Acquiring and Transferring Pace Skill from a Simulated Training Environment to Performance of a 3000m Pursuit: The Role of Task Specific Imagery

by

Michael Irving Pierzchalski
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[redacted]

Supervisor, Dr. G. Van Gyn
(School of Physical Education)

[redacted]

Departmental Member, Dr. B. Howe
(School of Physical Education)

[redacted]

Outside Member, Dr. C. Porac
(Department of Psychology)

[redacted]

External Examiner, Dr. B. Harvey
(Department of Psychological Foundations in Education)

University of Victoria

ABSTRACT

The purpose of this study was to investigate the use of imagery to enhance nonspecific training for pacing in the 3000m pursuit. Twenty-four competitive cyclists were randomly divided into four training groups; physical practice only (PP), imagery prior to physical practice (IPP), imagery during physical practice (IDP), and control. The results of each subject's pace profile for the pre and post tests were compared to an optimal pace profile (OPP) developed by Wilberg and Pratt (1987), and the deviations recorded. The results of a one way ANOVA on the deviations from the OPP demonstrated that there was no significant (p=0.35) difference between the groups on the pretest. However, there was significant (p=0.028) difference between the groups on the post test. Further analysis demonstrated that both the IPP and PP groups deviated significantly from the control in the post test. Examination of the pretest and post test performances demonstrated that only the IPP group showed a significant (p=0.035) change in their pace profile over the training period.

[redacted]

Dr. G. Van Gyn

[redacted]

Dr. B. Howe

[redacted]

Dr. C. Porac

[redacted]

Dr. B. Harvey

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

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DEDICATION

I dedicate this work to Karen, my partner in life and to my parents for their never ending love and support.

INTRODUCTION

A cognitive understanding of the functioning of time is an essential process for humans, in that it provides an orientation with their surrounding world. Our total cognitive experience of time is the sum of three different aspects of time; succession, duration and temporal perspective (Block, 1990).

Succession refers to the sequential occurrence of events (e.g., changes), from which an organism may perceive successiveness and temporal order (Block, 1990). Duration can be divided into two distinct aspects, remembered and experienced. Fraisse (1984) suggested that remembered duration takes place when memory is used either to associate a moment in the past with a moment in the present or to link two past events, whereas experienced duration involves the psychological present. Such an explanation suggests that remembered duration is influenced by cognitive processes more so than experienced duration; since it is linked to changes that serve as reverents, or memory cues. Temporal perspective is an individual's experiences and conceptions concerning past, present and future time (Block, 1990).

In athletics, when we speak of pacing we are referring to the individual's ability to apply their remembered duration for the activity to their present performance. It is logical to suggest that the stronger the memory cues are for the remembered duration the easier it would be for the athlete to access the duration cues and adjust their performance closer to the remembered pace.

Wilberg and Pratt (1988) demonstrated that the ability to maintain an "optimal" pace was essential for a cyclist's success in the pursuit track cycling event. Traditionally, the ability to pace in cycling has been taught by using a time to target task, in which the athlete is required to cross the pursuit lines at the same time as a whistle is blown to signify proper pace. The rider using cognitive cues such as pedal rate, perceived exertion and distance information, among other sources of information, adjusts his/her effort to coincide with the set pace.

Due to a lack of facilities, funding and time, it is not always possible for cyclists to practice their pacing on a velodrome. As a result, athletes and coaches are forced to use non-specific pace training in the hope that the devised training will transfer to the performance situation.

Lee (1988) suggested that the greatest transfer effect would be elicited when processing activities promoted by practice conditions are similar to the processing activities required in performance. This concept is commonly referred to as transfer-appropriate processing.

Van Gyn, Gaul and Wenger (1990) demonstrated that the combination of task specific imagery with non-specific physiological training enhanced the transfer of training to the actual performance of a 40m sprint. Subsequent findings by Kohl, Ellis and Roenker (1992) support the concept that imagery combined with actual practice, can facilitate motor learning and that practice specificity may be a factor in the promotion of the desired performance.

Based on Wilberg and Pratt's (1983) work evidently the ability for a cyclist to maintain a prescribed pace is essential to be competitive in the pursuit. This raises the question of what method would be most effective in training pacing for the pursuit, if the cyclists lack the proper facilities for standard training. Van Gyn, Gaul and Wenger's work suggests that non-specific training could be enhanced by the use of task specific imagery.

The purpose of this study is to examine the effectiveness of various imagery and non-imagery protocols in enhancing non-specific training for the 3000m pursuit.

LITERATURE REVIEW

IMAGERY

Definitions of Imagery

Mental practice and imagery have been used synonymously throughout the literature, although by definition imagery should be considered a component of mental practice. Mental practice can be best defined as the symbolic rehearsal of a physical activity in the absence of any gross muscular movements and takes the form of the individual either thinking about the skill or just observing someone else performing the skill (Eby, 1986).

In comparison, imagery has been defined as a psychological activity that evokes the physical characteristics of an absent object that is either permanently or temporarily absent from the perceptual field (Denis, 1985). Similarly, Richardson (1969, p.2) defined imagery as all those quasi-sensory or quasi-perceptual experiences of which we are self-consciously aware and which exist for us in the absence of those stimulus conditions that are known to produce their genuine sensory or perceptual counterparts. It is the lack of stimulus that separates imagery from mental practice and sets up the paradigm that all imagery is considered to be mental practice, but not all mental practice refers to imagery (Denis, 1985).

Theories of Imagery

There are several theories that try to account for the effect mental imagery has upon the learning and performance of motor skills. The most prevalent theories are the Symbolic Perceptual Theory, Information Processing Theory, the Attention-Arousal Set Theory and the Psychoneuromuscular Theory.

The Symbolic Perceptual Theory contends that imagery enables an individual to think about and become more familiar with the symbolised or cognitive elements of the task (Richardson, 1967b).
The basis for testing this theory has been the hypothesis that tasks that were highly cognitive would benefit more from imagery than those tasks that were predominantly motor in nature (Morrisett, 1956; cited in Richardson, 1967b). This premise has been consistently supported in research (Feltz & Landers, 1983; Kohl & Roenker, 1980; Wrisberg & Ragsdale, 1979).

The Information Processing Theory examines mental imagery in terms of the brain's information processing mechanisms. Lang (1989) suggested that imagery involved the activation of a network of coded propositions and that this information network serves as a prototype for behaviour. Imagery acts to help strengthen the prototype that is then compared to actual performance, making judgements and correcting errors in further replication efforts. Research has offered a variety of evidence for this theory (Lang, 1989; Hecker & Kaczor, 1988; Ziegler, 1987; Levin, Cook, & Lang 1982).

In the Attention-Arousal Set Theory, imagery is seen as serving as a preparatory set for the performer. The general increase in muscle action potentials that occurs throughout the body during imaging of a skill may increase the individual's arousal level and thereby prepare the individual mentally and physically for performance of the skill (Schmidt, 1982).

It has been suggested that imagery may play a part in the preparation by elite athletes for an upcoming task by serving as an aid in concentration or "psyching up" (The Coaching Association of Canada, 1990; Burnhans, et al., 1988). However, much of the support for the concept of imagery acting as a primer for sporting application is anecdotal (Magill, 1985).

The final theory for imagery is the Psychoneuromuscular theory. This theory is based on the finding that as a subject mentally images a movement, below threshold innervation of the necessary muscle groups for the movement can be recorded. It is suggested that innervation of the muscles provides kinaesthetic feedback necessary to make adjustment for future trials, and thus possibly lead to improved performance (Richardson, 1967b). However, there is increasing evidence that this phenomenon has little if any processing pertinence (Kohl & Roenker, 1983).

Although, none of these theories has universal support, all justify some consideration when examining the phenomena of imagery. It could be that the effects of imagery are the result of a combination of two or more of these theories.

Modality

Imagery has been described as being dynamic and multi-modal, in that it has the ability to change rapidly between images and the different senses (Sheehan, 1967a). Although visual imagery is seen as the primary sense, the dominant mode of imagery is dependent on the individual and the object or event being imaged (White, Sheehan, & Ashton, 1977).

In sport it is necessary for an athlete to be able to conceptually understand the task that is being asked of them, thus being able to see the movement executed assists in development of the task. Likewise, the parameters of a movement are products of the kinaesthetic feedback from the involved muscles (Stelmach, Mullins, & Teulings, 1984). Therefore, it can be surmised that it is the basic nature of sport that promotes the visual and kinaesthetic modalities of imagery (Hall, Pongrac, & Buckolz, 1985; Suinn, 1983).

Goss, Hall, Buckolz, & Fishburne (cited in Eby, 1986) examined the relationship between the visual and kinaesthetic components of imagery and found that the two are independent but related abilities. This finding lends support to McFadden's (1982) claim that the specific requirements of the sport under analysis should be assessed in order for the correct imagery approach to be employed. Furthermore, McFadden (1982) suggested that when a field remains unchanged a reliance on kinaesthetic and proprioceptive feedback might be predominant. Conversely, for an interactive sport characterised by changing fields an imagery technique sensitive to essentially visual adaptations would be appropriate.

Imagery Perspective

Imagery perspective has been categorised into two approaches, an external imagery approach and an internal imagery approach (Mahoney & Avener, 1977). The external perspective is predominantly visual, in that the athletes are required to view themselves from a third-person perspective, much like "watching a movie." The internal approach is experienced from a first-person phenomenological perspective. The internal approach is seen as being potentially kinaesthetic since the subject is rehearsing the task from within the body and may include the feeling of movement as part of the image (Epstien, 1980).

