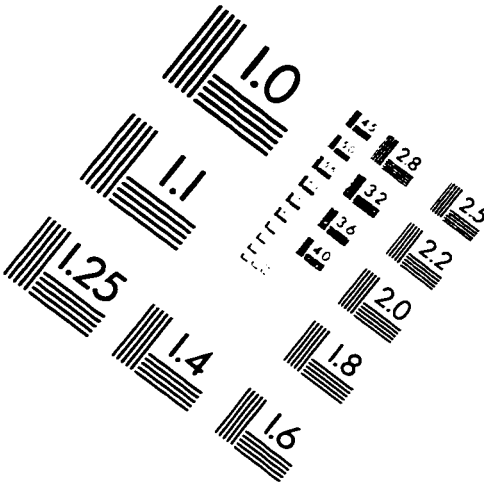
Sort: Sorter #10

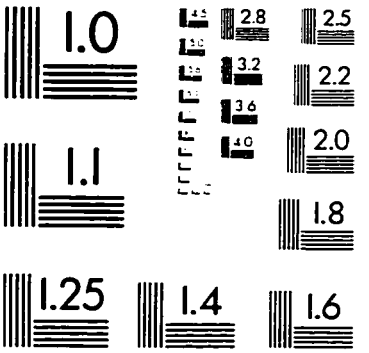
****

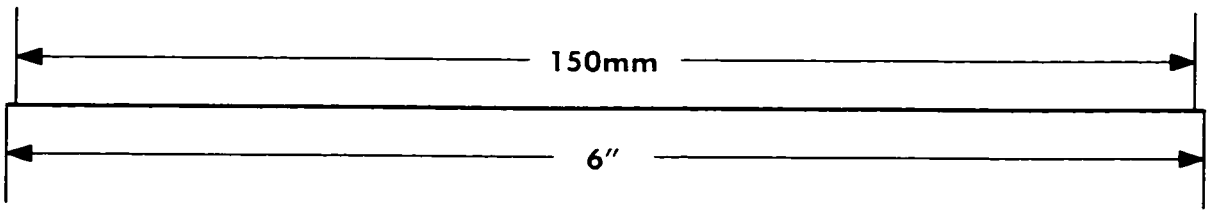
Item/Pile		Item/Pile		Item/Pile		Item/Pile		Item/Pile		Item/Pile		Item/Pile	
1	4	15	7	29	1	43	5	57	1	71	6	85	5
2	4	16	6	30	1	44	5	58	2	72	4	86	5
3	1	17	2	31	5	45	4	59	6	73	3	87	4
4	1	18	5	32	2	46	4	60	3	74	2	88	7
5	4	19	7	33	6	47	6	61	4	75	4	89	4
6	2	20	1	34	7	48	5	62	3	76	7	90	5
7	6	21	3	35	6	49	2	63	2	77	2	91	5
8	6	22	3	36	7	50	7	64	1	78	1	92	5
9	3	23	6	37	6	51	3	65	6	79	4	93	3
10	3	24	4	38	3	52	5	66	5	80	7	94	7
11	4	25	4	39	3	53	3	67	6	81	5	95	4
12	5	26	6	40	4	54	5	68	6	82	7	96	4
13	5	27	1	41	6	55	3	69	7	83	3	97	3
14	6	28	1	42	1	56	4	70	4	84	2	98	5

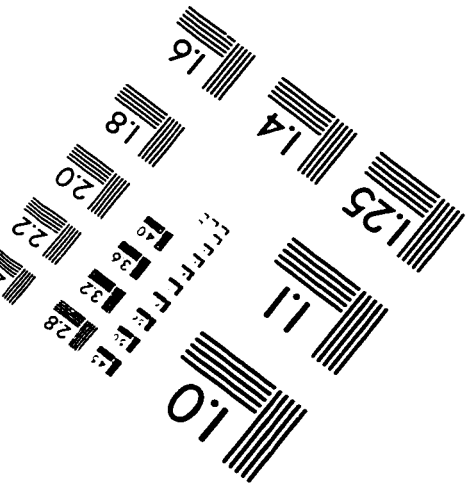
IMAGE EVALUATION TEST TARGET (QA-3)

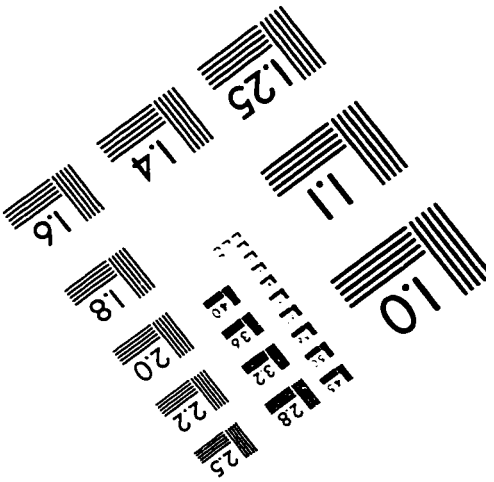












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