Mumford and Hall (1985) examined the influence of internal and external imagery perspectives on figure skaters of three different skill levels. The results indicated that there was no significant difference between imagery styles. However, they did report that the senior skaters showed both greater performance improvements and were superior kinaesthetic imagers than novice skaters.

Similarly, Epstien (1980) found that dart throwers showed no significant difference between imagery styles. However, this study may have been flawed in that the subjects received only minimal imagery training. This could account for the lack of difference between the control and the two treatment groups.

Although, there is little evidence for distinguishing between the two approaches, research has indicated that athletes themselves tend to prefer an internal perspective (Mahoney & Avener, 1977; Rotella, Candneder, Ojala & Billings, 1980). Murphy, Jowdy and Durtschi (1989) obtained the responses to a questionnaire from 87 elite athletes and 34 of the athlete's coaches. Fifty-six percent of these athletes responded that they preferred using an internal perspective as they became more skilled in their sport. Fifty-five percent of the athletes indicated that they found an internal perspective to be more effective at improving their performance than an external perspective. Nineteen percent disagreed, and cited an external perspective as being more effective. Likewise, 62% of the coaches felt that internal imagery was more effective, only 7% of the coaches believed an external perspective to be more beneficial. Of the athletes, 50% agreed that an internal perspective made the image clearer, versus 31% who thought an external perspective provided a clearer image. Similarly, the athletes felt that the internal perspective enhanced the ability to feel body movements (62% versus 12% for an external perspective), and enhanced the ability to become emotionally involved in the imagery (64% versus 23% for an external perspective).

This preference by athletes and coaches, towards an internal perspective may reflect the finding that a greater amount of EMG activity is produced by the use of an internal perspective (Burhans, Richman & Bergey, 1988).

Skill Level

The performer's experience of the task has been demonstrated to influence his/her imagery ability (Richardson, 1967a). The findings indicate that only a minimal amount of experience is necessary to augment the effectiveness of the imagery (Feltz & Landers, 1983). Similarly, it has been demonstrated that mental imagery is most effective in the early stages of skill learning (Minas, 1980; Wrisberg & Ragsdale, 1979).

Other research has indicated that vividness of the skill imagery increased as a function of the skill level (Chevalier-Girard, 1983; Yamamoto & Inomata, 1982). Mumford and Hall (1985) found a similar relationship between skill level and kinaesthetic imagery in a study of novice, intermediate and senior figure skaters. The skill level of the performer has also been linked to the duration that a performer could maintain visual images. Denis (1985) examined yoga students and discovered that advanced yoga students could maintain longer image durations than novice students.

TRANSFER

Transfer and Imagery

Imagery is a practice variable that facilitates learning and performance of motor skills (Feltz & Landers, 1983; Richardson, 1967a). These findings suggest that there is a transfer effect from imagery to the physical performance of a skill. However, most of these findings suggest that imagery does assist in intra-task type transfer.

There has been some research that implies that imagery may be effective in other types of transfer. Van Gyn, et al.

(1990) demonstrated that imagery enhanced transfer of non-specific training to the performance in a 40-meter sprint. Kohl and Roenker (1983) found that bilateral transfer occurred when training of the contralateral limb was performed through mental imagery. In contrast, studies by Steinbrink-Kelly (1990) and Kelly (1991) showed no evidence of imagery enhancing transfer of the performance of a skill. Overall, there is still a lack of empirical testing of the relationship between imagery and transfer to applied situations.

Definitions of Transfer

Drowatzky (1981) defined transfer as the process in which a person uses learning that he or she has acquired in one situation by applying it to a new or different situation. Similarly, Magill (1985) defined transfer of learning as the influence of a previous practised skill on the learning of a new skill.

Since the transfer of learning is usually an unseen factor in motor skills, Schmidt (1975) suggested it would be more appropriate to define transfer of learning as the gain (or loss) in habit strength for one task as a result of practising another task, with those habit gains being estimated by the gains or losses in performance of the task.

It is possible that after a very young age, transfer is not the application of previous skills to new skills but the employment of old skills to new situations (Schmidt, 1975).

Theories of Transfer

Thorndike (1914) formulated one of the first theoretical accounts for transfer. His "Theory of Identical Elements" proposes that practice on one task will facilitate transfer to a second task only to the degree that the two tasks share common elements. Critics of this theory argue that the comparison of two different tasks is quite difficult since the performance of one task on two separate occasions is never entirely the same (Lee, 1988).

The Process-Oriented approach suggests that transfer performance is facilitated by the extent that the feedback conditions during transfer matched the feedback conditions available during practice (Lee & Magill, 1985a). Most of the support for this theory was derived from studies using simple arm displacement tasks. However, these tasks require the learner to pay attention to the movement-produced feedback in order to learn the task. Thus, the generalizability of this concept to more complex tasks is questionable (Lee, 1988).

A third theory of transfer is the Transfer-Appropriate Processing concept. This concept emphasises that practice conditions that promote a particular type of cognitive processing during acquisition trials will facilitate transfer to the extent that these processing activities are also encouraged during the transfer trials (Lee, 1988). One of the strengths of the concept is that it compels the researcher to consider the processing activities promoted by the transfer test to be of equal importance as the acquisition processing activities in an experimental design (Lee, 1988).

Types of Transfer

Transfer of learning can be positive, negative or zero. Positive transfer has been defined as the learning of one task which facilitates the learning of the second task (Magill, 1985). Conversely, negative transfer is when the experience with the previously learned skill hinders the learning of a new skill (Sage, 1977). If the learning of one task has no measurable influence on the learning of the second task, zero transfer is said to occur (Magill, 1985).

Transfer can occur in a number of different situations and has been subdivided into a number of categories (Schmidt, 1975). Inter-task transfer is concerned with the transfer from one task to another. An example of this would be the transfer of skill that occurs from skateboarding to snowboarding. Intra-task transfer deals with the transfer from one variation of a task to another, such as driving one car then driving another. Part-whole transfer explains the transfer from one part of a task to the whole task. An example of this is the transfer of practising the pedal stroke of a bicycle to being able to ride the bicycle. Finally, bilateral transfer examines the transfer of skill between limbs. A test of this transfer may examine the effect of learning to dribble a basketball with the left hand on the learning of the same skill with the right hand.

TIME ESTIMATION

Methods of Time Estimation

The principal methods of time estimation are the methods of reproduction, production and verbal estimation (Bindra & Waksberg, 1956). With the reproduction method, the experimenter demonstrates the standard physically, which the subject then reproduces in the same manner. With the method of production, the subject produces physically a temporal interval corresponding to the verbal standard given by the experimenter. In the verbal estimation method the subject verbally estimates the standard that has been physically produced by the experimenter.

Objective versus Subjective Time judgements

There are two manners in which the standard or the subject's judgement is reported. The methods differ according to their use of objective time or subjective time (Guay & Alain, 1983). The report is said to be objective when the form of presentation is operative or demonstrative. Conversely, subjective judgements refer to time estimations that are specified verbally.

Guay and Alain (1983) suggest that the methods of verbal estimation, and production are characterised by the fact that both contain subjective and objective time; in that the subject is required to attend to temporal time (ie. minutes and seconds). In comparison, the method of reproduction utilises two objective times. Although, this does not prevent the subject from using temporal units, it does not encourage their use.

Smythe and Goldstone (1957) examined the effects of age on the reproduction and verbal estimation methods of time estimation. The results indicated that a reproduction task is less dependent on learning and maturation than verbal estimation, and thus by implication, the method of production. Therefore, an experimenter should be wary of using subjective judgements with subjects younger than seven years of age.

Effect of Time Estimation Method on Results

In selecting a method of time estimation a researcher should be aware that the choice of method could have an effect on the accuracy, variability and reliability of the study.

Research contends that the reproduction method produces more accurate and less variable time estimations than do the methods of production and verbal estimation (Clausen, 1950; McConchie, 1969; McConchie & Rutschmann, 1971).

Studies of the difference in reliability of the principal methods of time estimation found that the reproduction method to be the least reliable of the three time estimation methods (Clausen,1950; McConchie, 1969; Kruup, 1961). However, for short duration judgements (0.5 - 4 sec), reproduction was as reliable as the two other methods of time estimation (Kruup, 1961; McConchie, 1969).

Characteristics of the Performance

The range effect in time judgements can be characterised by an under-estimation of long durations and an over-estimation of short durations (Guay & Alain, 1983). Between these two poles is a zone of difference or the interval zone in which the subject sometimes over-estimates and othertimes under-estimates durations of average length. The length of the standard presented also influences the response variability, an aspect of accuracy (Buckolz, 1972; Buckolz & Guay, 1975). Thus, the consistency of performance of the subjects may be affected by manipulating the size of the duration to be estimated.

Another factor affecting the estimation of time is the context in which the duration is perceived. Depending on the situation the duration may be perceived as being longer or shorter by the subject. It has been suggested that this characteristic is a result of a development of a central tendency relative to the range of perceived duration (Hollingworth, 1913; Clausen 1950).

Knowledge of Results

Knowledge of results communicated verbally has been demonstrated to improve the accuracy of time estimation, when expressed in terms of constant error (Aiken, 1965; Bakan, Nangle & Denny, 1958).

Verbal knowledge of results has also been effective in improving performance of time estimation, when expressed as variable error (McConchie, 1969). Buckolz and Guay (1975) further demonstrated the addition of an operative dimension to verbal knowledge of results does not improve performance above that of verbal only knowledge of results. However, Buckolz and Guay (1975) demonstrated that a more complex procedure, wherein four estimates with knowledge of results were given for each trial, did maximise the effect of knowledge of results on temporal estimation.

PACING

Definition of Pacing

Pace has been defined as the rate of progress in some activity (Hawkins, 1988). With regards to cycling on a velodrome track, Wilberg and Pratt (1988) defined pace as the ability to maintain a consistent velocity lap after lap. For this paper, pace will be defined as the rate of progress required to cover a prescribed distance within an established period of time.

Necessity of Pacing

Much of the empirical evidence for maintaining an even pace is physiological in nature. The three important metabolic systems that supply energy for muscle contraction are the phosphagen system (adenosine triphosphate and phosphocreatine), the glycogen-lactic system and the aerobic system (the citric acid cycle) (Rhoades & Pflanzer, 1989). Pernow and Saltin (1971) found that cyclists pedalling at heavy work loads for short periods of time (1-2 min.) could use up to 70% of their muscle creatine phosphate stores after only 60 seconds.

The decline in performance of the phosphagen system places a greater demand on the glycogen-lactic system. The rate of glycogen used in this system is proportional to the rate of exercise and is depleted exponentially (McArdle, Katch & Katch, 1994). Likewise, a by-product of this system is lactic acid which is detrimental to continued performance, particularly under maximal conditions (Thoden, 1991). Therefore, the greater the demand placed on this system the greater the increase in the rate at which in becomes ineffective the aerobic system to supply the majority of the energy for muscle contraction. Unfortunately, the aerobic system is the weakest system when it comes to producing energy for muscle contraction (Rhoades & Pflanzer, 1989). The physiological evidence suggests that performers who rapidly accelerate to maximum velocity, and then attempt to maintain that level, quickly deplete their phosphogen supplies and are unable to perform well in later stages of an event (Wilberg and Pratt, 1988).

Wilberg and Pratt (1988) supplied evidence for the support of maintenance of a prescribed pace in their examination of race profiles of cyclists in the pursuit and kilometre track events.

They examined the results of three separate world-class competitions and found that the cyclists in the top ranked group rode a different pace profile than those cyclists in the bottom ranked group regardless of their finishing times. The slower riders accelerated to maximum velocity within the first lap, frequently exceeding the velocities of the top ranked riders. They maintain a velocity above their mean lap time until approximately the fourth lap, after which they rode slower and slower laps until the finish.

In contrast, the top ranked riders started well below their mean lap time, and taking until the second lap to reach their peak velocity. By the third lap the top cyclist had adjusted their velocity to be on or near their mean lap times, and then were able to maintained the pace until the finish with little or no reduction in velocity. Thus, Wilberg and Pratt (1988) concluded that it was the race profile that was all-important, not the maximal accelerations or peak velocities that a rider could attain.

Hypotheses

Purpose: In general, the purpose of this study was to examine the effectiveness of various imagery and non-imagery protocols in enhancing non-specific training for the 3000m pursuit. Specifically, the following hypotheses were examined:

1) Subjects in the treatment groups will conform to a pace profile in the final testing session that is closer in form to one specified by Wilberg and Pratt (1988). In that, the cyclists will reach peak velocity in the second lap and then maintain a velocity at or near their mean lap time until the

finish. Thereby, reducing the absolute error from the prescribed pace profile.

2) The subjects in the physical practice only group (PP) will deviate less from the optimal pace profile for the 3000m pursuit than those subjects in the control group in the final test session.

3) The subjects in the imagery prior to non-specific physical practice group (IPP) will deviate less from the optimal pace profile for the 3000m pursuit than those subject in either the control group or those in the physical practice only group (PP) in the final testing session.

4) The subjects in the imagery during non-specific physical practice group (IDP) will deviate less from the optimal pace profile for the 3000m pursuit than those subjects in either the physical practice only group (PP) or the control group.

RESEARCH METHODS

Subjects

The subjects were volunteers from local cycling clubs. All of the subjects were considered to be competitive cyclists in that they held current racing licences from the Canadian Cycling Association. Although, only a few of the subjects had previous experience in the pursuit, all of the subjects had experience at road time trialing. There were a total of 25 subjects ranging in age from 16 to 38 years, with a mean age of 24. By racing category the sample tested was made up of 4 Senior Women (18 - 34 years), 14 Senior Men, 1 Junior Woman (15 -17 years), 3 Junior Men, 1 Veteran Woman (35+ years), 3 Veteran Men.

Independent Variables

The independent variables for this study were the various levels of treatment.

Physical Practice (PP): In which the subjects rode a 3000m pursuit on rollers, twice per week.

Imagery Previous to Physical Practice (IPP): In which the subjects imaged themselves doing a pursuit prior to physical practice.

Imagery During Physical Practice (IDP): In which the subject imaged himself or herself riding a pursuit while completing the physical practice.

Control: Which maintained their regular training routines while avoiding any practice for the pursuit.

Dependent Variables

Deviation from the Optimal Pace Profile: Was calculated for each of the 9 laps for both pre and post-tests.

Relative VO2 max (see definition of terms): Recorded prior to both the pre and post tests as a possible co-variant.

Absolute VO2 max (see definition of terms): Recorded prior to both the pre and post tests as a possible co-variant.

Limitations

1/ The study is restricted to competitive cyclists between the ages of 16 and 38.

2/ The results are limited to cyclists riding on a track using road bikes.

Definition of Terms

Absolute VO2 max - The maximum amount of oxygen that can be consumed per unit of time by an individual during large-muscle-group activity of progressively increasing intensity that is continued until exhaustion, expressed as an absolute volume per minute (L * min).

Competitive Cyclist - An cyclist who holds a current racing licence from the Canadian Cycling Association or any other nation's registered cycling association.

Individual Pursuit - A cycling race contested by two riders, who start on opposite sides of the track. The race begins from a standing start. The first rider to cover the specified distance is declared the winner (Jurbala, 1986).

Mental Practice - The symbolic rehearsal of a physical activity in the absence of any gross muscular movement (Richardson, 1969).

Mental Imagery - The mental rehearsal of a motor performance in conditions where auditory, visual or kinaesthetic qualities of movement may be experienced (McIntyre, 1987).

Optimum Pace Profile (OPP) - The pace profile most frequently produced by cyclists of national and international calibre (Wilberg & Pratt, 1988).

Pace - The rate of progress required to cover a prescribed distance within an established period of time.

Relative VO2 max - The maximum amount of oxygen that can be consumed per unit of time by an individual during large-muscle-group activity of progressively increasing intensity that is continued until exhaustion, expressed as a volume per minute relative to body weight (ml * kg -1 * min -1).

Instrumentation

Stop Watch: The stop watch used to record lap times was a Micronta (Model no. 63-5012) with a nine lap memory.

Bicycles: The bicycles used in testing and training were the subject's own road bicycle. Prior to both testing sessions the equipment used on the bicycle was checked and recorded, see Appendix E.

Rollers: The subjects rode their own bikes mounted to a set of rollers (Tacx, pn. T 1000) with a single resistance fan (pn. T 1500) and a handlebar support (pn. T 1250).

Odometer: A Sach-Huret Cyclometer (pn. 25 0400 400 201) was mounted on a Ukai 700x25c wheel shod with 700x23c Continental Super Sport Tire. This unit replaced the subject's own front wheel during training on the rollers.

Procedures

Testing of the 3000-meter pursuit took place at the Victoria Commonwealth Games Velodrome. This track is an outdoors-concrete track of 333.33 meters in length with 28-degree banking. Prior to the start of testing, information was collected as to the cycling equipment used by the subject, the track temperature and wind direction. Each subject began from a standing start in which the rider was held. The subject then rode 9 laps of the track with each lap split recorded.

Each subject completed a VO2 max test. This test was used to determine if the subject's fitness level increased significantly during the training period and to ascertain if this increase in level of fitness had any effect on the subject's performance. VO2 max testing was completed at the University of Victoria's Olympic Testing Centre. VO2 max was determined by using a stepwise incremental protocol on a Monarch cycle ergometer. Expired gases were analysed by a Beckman Metabolic Measurement Cart (MMC) (model no. 760392) every 30 seconds. The MMC was calibrated against primary gas standards prior to and after each test. Throughout, the test heart rate was recorded every minute.

The criterion for determining VO2 max was a combination of :

1/ A plateau in VO2 increases with an increase in power output.

2/ Subject stopped due to volitional exhaustion.

3/ Respiratory exchange ratio (RER) exceeded 1.15

Training Procedures

Following the first testing session the subjects in the training intervention groups under went two training sessions per week for five consecutive weeks. Each subject completed a minimum of nine training sessions.

Physical Practice:

Subjects in the physical practice only group (PP) was positioned similar to their start at the track. The rider was then given the same pattern of commencement as at the track testing. The researcher provided the subject feedback with regards to their coherence with the prescribed pace profile every .33 of a kilometre. This feedback was in the form of the amount of time the subject deviated, positively or negatively, from the prescribed pace profile. The subject's time of each .33 of a kilometre was recorded. The test was completed when the subject completed 3 kilometres. Following practice the subjects were shown their pace profile for the practice session and deviations in the pace profile were discussed.

Imagery Prior to Physical Practice:

The subjects in the imagery prior to physical practice (IPP) were shown videotape in their first session outlining the concepts of imagery and its application. The subjects were then instructed in a deep breathing technique for relaxation. Upon completion of the relaxation, subjects were asked to visualise their bicycle and then themselves on the bicycle. The session ended by questioning the subject as to the clarity of the image.

The subsequent sessions took place outside on the rollers. In these sessions the subject's bikes were attached to the rollers and the subject was allowed to warm up. Upon completion of the warm up, the subject was removed from the bike and asked to relax in a sitting position. The subject repeated the deep breathing relaxation technique introduced in the first session.

Once the subjects were relaxed, they were asked to picture themselves on their bike at the start line for the pursuit in the velodrome. The subjects were then asked to visualise different aspects of the track (the infield, the painted lines on the track, the railing and the grandstands), finishing with them preparing themselves for the start of a pursuit. When the subject acknowledged that they were ready to start the pursuit the researcher gave them the commencement. Using the subject's pace profile and a stopwatch the researcher guided the subject with their imagery, providing track position, focus points and number of laps completed.

Upon completion of the visualisation of the pursuit the subject was then placed on their bicycle mount on the rollers. The subject was then given the starting commencement. As the subject rode the 3000 meters, the subjects times were recorded every .33 of a kilometre and feedback was given as to their adherence to their OPP. The ride was ended when the subject had completed 3 kilometres. The subject's lap times were shown to the subject to provide feedback as to their performance for the testing session.

Imagery During Physical Practice:

The subjects in the imagery during physical practice (IDP) received the same orientation to imagery usage as the IPP subjects.

The following sessions took place outside on the rollers. In these sessions the subject's bikes were attached to the rollers and the subject was allowed to warm up. Upon completion of the warm up the subject was asked to relax while astride their bicycle. The subject repeated the deep breathing relaxation technique that was introduced in the first session.

Once the subject was relaxed they were asked to picture themselves on their bike at the start line for the pursuit. The subjects were then asked to visualise different aspects of the track (the infield, the painted lines on the track, the railing and the grandstands), finishing with them preparing themselves for the start of a pursuit.

When the subject acknowledged that they were ready to start the pursuit the researcher gave them the commencement. Using the subject's pace profile and a stopwatch the researcher guided the subject with their imagery while they rode a 3000-meter pursuit. The researcher provided the subject with picture of where they were on the track, focus points and the number of laps completed. The subjects were also give feedback as to how close they were to their prescribed pace profile. At the completion of 3000 meters, the subject was told to stop and their times for each .33 of a kilometre was recorded. The subject was then shown their lap times for the ride and any errors with regards to their pace profile were discussed.

Control:

The subjects in the control group were asked to maintain their normal training habits, but to refrain from training at the velodrome until the experiment was complete.

Pace Profile Construction

The pace profile for each subject was a result of the mean lap time (MLT) as calculated from their lap splits for laps 2 through 9 of the testing session divided by eight. The pace profile was then developed by adding or subtracting time intervals, as specified by Wilberg and Pratts (1988) optimal race profile, to the subject's MLT for each of the nine laps of the 3000 meter pursuit. The time intervals for each lap are as follows:

Lap 1 = + 3.50, Lap 2 = - 0.80, Lap 3 = - 0.30, Lap 4 = - 0.25, Lap 5 = + 0.00, Lap 6 = + 0.20, Lap 7 = + 0.30, Lap 8 = + 0.40, and Lap 9 = + 0.15.

For example if a subject had a MLT of 30 seconds the pace for their first lap would be 33.50 or their MLT of 30 seconds plus 3.50 seconds. If these calculations were carried out for all the laps the subject's pace profile would be as such:

Lap 1 = 33.50 sec., Lap 2 = 29.20 sec., Lap 3 = 29.70 sec., Lap 4 = 29.75 sec., Lap 5 = 30.00 sec., Lap 6 = 30.20 sec., Lap 7 = 30.30 sec., Lap 8 = 30.40 sec., and Lap 9 = 30.15 sec.

By this method the subject's overall time does not factor into the equation, and only the subject's acceleration and velocity patterns are distinguished.

Data Analysis

The mean absolute deviation from the optimal pace profile was calculated for each subject (see Appendix K). A one way analysis of variance (ANOVA) was conducted on the mean deviations for both the pre and post-tests.

RESULTS

Means & Standard Error

An analysis of the mean deviation for the pre-test (Table 1) demonstrated that of the four groups the IDP group had the majority of lowest mean deviation scores. In comparison, the lowest mean deviation score for the post-test (Table 2) were predominantly held by the PP group. The IDP group dropped from having 5 of the lowest deviation scores in the pre-test to only having a single low deviation in the post test. These changes are graphically represented in figures 1 and 2.

An examination of the individual group's scores for both the pre and post-tests showed that the control group had higher mean deviations on all the laps of the post test, with exception of laps 4, 5, and 6. Similarly, the IDP group had higher mean deviation scores for the post-test with the exception of laps 1 and 3. In contrast both the PP and IPP groups had mainly lower mean deviations in the post test, the exceptions being laps 5 and 6 for the PP group and laps 8 and 9 for the IPP group. The changes for each group are demonstrated in figures 3, 4, 5, and 6.

Table 1

The Standard Error of the Mean and the Mean Deviation from OPP for each Lap of the 3000m pursuit for the Four Treatment Groups for Pre-Test.

Lap		Control	PP	IPP	IDP
1	*M*	1.44	1.65	2.17	1.33
	sem	0.19	0.41	0.54	0.49
2	*M*	1.26	0.65	1.82	0.87
	sem	0.33	0.42	0.22	0.27
3	*M*	0.73	0.89	0.79	0.58
	sem	0.16	0.21	0.25	0.16
4	*M*	0.27	0.84	0.61	0.70
	sem	0.11	0.28	0.20	0.19
5	*M*	0.43	0.54	0.87	0.52
	sem	0.15	0.08	0.16	0.18
6	*M*	0.53	0.34	0.75	0.36
	sem	0.23	0.12	0.12	0.09
7	*M*	0.79	0.63	0.71	0.26
	sem	0.20	0.18	0.19	0.09
8	*M*	0.59	0.52	0.53	0.37
	sem	0.13	0.09	0.16	0.14
9	*M*	0.75	0.89	0.56	0.75
	sem	0.09	0.27	0.14	0.38

Table 2.

The Standard Error of the Mean and the Mean Deviation from OPP for each Lap of the 3000m pursuit for the Four Treatment Groups on the Post-Test.

Lap		Control	PP	IPP	IDP
1	M	1.92	1.16	0.94	1.17
	sem	0.51	0.29	0.24	0.18
2	M	1.48	0.46	0.80	1.13
	sem	0.37	0.19	0.36	0.16
3	M	0.74	0.49	0.56	0.57
	sem	0.27	0.23	0.16	0.17
4	M	0.19	0.76	0.48	0.80
	sem	0.09	0.25	0.06	0.24
5	M	0.69	0.62	0.28	0.59
	sem	0.21	0.19	0.12	0.21
6	M	1.07	0.49	0.44	0.42
	sem	0.24	0.21	0.12	0.11
7	M	0.81	0.31	0.46	0.59
	sem	0.20	0.06	0.11	0.10
8	M	1.04	0.37	0.62	0.69
	sem	0.25	0.08	0.05	0.22
9	M	0.97	0.68	0.79	0.85
	sem	0.35	0.17	0.29	0.24

ANALYSIS

A one way analysis of variance (ANOVA) of the pre-test scores demonstrated that there was no significant difference between groups ($F(3,20) = 1.17$, $p = 0.35$). This is demonstrated in Figure 1. An ANOVA of the post-test scores exhibited a significant deviation between the groups ($F(3,20) = 3.75$, $p = .028$). The deviation between the groups for the post test scores is clearly illustrated in Figure 2.

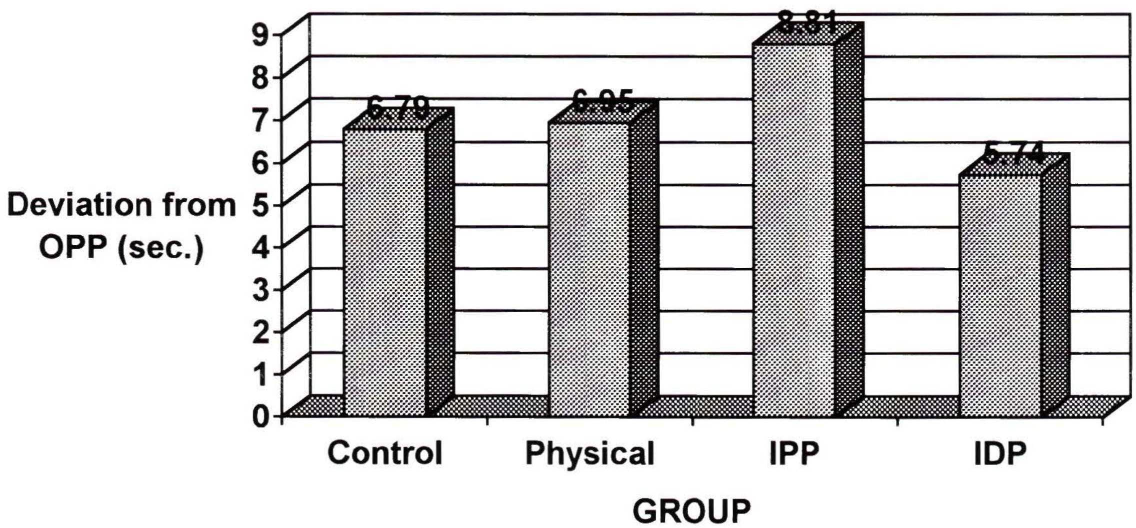

Figure 1 Cumulative mean deviation from the optimal pace profile (OPP) in the pre-test for all groups.

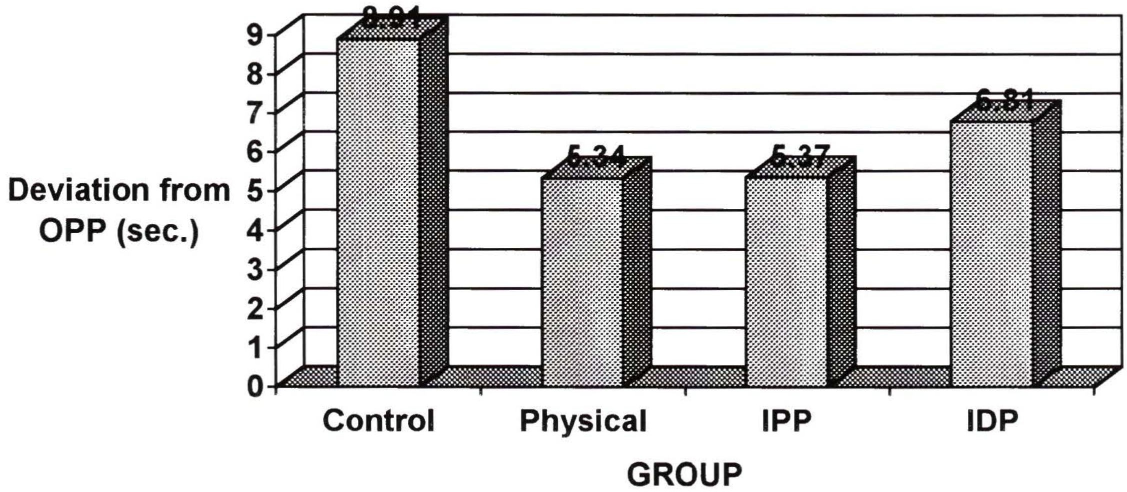

Figure 2 Cumulative mean deviations from the optimal pace profile(OPP) in the post-test for all groups.

Post Hoc Analysis

Due to the finding of a significant difference between groups in the post-test independent t-tests were run between each group on their post-test scores. The results on these test demonstrated that the control group deviated significantly from both the physical practice group ($t = 2.46$, $p = .033$) and the IPP group ($t = 2.54$, $p = .029$).

Paired t-tests were then run to examine whether the group's performance had changed between the pre and post-tests. The findings of these paired t-tests suggested that only the IPP group's performance changed significantly between the two testing sessions ($t = 2.88$, $p = .035$). The changes between pre and post-tests are illustrated for each group in figures 3, 4, 5, and 6.

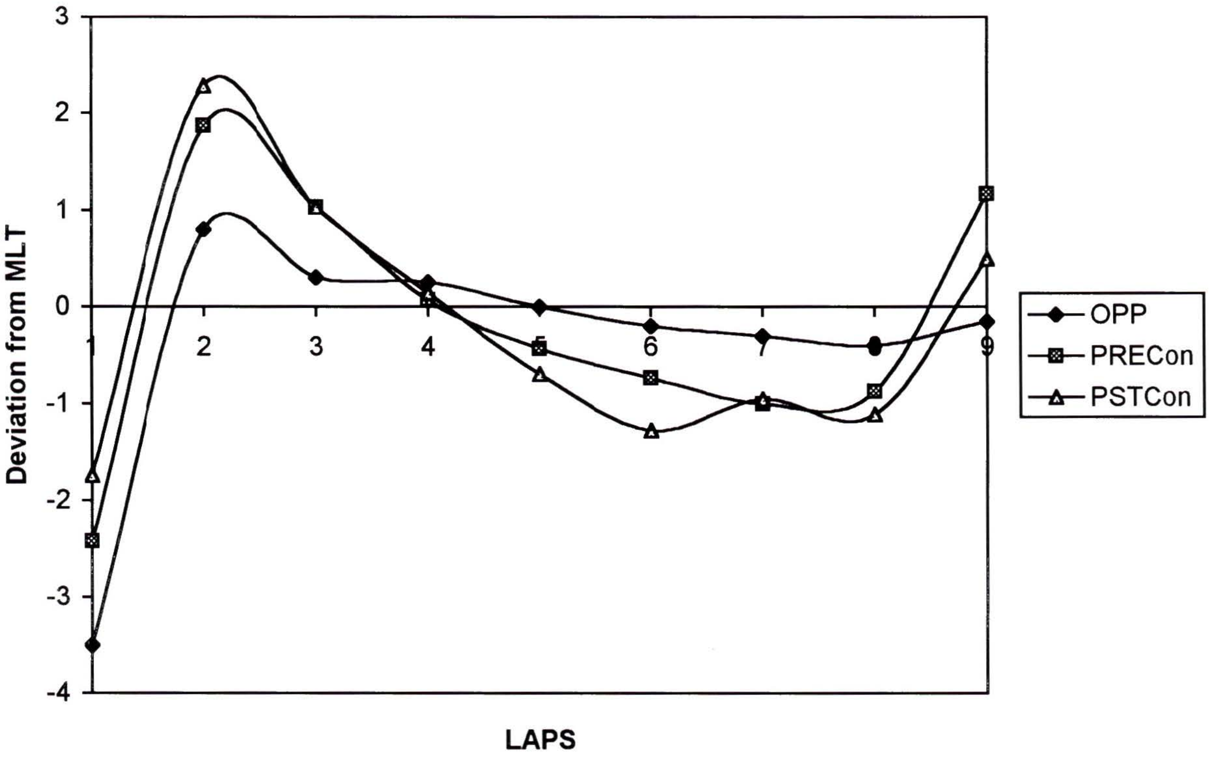

Figure 3 Pace profiles for the control group for the pre and post-tests.

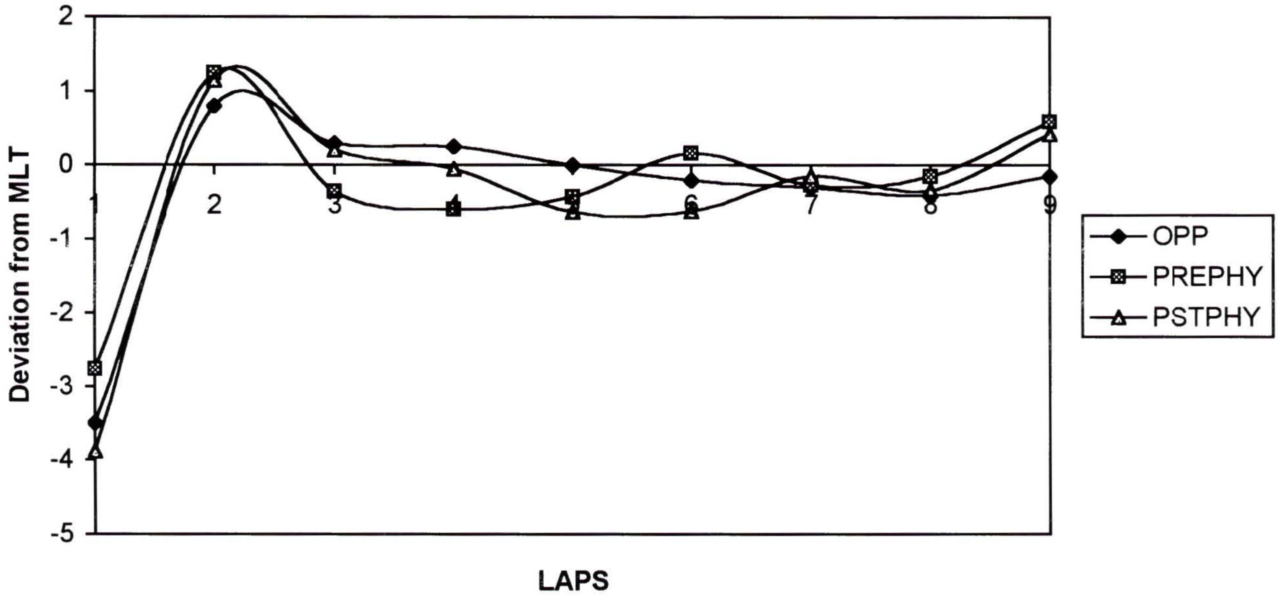

Figure 4 Pace profiles for the physical group for the pre and post-tests.

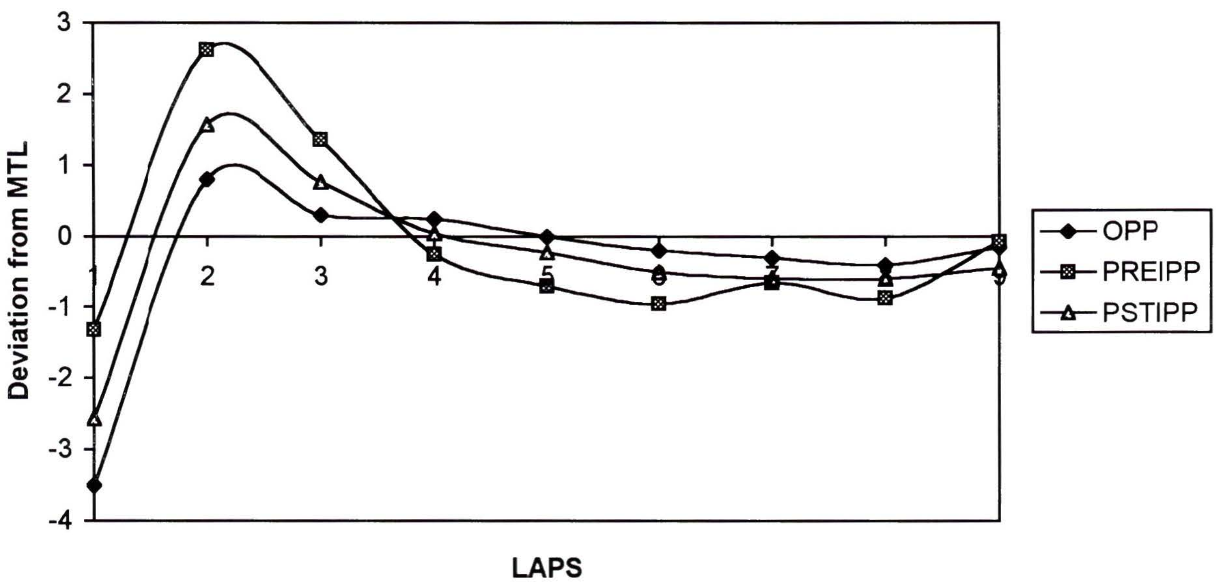

Figure 5 Pace profiles for the IPP group for the pre and post-tests.

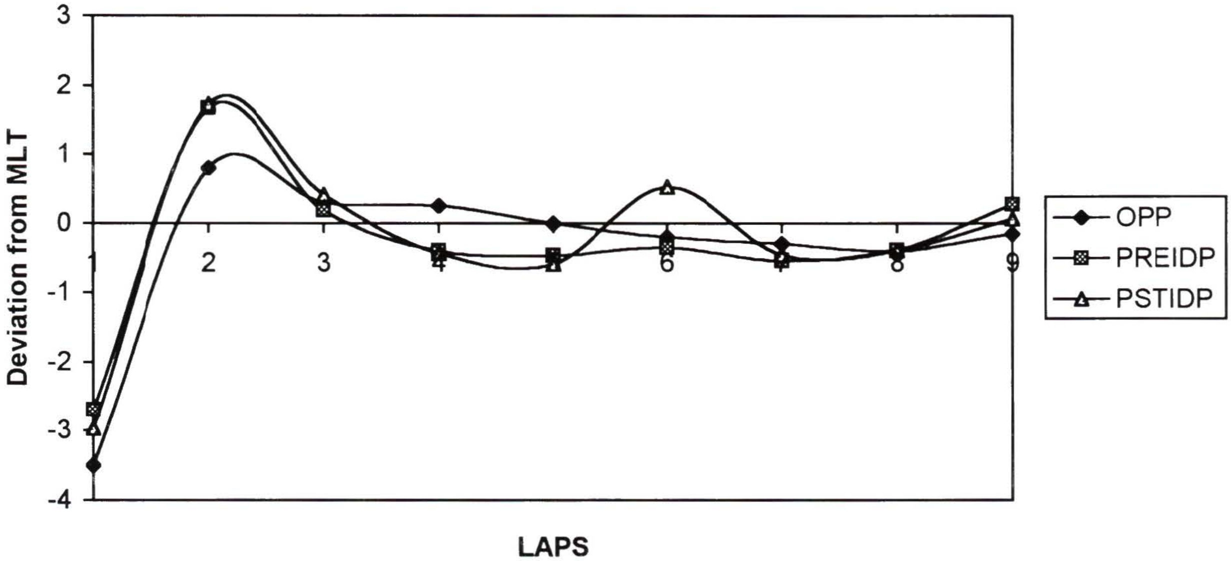

Figure 6 Pace profiles for the IDP group for the pre and post-tests.

Having viewed the results in terms of statistical analysis it becomes necessary to examine how the results relate to the hypotheses stated at the beginning of this paper. This analysis will merely examine the statistical support or lack of support for each of the stated hypotheses, leaving the implications of these findings for further interpretation in the discussion.

Hypotheses

1) Subjects in the treatment groups will conform to a pace profile in the final testing session that is closer in form to one specified by Wilberg and Pratt (1988). In that, the cyclists will reach peak velocity in the second lap and then maintain a velocity at or near their mean lap time until the finish. Thereby, reducing the absolute error from the prescribed pace profile.

An examination of the mean deviations for the treatment groups (Table 1 and 2) demonstrates that this hypothesis must be rejected. The mean deviation scores cited in Tables 1 and 2 suggest that the IDP group conformity to Wilberg and Pratt's OPP actually decreased for all laps in the post test except laps 1 and 3. In comparison, the PP and IPP groups were able to improve their conformity to the OPP stated by Wilberg and Pratt. The PP group was closer to the OPP in all but laps 5 and 6. Were as the IPP group performed better in all laps but laps 8 and 9.

2) The subjects in the physical practice only group (PP) will deviate less from the optimal pace profile for the 3000m

pursuit than those subjects in the control group in the final test session.

The results demonstrated that the PP group deviated significantly ($t = 2.46$, $p = .033$) from the control group in the final testing session. This finding in combination with the PP group's lower mean deviation from OPP in the post-test would suggest that the PP group conformed closer to the OPP than did the control group.

3) The subjects in the imagery prior to non-specific physical practice group (IPP) will deviate less from the optimal pace profile for the 3000m pursuit than those subject in either the control group or those in the physical practice only group (PP) in the final testing session.

The subjects in the IPP group did deviate significantly ($t = 2.54$, $p = .027$) less from OPP in the final testing session than those subjects in the control group. However, the IPP group's deviation from OPP was not significantly ($t = -0.04$, $p = .972$) different from the subjects in the PP group. Therefore, the hypothesis must be rejected.

4) The subjects in the imagery during non-specific physical practice group (IDP) will deviate less from the optimal pace profile for the 3000m pursuit than those subjects in either the physical practice only group (PP) or the control group.

This hypothesis must be rejected because the subjects in the IDP group's deviation from OPP was not significantly different than those of either the control group ($t = 1.69$, $p = .122$) or the PP group ($t = -1.19$, $p = .260$).

DISCUSSION

With regards to the question of transferability of non-specific training for the 3000m pursuit, only the IPP group showed any significant ($t = 2.88$, $p = .035$) change in pace performance between pre and post-tests. This is quite evident in figure 5. However, this finding must be viewed in light of a lack of significant difference between the IPP group and either the PP or the IDP groups in the post-test. Furthermore, the significant differences between the control group and the IPP and PP groups in the post-test are a result of decreasing in conformity by the control group and an improved conformity by the IPP and PP training groups. Which of these factors played the greater part in the difference between the control and the IPP and PP groups is a matter of speculation.

The lack of a significant difference between treatment groups after training is not surprising when viewed in light of the experience of the subjects and the minimal deviation from the OPP in the pre-test. Each subject had a minimum of 2 years of competitive experience before participating in this study, within that time it would be expected that the cyclist would have developed a personal strategy for pacing, be it respiration rate, pedal cadence, or kinaesthetic feedback.

If we accept the idea that the subject's have already developed a personal strategy for pacing, it could be hypothesised that the training sessions only acted as a maintenance program for the cyclist's personal pacing strategy. This seems to hold true for those subjects in the IDP and Physical groups, who's pace profiles in the pre-testing session were already very close to the OPP. Likewise, the decline in the Control group's pacing ability also points toward the idea that the training sessions did act as a maintenance program. The question then arises of whether a cyclist's race profile can be modified or do those racers who excel at the pursuit do so because their own personal pacing strategy is better suited for the event.

Another factor that lies at the root of the lack of significant differences between the OPP and the subject's own performance lies in the establishment of the OPP. As demonstrated in Appendix K the establishment of the OPP for each subject was based on the subject's own mean lap time in the testing session. By using the subject's own mean value the amount of deviation from OPP is automatically reduced in comparison to some arbitrarily produced OPP.

Likewise, the OPP used in this study is a replica of the "optimal race profile" developed by Wilberg and Pratt (1987), that was based on actual competition performances by elite cyclists. Therefore, it is inherent in the design that a subject will ride slower in the first lap because they are accelerating the mass from a stand still, then overshoot the mean lap time before settling in to the pace most comfortable to them. In contrast, if the study had used a pace profile as theorised by Boyer (see Thieriot, 1995) in which the cyclist accelerates to a speed which they can maintain without tiring and then increases their speed every 30 seconds by initially large amounts and then by smaller and smaller increments, it should have be easier to view the difference between the rider's natural tendency and the theorised pace profile.

The change in the IPP group's pace profile is the one piece of evidence that suggests that non-specific training is a viable means of training cyclist's to ride the pursuit. There are two factors that could have attributed to the significant improvement by the IPP group. The first of these is that fact the training protocol subjected the IPP group to twice the amount time on task in comparison to the other training groups. It could be surmised that the change in the

IPP group's pace profile was the result of a greater amount of time on task.

Related to the amount of time on task is the concept of warm up decrement. Schmidt (1982) defined warm up decrement as a retention loss caused by the imposition of a rest in a series of practice trials. With the protocol calling for only one training run per session it would be plausible that training would be affected by a warm up decrement. Ainscoe and Hardy (1987) discovered that imagery prior to performance of a gymnastic task significantly reduced the warm up decrement. In light of this study one could argue that the imagery prior to the physical practice reduce the warm up decrement and thus, the IPP group were able to gain more from their training sessions.

The other possibility is that the use of imagery prior to physical practice assisted in focusing the subject's attention on the task and there by aiding in the retrieval of meaningful cues. The physical practice following the imagery helped reinforce the proper pace profile. This concept is in consensus with Mackay's (1987) node structure model, in which the segments of a skill are handled by distinct processing units (nodes), the activation of which were the result of priming. The improvement in a skill is the result of the formation of higher order mental nodes that are similar to

Schimdt's (1975) concept of schemas, and the rate of onset of the priming condition (Linkage Strength).

The lack of any change in the IDP group is of great interest. The question arises of why the subject is not in some way influenced by the training sessions, one would have expected some variation in the pace profile over the course of six weeks due to a greater familiarity which the prescribed task. It is the contention of this author that the attentional demands during the training were too great, in that the subjects were receiving kinaesthetic feedback from their physical performance, verbal feedback and attentional cues from the researcher, and all while trying to visualise their performance. Thus, as suggested by a number of limited-capacity models of attention (Kahnneman, 1973; Kinsbourne & Hicks, 1978; Wickens, 1980), the demands of the task were greater than the amount of attentional resources and the resulting capacity interference caused a decrement in learning performance.

The change in the physical practice group's OPP could be the result of two factors. One, Wilberg and Pratt were correct in that a slower start does provide the rider with the ability to main a higher pace for a greater period of time. Or, two, the increase in the subject's fitness level allowed them to maintain a faster pace for a longer period of time. Due to the lack of significant difference between the starting laps of the two testing sessions, it is more likely that the increase in the cyclist's aerobic capacity (see Appendix J) was the cause of the change in the physical practice group's change in the pursuit profile.

Recommendations for Future Research

1/ A mechanism must be developed to increase the resistance on the rollers at the start of the training pursuit. The subjects in this study found that the fan resistance on the rollers was too easily accelerated, thus the rollers lacked the same kinaesthetic feel as the start of the pursuit on the track. This in turn created difficulty in duplicating the pace profile for the first two laps of the pursuit.

2/ The subjects were given only one training session in the use of imagery, it may be beneficial to increase this training until the subjects feel confident in its application and then add in the physical training. This may eliminate the conflict for mental resources that was demonstrated in the IDP group.

3/ This study failed to discover the effect imagery alone has on pacing for the pursuit. Therefore, any further studies should include a separate imagery only group to examine this effect.

4/ The imaging used in this study needed greater controls. It is suggested that the subjects were using imagery during their practice sessions. However, due to the lack of any measurement device we are unable to conclude how effective the imagery was for the subjects or whether the subjects were truly imaging at all. It is imperative that further studies use some measurement to examine the effectiveness and application of the imagery.

5/ The one assumption that should be examined before such training is used in a practical application is whether the OPP used truly the optimal pace profile for the pursuit. Although derived from the pace profiles of elite competitive cyclists there is no evidence to suggest that this profile is the best profile physiologically. Therefore, before this training is used in an applied setting the question "what is the optimal pace profile?" must be examined.

6/ Due to the ceiling effect created by the calculation of optimal pace profile, future research may benefit from the use of single subject design testing.

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APPENDIXES

APPENDIX A

INFORMED CONSENT

I, ________________________ , having been informed of the activities proposed in the research project by the researcher, do voluntarily agree to participate in the training study. I regularly engage in exercise and activities similar to and of like intensity to those described to me in the research project as part of my normal activities. I am also unaware of any physical or medical reason which would make me at risk for engaging in such activities. I also understand that I am free to withdraw from the study at any time and that my performance in the study will not influence any team selections or my current status on such a team. It has been explained to me that my records are confidential and will not be released without my consent. Similarly, my anonymity has been assured in both data collection and the reporting of the final results.

Name: ________________________________
please print

Signature: __________________________

Date: ____________________

APPENDIX B

PARENTAL CONSENT FORM

I do / do not agree to allow ____________________________ to participate in the project proposed by Dr. G. Van Gyn and Mike Pierzchalski from the University of Victoria.

Name of Parent/ Guardian: _________________________________

Signature of Parent/Guardian: ______________________________

Date: ___________________

APPENDIX C

To : The Parent / Guardian of:________________________________

Dear Parent/ Guardian,

I am a graduate student at the University of Victoria, working in the area of motor learning, and I am presently investigating the effects of imagery on a cyclist's ability to maintain pace over a 3000 meter pursuit. As a means of investigation I propose to administer four 3000 meter pursuits at the Commonwealth velodrome.

If selected for one of the training conditions _____________________________ would be required to attend two training sessions per week for a six week period. During these sessions each subject will be required to complete two 3000 meter pursuits per session on a bicycle affixed to a resistance type trainer.

_____________________________ has agreed to participate in this study (see enclosed consent form). It would be appreciated if you would give your consent by signing the enclosed form and returning it to me in the envelope provided.

Thank you for your co-operation. should you require any further information, please feel free to contact me at 721-1322.

Sincerely,

___________________________ ___________________________

Mike Pierzchalski Dr. G. Van Gyn, Advisor

APPENDIX D

PROTOCOL FOR 3000 m PURSUIT

1/ All subjects will be allowed to warm up as they deem necessary prior to the start of testing.
2/ Information with regards to the subject's bicycle set up will be recorded prior to the start of the test (see Appendix 2a).
3/ The rider will be brought to the start lines, and set up on their bikes. The start and testing procedure will explained to the subject at this time.
4/ When the subject is set the starter will call out; Riders ready, Timers ready, and a whistle will be blown to signal the start.
5/ Timers will record the lap times for 9 consecutive laps to the 1/100 of a second.
6/ The riders will be informed of the number of laps to be completed.
7/ A whistle will blown to signal one lap to go.
8/ A whistle will blown twice to signal the end of the ride.
8/ The time sheets will be gathered and affixed to the rider's data sheet.

Start Procedure:

1/ The bike is to lined up so the front tire does not break a plane extending vertically form the red half lap line.
2/ The rider once settled and ready to start will inform the start assistant, who will then raise their arm to indicate readiness.
3/ When both riders are ready the start will announce; Rider ready, Timers ready and then blow a whistle. At the sound of the whistle the ride can begin their ride.
5/ Number of laps left to complete will be given either by lap board or verbally by start assistant at the start line.
6/ With one lap to go a whistle will be blown as a signal to the rider.
7/ The end of the ride will be signalled by two sharp blasts on a whistle as the rider crosses the line for the final time.

APPENDIX E

Subject Pursuit Testing Data Form

Name____

Age____________   M   F

BIKE SET UP

Name of Bike ____

Colour _____________________________

Tire Pressure _____________ psi

Aero-Bars   Y   N

Disc Wheel Y   N

Aero FT   Y   N

Fixed Gear Y   N   Gearing _______ X ________

RIDER

Skin Suit   Y   N

Aero Helmet   Y   N

MISC.

Other Notes

____

Air Temp ______________________

Wind Speed ____________________

APPENDIX F

PROTOCOL FOR PHYSICAL PRACTICE SESSIONS

1/ Install front wheel fitted with odometer on subject's bike.
2/ Attach subject's bicycle to wind trainer.
3/ Subject is then allowed to warm up at their own pace for @ 15 min.
4/ The data sheets are prepared with subject's name, time of testing and date, as well as the name of the person recording the times.
5/ The subject is then informed about the schedule they are suppose to ride for the testing.
6/ The subject's bike is then placed in the same gear as they used for testing at the track.
7/ The odometer is zeroed.
8/ The subject is then given the same instructions as were given prior to the start of the testing at the track.
9/ The ride is started in the same manner as at the track; Rider ready, Timers ready, Go.
10/ The subject's times are recorded every .33 of a Kilometre and the subject informed as to their pace.
11/ The subject is informed of one lap to go.
12/ Once the subject has completed the 3000-meter test they notified and the resistance is eased off and the subjects are allowed to spin easily until they feel recovered.
13/ The bike is removed from the stand and the testing wheel with odometer is removed.
14/ The subject is then shown the pace profile they just completed and it is compared to the optimal pace profile to provide feedback.
15/ If the subject had any insights or opinions on the testing session these should be recorded.
16/ All recorded data is placed in the subject's folder.
17/ Make sure subject is not experiencing any physical abnormalities, if ok allow them to leave, if not make them remain until feeling better or escort to medical clinic.

APPENDIX G

SCRIPT FOR IMAGERY

1/ Start with 10 deep breaths, in on a count of three hold for one then exhale on a count of four. With each breath you should be feeling more relaxed starting from the neck, then the chest, followed by the waist, then the hips, now the thighs, and then the calves and finally the feet.

2/ Now that your relaxed I want you to picture yourself sitting on your bike at the track. See the infield, note the unfinished turf. Look at the track see the different lines first the black line closest to the infield, then the red sprinters line and finally the blue pacers line at mid track. Look up and see the rail and the stands. Now reach down and grab your handle bars feel the pressure. Take a few deep breaths and prep yourself for the start.

3/ Nod when your ready to start. Rise out of the saddle and feel the pressure on the pedals.

4/ Rider ready. GO.

5/ See a good strong start, nice and steadily winding it up. Feel the pull on the bars. See the corner rushing up to you.

6/ (odo .08) Your in the middle of the first corner now, feel the pull. Your holding the bike nice and close to the black line.

7/ You exit the corner and settle in to the saddle feel the pressure. Your still accelerating steadily.

8/ (odo .16) Your at half lap. Now really try to see and feel the bike moving along the track. Feel the bumps and the pressure of the pedals and handlebars.

9/ You have enter the corner keep a nice steady line and keep accelerating. (Odo .25) You have reach the middle of the second corner.

10/ Your out the corner and head down the front straight see Mike standing at the side of the track timing you hear him yell up eight to go. (Odo .33 or first lap split)

11/ You have settled into a good pace, hear your breathing, feel the exertion. Really focus on the seeing the track, get a good vivid picture. If its not coming take a couple of deep breaths and focus again start simple and build on it.

12/ (odo .41) Your in the middle of the corner again. your feeling good. Nice and steady.

13/ Your out to the straight see the far corner and accelerate toward it. (odo .49) You cross the half lap marker.
14/ Set the bike for the corner nice and close to the black. Look to you left and see the wide blue band at the base of the track.

15/ Refocus again and see the track coming at you (odo .57) your at mid corner.

16/ Your out of the corner and settled in to your pace, feel the amount of pressure on the pedals. Check your breathing.

17/ Good steady pace. (odo .66) There goes the start line, 7 to go.

18/ Repeat 11

19/ Repeat 12 at Odo .74, 1.08, 1.41, 1.82, 2.23, 2.64

20/ Repeat 13 at odo .82, 1.16, 1.49, 1.90, 2.31, 2.72

21/ repeat 14

22/ repeat 15 at odo .90, 1.24, 1.57, 1.98, 2.39, 2.80

23/ repeat 16

24/ repeat 17 at odo 1.0, 1.33, 1.66, 2.0, 2.33

25/ Odo 2.66 one lap to go, hear the whistle. Try to pick it up but stay in the saddle nice and smooth to the finish line.

26/ Odo 3.0 your done.

APPENDIX H

Raw Data

Pre-test

Group				Lap				
1	2	3	4	5	6	7	8	9
Con								
-1.07	-0.56	0.22	-0.57	-0.24	-0.36	0.28	0.36	0.58
1.04	1.45	0.64	-0.68	-0.58	-0.35	-1.01	-0.33	0.59
1.58	0.44	0.51	0.18	-0.11	-0.02	-0.46	-0.30	-0.55
1.86	0.97	0.94	0.11	-0.77	-0.76	-0.87	-0.73	0.81
1.00	1.45	0.67	-0.02	-0.02	-0.13	-0.49	-0.70	-1.05
2.10	2.68	1.40	-0.09	-0.89	-1.55	-1.63	-1.13	0.94
Phys								
0.61	-0.15	-1.38	-0.85	-0.61	0.68	1.24	-0.25	1.00
2.42	0.37	-1.01	-1.30	0.35	-0.08	-0.14	0.63	0.86
-1.73	-0.05	-1.56	-1.96	-0.72	0.51	0.10	0.86	2.13
3.22	2.74	0.70	-0.48	-0.81	-0.61	-0.82	-0.56	-0.46
0.91	0.20	-0.22	-0.33	-0.32	-0.13	-0.38	0.41	0.50
-1.00	-0.40	-0.45	-0.10	-0.40	-0.01	0.21	0.43	0.41
IPP								
3.19	1.55	0.40	-1.48	-1.58	-0.88	0.93	-0.29	1.06
1.77	1.41	-0.10	-0.86	-1.00	-0.57	0.15	0.17	0.52
0.59	2.32	0.65	-0.38	-0.45	-0.41	-0.72	-0.52	-0.78
4.20	2.60	1.89	0.33	-0.61	-1.16	-1.48	-1.30	-0.59
1.14	1.76	0.99	-0.14	-0.82	-0.96	-0.63	-0.37	-0.10
2.16	1.26	0.73	-0.44	-0.74	-0.52	-0.36	-0.50	0.29
IDP								
3.22	1.97	0.25	-0.36	-0.70	-0.71	-0.42	-0.22	-0.13
-0.45	0.79	-0.38	-1.21	0.12	0.44	0.02	-0.05	-0.06
0.77	0.58	0.10	-0.56	-1.08	0.20	-0.16	0.37	0.26
-0.86	1.31	1.08	0.16	-0.30	-0.38	-0.59	-0.77	-0.81
2.43	0.47	-0.82	-0.61	0.03	-0.07	0.04	-0.04	0.71
-0.26	0.12	-0.87	-1.29	-0.91	-0.35	-0.32	0.79	2.54

APPENDIX I

Raw Data

Post-test

Group				Lap				
1	2	3	4	5	6	7	8	9
Con								
-0.50	0.54	0.21	-0.11	-0.27	-0.46	-0.32	-0.33	0.44
1.15	0.84	-0.02	-0.09	-0.19	-0.44	-0.75	-1.01	1.36
2.64	2.50	1.01	0.15	-1.31	-1.90	-1.25	-2.00	2.49
1.72	0.60	0.25	-0.65	-0.90	-1.05	-1.00	-1.18	0.22
1.51	2.03	1.38	0.09	-1.19	-1.03	-0.18	-0.40	-0.98
4.02	2.39	1.55	-0.04	-0.29	-1.53	-1.36	-1.31	0.32
Phys								
-1.56	0.67	1.21	1.36	-1.51	-1.53	0.09	-0.24	-0.35
2.37	1.26	-0.07	-1.57	-0.75	0.22	0.42	-0.59	0.81
-1.01	-0.33	-0.11	-0.71	-0.36	-0.41	0.31	0.48	0.85
-0.46	-0.02	-1.22	0.02	-0.36	-0.08	0.18	0.34	0.84
-1.11	0.06	0.01	-0.24	-0.47	-0.31	-0.50	-0.08	1.20
-0.48	0.45	-0.33	-0.67	-0.31	-0.39	0.38	0.50	0.04
IPP								
0.84	0.20	-0.28	-0.35	-0.62	-0.86	-0.30	0.64	1.27
0.90	0.49	0.53	0.31	0.05	-0.34	-0.51	-0.43	-0.38
0.73	2.39	1.17	-0.41	-0.14	-0.68	-0.86	-0.71	-1.06
1.54	1.25	0.89	0.49	-0.10	-0.29	0.09	-0.78	-1.82
0.03	0.41	0.32	-0.63	0.10	0.42	-0.60	-0.53	0.22
1.61	-0.08	0.17	-0.68	-0.67	-0.06	0.42	0.60	-0.01
IDP								
1.27	0.90	-0.13	-0.64	-1.14	0.07	0.31	0.45	-0.12
1.29	1.20	0.73	-0.58	-0.19	-0.35	-0.42	-0.14	-0.56
-1.47	-0.60	-0.55	-1.92	-1.26	0.64	0.99	1.66	0.73
-0.44	1.78	1.33	0.34	-0.18	0.76	-0.68	-0.84	-1.26
0.86	1.12	-0.28	-0.45	-0.07	0.16	-0.67	-0.76	0.65
1.68	1.19	-0.42	-0.88	-0.69	-0.55	-0.47	-0.31	1.81

APPENDIX J

Raw Data

VO2 Max Tests

Group	Pre-test R VO2	Pre-test A VO2	Post-test R VO2	Post-test A VO2
Control				
	59.5	3.986	63.5	4.222
	57.2	3.998	58.4	3.953
	63.1	3.951	66.9	4.203
	63.6	3.863	70.1	4.187
	52.0	4.226	56.2	4.429
	57.3	4.280	56.3	4.129
Physical				
	55.3	2.903	56.6	2.920
	48.0	3.636	49.3	3.708
	54.7	3.744	58.7	3.973
	60.8	4.349	62.6	4.452
	58.2	4.397	60.6	4.508
	61.8	4.872	64.6	5.184
IPP				
	59.0	4.567	60.3	4.757
	63.5	4.833	67.0	5.138
	64.1	4.193	61.4	4.067
	58.3	4.254	63.5	4.649
	54.4	3.770	62.3	4.306
	63.6	4.117	72.6	4.610
IDP				
	60.9	4.057	63.7	4.185
	73.6	4.904	73.9	4.851
	66.8	4.457	73.9	4.999
	60.1	4.429	62.7	4.638
	58.9	3.159	58.7	3.261
	59.4	5.417	64.1	5.720

Appendix K

Calculation of OPP and Mean Deviations

Mean Lap Time (MLT) = (The sum of the subject's actual lap times for laps 2 through 9)/ 8

OPP

Lap 1 = MLT + 3.50

Lap 2 = MLT - 0.80

Lap 3 = MLT - 0.30

Lap 4 = MLT - 0.25

Lap 5 = MLT - 0.00

Lap 6 = MLT + 0.20

Lap 7 = MLT + 0.30

Lap 8 = MLT + 0.40

Lap 9 = MLT + 0.15

Mean Deviations = The absolute value (unsigned) of the difference between the subject's actual lap times (ALT) and the calculated OPP summed and then divided by 9.

$$\frac{(\text{lap 1 ALT} - \text{lap 1 OPP}) + \ldots\ldots\ldots\ (\text{lap 9 ALT} - \text{lap 9 OPP})}{9}$$

VITA

Surname: Pierzchalski Given Names: Michael Irving

Place of Birth: Salmo, B.C. Date of Birth: July 13 1962

Educational Institutions Attended:

University of Victoria	1988 to 1997
Selkirk College	1986 to 1987

Degrees Awarded:

B.A.	University of Victoria	1992

Honours and Awards:

University of Victoria Fellowship	1992 to 1994
Canadian Sports Council Research Grant	1993

Publications: