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**The Effects of Personal Knowledge
and Mental Imagery on the Skating Performance
of Female Figure Skaters**

Diane Mack

Carleton University

Running head: PERSONAL KNOWLEDGE AND SKATING

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The undersigned recommend to the Faculty of Graduate Studies

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THE EFFECTS OF PERSONAL KNOWLEDGE
AND MENTAL IMAGERY ON THE SKATING PERFORMANCE
OF FEMALE FIGURE SKATERS

submitted by Diane E. Mack, B.A.
in partial fulfillment of the requirements for
the degree of Master of Arts

Thesis Supervisor

Chair, Department of Psychology

Carleton University
August, 1992

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Personal Knowledge and Skating

Abstract

This study compared the effectiveness of mental imagery and personal knowledge training on forty 10 - 15 year old female figure skaters. Fifteen matched pairs of skaters were randomly assigned to one of two treatment conditions. A quasi control group comprised of 10 skaters were also selected. A moderately challenging skating element was assigned to each matched pair of skaters. Training to improve personal knowledge of skating skills involved guiding the skater to translate coaching feedback into a script of personally meaningful action cues. Mental imagery training involved instructions to improve the vividness and control of the mental representation of performance-related feeling states. Skaters performance was videotaped 3 times during the 20 day intervention. Performance changes were assessed from judges' blind ratings of video samples. Results show that (a) both experimental groups performed the selected skill better than the control; (b) the personal knowledge group performed the skill better than the imagery group; (c) mental imagery and personal knowledge skills improved significantly and differentially for the two treatment groups. Differential treatment effects were discussed in reference to broad educational and cultural factors.

Personal Knowledge and
Mental Imagery in
Figure Skating Performance

In order to excel, high performance standards are often required. With the increased popularity of sporting events, athletes and coaches alike have been put under increased pressure to improve performance. Throughout the years, sport science investigators have joined the quest for excellence by examining various ways to enhance training and improve performance, particularly in the following areas: strength and fitness; nutrition; exercise physiology; biomechanics; psychomotor development; learning and control; and mental training. Researchers are able to design highly sophisticated training programs that lead to desired changes in such things as: body composition, aerobic capacity, form and technique, strength and flexibility, and mental factors related to performance. In addition, investigation in sports medicine and sport psychology have made significant advances in the prevention, management, and rehabilitation of sport-related injuries and in the physical and emotional challenges related to retirement from competitive sport.

More and more athletes, coaches and sport psychologists have come to recognize the significance of mental processes involved in competitive performance. Olympic and World Champion athletes report that their

consistently high level of achievement is the result of mental factors which they have developed (Orlick & Partington, 1988). According to Loehr (1982) many athletes and coaches claim that the process of performing well is 70 to 90 percent mental. However, when athletes were asked by Loehr how much of their total practice time they devoted to strengthening these mental skills, they reported between five and ten percent. If mental skills are seen by athletes to account for a large measure of their performance success, why do coaches and athletes spend only five to ten percent of their time working on these skills? One possible explanation for this is that athletes and coaches may be unclear as to the best way to improve performance through mental training.

Until very recently, the majority of research which examined the effects of mental training on performance was conducted with either university students or older athletes. Attempts to discover whether or not mental training is successful with younger subjects has led to inconsistent findings (Suinn, 1984; Harris & Harris, 1984). Although it was once widely believed that elite athletes benefitted more from mental training, recent findings seem to negate these original conclusions. Kerr, Koivu, and Blais (1990), have shown that by using more types of instructional methods, more learning can be facilitated even for second graders.

This paper will focus on two mental skills that have been found to benefit athletic performance. The effects of the first skill, mental imagery, on athletic performance has received considerable attention in the sport psychology literature. A second skill, knowledge structuring, or creating personalized knowledge, although rarely examined to date in sport performance enhancement research, has been acknowledged to differentiate between experts and novices. Literature on both mental imagery and personal knowledge will be reviewed in the following sections.

Literature Review

The first section of the literature review will discuss the role of mental imagery in sport performance. The section begins at a general level outlining theoretical perspectives, empirical findings on beneficial effects of imagery, and factors associated with imagery effectiveness. This section closes with a more sport specific review of imagery effects with figure skaters. The second section of the review covers theory and research on personal knowledge.

Theoretical Positions on Mental Imagery Effects

Two major explanations have been put forth in an attempt to explain the beneficial effects of mental imagery on physical performance.

Symbolic learning. The Symbolic Learning explanation postulates that people learn something from their physical performance of an unfamiliar task (Richardson, 1967). Through mental practice the cognitive factors of the motor skill will be remembered. Thus, mental practice will result in a mental representation of the skill and subsequent physical performance will be improved.

Research driven by symbolic learning theory has shown consistently large effect sizes for skills which have primarily cognitive elements (e.g., maze learning tasks). However, the majority of sporting events involve motor tasks with considerably fewer cognitive elements relative to motor or strength elements. Results from studies which employed tasks with fewer cognitive elements have been mixed (Kohl & Roenker, 1980; Rawlings & Rawlings, 1974).

Wrisberg and Ragsdale (1979), conducted an experiment to determine the effect of mental imagery on two motor tasks. The first task being one of high cognitive demand (McCloy test of multiple response), the second of low cognitive demand (stabilometer). Results of this study indicate that mental imagery is as effective as physical rehearsal, but only for the task involving high cognitive demands.

As a theory of imagery rehearsal, the symbolic

learning position has some serious problems. Although it can account for the finding that mental practice facilitates early skill acquisition, little has been said about well-learned athletic skills. In addition, the division of tasks into cognitive and motor components appears to be artificial (Richardson, 1967).

Psychoneuromuscular theory. The most commonly mentioned alternative to the symbolic learning explanation is the psychoneuromuscular theory (Suinn, 1987). The rationale behind this theory contends that when imagining a movement, measurable muscle contractions occur that appear to mirror those of the actual movement. Each time an athlete rehearses a movement in imagery the body replicates the experience, but transfers it to the brain. Researchers who support the psychoneuromuscular theory believe that the muscular contractions resulting from mental imagery lead to improved motor learning (Schramm, 1967; Suinn, 1976).

Hale (1982) tested the proposal that minute muscle innervation caused by mental rehearsal may be responsible for the motor learning that takes place during mental practice. Results indicate that the recorded action potentials were not identical to the muscles used in overt physical performance of a bicep curl. Subjects included were 48 male university students and faculty who were considered "experienced" weight

lifters (i.e., lifted weights at least twice a week). Twenty-four "inexperienced" weight lifters were also included. These men did not regularly lift weights. When subjects imagined performing a curl, activity in the biceps increased as expected. However, during visualization, tricep activity also increased. From these findings, it appears as though imagery does not parallel physical performance, but muscular activity is more generalized throughout the whole body. Many researchers question the psychoneuromuscular theory that mental practice effects are the result of muscle activity (Feltz & Landers, 1983; Ryan, Blakeslee & Earnst, 1986).

Although there is support for the proposition that imagery rehearsal is accompanied by small but measurable muscle activations, the psychoneuromuscular view is weak in explaining how feedback results in improved performance. For example, are these improvements in motor performance the result of conscious cognitive processes or do they occur without conscious awareness? If unnecessary muscles are activated, what mechanism signals that this is an inappropriate response? The psychoneuromuscular view is perhaps best considered a description of an important aspect of effective imagery rehearsal (i.e., visceral and muscular activation) rather than an explanation of the processes involved in improved performance.

Research has empirically demonstrated the beneficial role of mental imagery in the acquisition of athletic skills, the reduction of anxiety in performance situations, improvements of physical coordination and reaction times, and to the development of complex strategies (Feltz & Landers, 1983; Suinn, 1987). Athletes themselves have corroborated empirical results by repeatedly emphasizing the significance of mental factors to the outcome of their performance (Orlick & Partington, 1986). Brian Orser, 1987 Men's World Figure Skating Champion, described the importance of mental training to his practice " It was through actually feeling it in my mind that I started to make all my jumps consistent. I can remember one specific jump, the triple toe loop. I was thinking about it in bed, and when I went to the rink the next day I was thinking about the feeling, and all of a sudden I landed my first one. The night before I had the feeling of it. I couldn't wait to get to the rink the next day so I could try it, to see if it would work. There was a certain feel I was thinking of, and I said, I will try that tomorrow, and it worked... My imagery is not so much visual. It is more just feel, I don't think it is visual at all. When I'm watching it on video, I usually look at it, and then I get this internal feeling. When I'm actually doing it I get the same feeling inside. It is a very internal

feeling that is hard to explain. You have to experience it, and once you do, then you know what you are going after" (Orlick & Partington, 1986, pp. 142-143).

Now that the beneficial effects of mental imagery have been documented, both by reference to research and to self-reports of athletes and coaches themselves, researchers have set out to discover characteristics of mental imagery that are related to improved performance. A number of factors appear to be influential, however two of these, perspective/feeling orientation and subject degree of control have been found to be essential for successful mental training. Essential factors will be discussed at length in the next section, followed by a brief discussion of other factors found to be related to successful imagery.

Perspective/feeling orientation. How individuals practice their imagery can be classified according to whether or not they experience the image from an internal or external perspective. Internal imagery requires an approximation of the real-life phenomenology, such that the person actually imagines being inside his/her own body, therefore experiencing the sensations which might be expected in the actual situation (Mahoney & Avenier, 1977). For example, a hockey player, when imaging, may see the defender skating up to him, the stick in his hands and the puck. As he tries to evade the defender

the hockey player may feel himself turning or a shift in weight, whatever is determined to be required by the player himself to make the best response. The athlete must simulate actual physical performance in the mind. This involves not only seeing, but feeling each movement as it would actually be performed. This type of imagery has also been labelled kinaesthetic imagery. In contrast, external imagery involves watching yourself perform from a third perspective, similar to watching a movie or a videotape of your performance.

Internal and external imagery are believed to be physiologically distinct, as greater muscle activity is reported for internal imagery (Corbin, 1972). Corbin concludes that kinaesthetic feedback is important to the effectiveness of mental practice. The association between internal and higher levels of muscle activity may result in higher levels of performance.

Mahoney and Avenier (1977) set out to find factors which appear to be related to superior athletic performance. Thirteen male gymnasts were interviewed for the purpose of finding out which psychological factors and cognitive strategies are used in their training and during competition. Final placement at the U.S. Olympic trials (Qualifiers vs. Non-Qualifiers) was used as the dependent variable and correlations were examined in order to assess factors related to superior athletic

performance. Although all competitors reported extensive imagery use, qualifiers reported a higher frequency of internal imagery. Due to the exploratory nature of the study, no causal relationship can be inferred. However, it appears as though internal imagery is associated with superior athletic performance.

When many of Canada's top 1984 Olympic medal winners were interviewed their perspectives appeared to be more internal in nature (Orlick & Partington, 1986).

Vividness and control. The development of well-controlled kinaesthetic imagery is important for the full benefit of mental imagery to be maximized. Control refers to whether the athlete is intentionally able to change the image. The more clearly and controlled a person can imagine a series of movements, the more beneficial the mental practice (White, Ashton, & Lewis, 1979). In addition, a poor image is analogous to "a degraded blueprint with the essential parts missing or so out of focus that the plan cannot be read off quickly and efficiently" (White et al., 1979, pp.76).

When questioning basketball players about mental practice, Corbin (1972) noted that several athletes reported that their images often seemed non-cooperative. For example, when imagining dribbling the basketball, one player reported that the ball would not bounce.

That successful performance is influenced by image

clarity has been demonstrated by Meyers et al. (1979). Nine members of a university racquetball team completed the Mahoney-Avener questionnaire. They found that athletes who possessed vivid and controlled imagery ability showed better performance than athletes who were uncontrolled imagers.

A report of correlates of competitive achievement by Canadian athletes at the 1984 Olympic Games underscores the importance of the perspective\feeling and control aspects of imagery (Orlick & Partington, 1988). Successful Olympic outcome was found to be correlated with kinaesthetic and well controlled images.

Secondary factors which are beneficial to successful imagery, but not essential are: the ratio of mental to physical practice; level of arousal; frequency and duration; and the stage in learning. Each of these will be considered briefly.

Ratio of mental to physical practice. White, Ashton & Lewis (1979) studied the effectiveness that mental and physical practice have on performance of a swimming skill. Twenty-four competitive swimmers were assigned to one of three treatment conditions; mental practice alone, physical practice alone, a combination of mental and physical practice, or a control group. The assigned swimming skill was sub-divided into six component parts. Post treatment performances for the components parts were

rated by judges following experimental manipulation. The findings clearly indicate improved performance as a result of incorporating both physical and mental aspects of a skill into training. Subjects in this group showed performance gains in all six elements. No difference was found between the mental practice alone and physical practice alone conditions. From this research it appears that attention must be paid to mind and body development. Development of one aspect, to the exclusion of the other, may hinder successful performance.

One issue not dealt with in the above study is that of the relationship between stage of learning and type of practice. Do mental practice and physical practice continue to be as effective when moving from learning to expert stages? This will be dealt with in a following section.

Level of arousal. When examining the literature regarding imagery it is apparent that some investigators believe that relaxation techniques will facilitate vividness and clarity of imagery by reducing distracting external stimuli (Suinn, 1984).

However, this contention has not received empirical support. Hamberger and Lohr (1980) tested the hypothesis that controllability of imagery increases as a function of relaxation training. Results indicate that the relaxation training did not improve image controllability

any more than did the control.

Gray, Haring & Banks (1984) compared the effects of arousal induction vs. relaxation to imagery vividness and controllability. From this case study, it was found that the most realistic representation was developed through mental imagery accompanied by arousal instructions that approximated performance conditions. These results are in general agreement with those of Weinberg, Seabourne & Jackson (1987), who determined that image vividness and controllability did not differ as a function of arousal vs. relaxation instructions. From this, one must realize that for some athletes, in certain situations, relaxation training may ultimately impede efforts to improve performance through mental practice.

Frequency and duration. Since there are individual differences among athletes, different physical training programs are required to best meet their needs. Mental training is no different. Mental training must also be personalized to fit the requirements of each performer. The inconclusive findings found from some mental training programs may result from failing to individualize the duration and type of interventions. Seabourne, Weinberg & Jackson (1983) suggest that an individualized training program will enable subjects to become more familiar with the requirements of their cognitive strategy. These researchers conclude that the training sessions must be

of sufficient duration and that the athletes must be allowed time to become intimately involved in their program.

Stage in learning. Some researchers believe that the benefits to be derived from mental practice occur at the initial stages of learning a particular task (Wrisberg & Ragdale, 1979). The cognitive element at this stage is thought to supersede the physical element. At later stages of learning, performance of the skill is thought to be more "automatic" with cognition playing a less significant role in the outcome of a performance.

However, more recently researchers have been examining mental practice effects on later stages of learning. Results have indicated that imagery training can facilitate performance in both the early and later stages of learning (Suinn, 1984). What about maintenance of a high level of performance. Once an athlete is consistently performing a skill to the satisfaction of the athlete and coach, that skill is practised less and less as the athlete moves on to new skills. Researchers have come to believe that mental imagery is capable of maintaining a high level of performance in the absence of physical performance (Cooper, 1985). If while practising new skills, an athlete could maintain mental practice of already acquired skills it is probable that regression on these

mentally rehearsed skills would be lessened.

Obviously there are differences among individuals imagery ability. Hall, Buckolz, and Fishburne (1989) caution that not all athletes should be encouraged to use imagery to a high degree, especially if an athlete is learning a new skill. They hold that athletes should imagine a skill as it should be performed. Imagery rehearsal depends upon how accurately physical performance is represented in memory. If an athlete's representation of performance is poor or inaccurate, imagery rehearsal may not be very beneficial, perhaps even detrimental. These researchers suggest that an athlete should practice a skill for a period of time, and then incorporate imagery into their training as a means of facilitating performance.

Performance enhancement resulting from mental practice may be different in early stages of an athlete's development than for later stages (Feltz & Landers, 1983). In the early stages of learning, mental practice may not improve performance due to the rough mental schema involved in visualization. Following more experience with a skill, a clearer image may be formed due to feedback from the muscles and senses. The link between successful performance and the vividness and clarity of an image has already been discussed.

Sport Related Research on Imagery

The information that exists on imagery in sport is largely descriptive in nature. Much of the data has been collected through anecdotal reports of athletes, athlete interviews and post-performance evaluation questionnaires. For example, Hall, Rodgers, and Barr (1990), conducted an extensive investigation of the use of imagery by athletes across various sports. The purpose of this study was to gain a better understanding of when, where, and how imagery is incorporated into their training and performances. For the purpose of this discussion only, the data gathered from figure skaters will be examined.

The forty-six figure skater participants were categorized into competitive levels (recreational, local, provincial, or national/international). Information about their imagery was obtained from a 37 item Imagery Use Questionnaire (IUQ). As expected, the results indicate that competitors at the provincial and national levels showed higher frequencies of imagery use, superior imagery vividness and control, and were more likely to visualize from a kinaesthetic perspective, as compared to skaters at the recreational and local level. One general trend evident across all levels was that athletes used imagery more in conjunction with competition than with practice. This suggests that they consider imagery to be

more important as a technique for enhancing performance than it is as a learning aid.

Evidence that imagery can facilitate the learning of motor skills is well documented in the literature (Corbin, 1972). Hall et al. (1990) recommend that coaches need to instruct and remind athletes to incorporate imagery into their everyday training sessions.

Previous experiments with skaters have not always supported the role of imagery in performance enhancement, for example, Mumford and Hall (1985) asked skaters to perform imagery on a variation of a senior level standard compulsory figure. Senior, junior and novice level competitors were assigned to either an external imagery condition, an internal imagery condition (kinaesthetic orientation) or a control condition. All skaters received four experimental training sessions, each lasting an hour long. Judges rated pre-treatment and post-treatment performance of the traced figure. Results indicated that mean scores for novice skaters remained constant between trials, while senior and junior level skaters showed a small improvement which did not reach statistical significance.

There are a number of reasons why these negative findings were obtained. For example, mental practice effects seem to be most beneficial when used in

combination with physical practice (Suinn, 1984). Mumford and Hall (1985) employed only mental training techniques. The only actual physical practice these skaters had was on the pre and post test judgement days. Without the benefit of physical practice it is difficult to effectively conceptualize performing the task. In addition, Mumford and Hall (1985) required skaters to perform a figure for which they had no previous experience. Again their design can be faulted on the grounds that Weinberg (1982) had already noted that a minimal level of skill proficiency must be observed before mental imagery aides skill acquisition.

In sum, this section has reviewed literature on one of the two cognitive components associated with sport performance. Discussed so far have been a theoretical background to mental imagery, experiential characteristics of successful imagery and factors related to successful imagery. Two studies relating mental imagery to figure skating have also been reviewed. The first described how, when, and where figure skaters at different performance levels incorporate imagery into their training. The second attempted to relate imagery to a specific skating skill. Methodological limitations of the previous study have already been discussed. This brings the discussion to the second cognitive component relevant to this study, personal knowledge.

Personal Knowledge

A second cognitive factor associated with sport performance is the level and quality of knowledge about skilled motor performance. In this section personal knowledge will be discussed in the following ways: from a theoretical perspective; from the cognitive psychology literature that focuses on expert\ novice differences; and from the perspective of research which has examined personal knowledge of figure skaters.

Theoretical position on personal knowledge. A three stage model for the role of personal knowledge in the development of a skill has been prepared by Fitts and Posner (1967). They call the first the cognitive stage. At this point subjects develop declarative encoding (i.e., knowledge about facts and things relevant to the skill). Learners typically rehearse these facts as they first perform the skill. The knowledge acquired in the cognitive stage is quite inadequate for skilled performance, as the learners tend to use domain-general problem solving procedures rather than domain-specific procedures.

In the second stage, known as the associative stage, the method for performing the skill is worked out. First, errors in the initial understanding are gradually detected and eliminated. Second, the connections among the various elements required for successful performance

are strengthened. In this stage declarative information is transformed into a procedural form. The outcome of the associative stage is a successful procedure for performing the skill.

The third stage of skill acquisition, the autonomous stage, can be considered an extension of the associative stage. Here the procedure becomes more and more automated and rapid. As ability to perform the skill increases, verbal mediation in the performance is lessened. The autonomous stage appears to extend indefinitely, and throughout it the skill gradually improves.

Expert/novice differences. Fitts and Posner (1967) have proposed a three stage theory of learning. One can assume that the first stage is associated with novices and it is through practice that expertise is achieved. When performance reports of expert and novice athletes are compared, the knowledge categories of experts include rule of thumb performance principles related to personal intentions, while novice knowledge is experienced at a more specific motor level (Allard & Burnett, 1985). The study of such cognitive differences between experts and novices has a fairly lengthy tradition in general psychology, with performance differences being reported for chess, geometry, physics, and computer programming. Generally, experts learn to perceive recurring patterns

in the problem and to associate their problem solutions to these patterns. Experts reorganize their approach to the problem in order to capitalize on features of the domain. For example, in geometry and physics this reorganization tends to take the form of transforming working backward into working forward. Also, experts develop better memory for information that is involved in the solution of problems specific to the particular domain (Chase & Simon, 1973; Larkin, McDermott, Simon, & Simon, 1980).

Differences between novices and experts can be found when examining physics problem representation. Chi, Feltovich and Glaser (1981) asked subjects to classify a large set of problems into similar categories. Subjects were either considered novices or experts in the field of physics. Novices were found to choose surface features, such as rotations or inclined planes, as their basis for classification. In contrast, experts classified problems together that were completely different on the surface but, were seen as similar because they both involved conservation of energy or they both used Newton's Second law. Thus, experts have the ability to map surface features of a problem onto these deeper principles. This is very useful because the deeper principles are more predictive of the method of solution. These researchers concluded that "expert-novice differences may be related

to poorly formed, qualitatively different, or non-existent categories in the novice representation" (pp. 122-123).

De Groot (1966) attempted to determine what separated expert chess players from novices. The major difference was that chess experts were able to reconstruct the positions of more than 20 pieces after just five seconds of study. Novice chess players could reconstruct only four or five pieces; an amount much more in line with the traditional capacity of short term memory. It appears that experts build up memory units of four or five pieces that reflect common board configurations as a function of their massive amount of experience with the task. Thus, they appear to remember not individual pieces but rather chunks.

As in the skills cited above, the development of sport-specific cognitive factors are essential for improved performance and to the development of expertise. In their review of the research on cognitive advantages to sport expertise, Garland and Barry (1990) conclude that the main difference between experts and novices for almost any sport is that novices do not appear to make use of the cognitive processes used by sport experts.

It is obvious that research on expert-novice differences in a number of domains has underscored the importance of the individual's level of knowledge.

Although most of this research has examined expert knowledge upon more intellectual activities, recently, attention has been directed toward the role of the athlete's knowledge with respect to sport performance and motor skill acquisition (Wall, 1986). Allard and Burnett (1985) found that expert basketball players categorized photographs of basketball plays on the basis of underlying performance principles. Similar to results described earlier by Chi et al. (1981), novices categorized these basketball plays on the basis of surface features, such as the number of players depicted in each photograph.

Russell (1990) faulted this study on methodological grounds, and cautioned against further studies of athletes personal knowledge with such methodology. However, the basis of her argument is that sport tasks are ill-defined compared to intellectual tasks. Unfortunately, her position was not substantiated.

In addition to the above, considerable weight of evidence in support of the role of personal knowledge in relation to sport was obtained before sport psychologists were even talking about personal knowledge. In retrospect, indices of athletes personal sport knowledge may be obtained from earlier studies of their self-talk/internal dialogue, performance scripts, lists of key words, and game plans. For a number of years sport

psychology consultants have believed that what athletes say or think to themselves is critical to performance (Bunker & Williams, 1986). The frequency and content of this internal dialogue varies from person to person and situation to situation. Self-talk can help the athlete stay appropriately focused on the present, not dwelling on past mistakes or projecting too far into the future. Self-talk gets in the way when it is negative, inappropriate, or so frequent that it disrupts the automatic performance of skills. Bunker and Williams (1986), studied the nature of self-talk at various levels of skill acquisition. During early learning, performance was found to improve with the aid of self-instructional talk to remind the performer of certain key aspects. Cue words can be used to describe a particular movement or to help in learning the appropriate sequence of actions. Keywords were designed to foster cognitive associations that would aid in learning the proper physical execution.

Many of Canada's top Olympic athletes utilize cue words in order to aid performance (Orlick & Partington, 1986). Linda Thom, 1984 Olympic Shooting Champion describes the importance of cue words to her performance as follows: "When I go to the line, and set everything up, and take the gun in my hand, I also mentally go through my shot-plan checklist before I shoot. This strategy started out very mechanically with a physical

list of words which I have on the shooting table, and I read exactly. These words represented every single step involved in shooting a shot. Then I reduced these key words so that I could go through the list faster. Finally, I didn't need the list anymore. I would usually write one word to emphasize what I wanted, such as "trigger" or "smooth". Then the shot plan rehearsal became a mix of simple verbal reminders and images which I "ran" before each shot" (Orlick & Partington, 1986, pp.174).

It is obvious that what goes on in an athletes' mind can influence performance. Anytime you think about something, you are in some sense talking to yourself. Self-talk has been labelled the key to cognitive control (Bunker & Williams, 1986). Thought content can effect self-concept, confidence, behaviour, and performance. It is therefore important that athletes learn to control their thoughts.

Bunker and Williams (1986) discriminate between various ways in which self-talk can be useful to performance including: The use of self-talk in aiding skill acquisition by reminding the athlete of key aspects; to force conscious control over thought processes in order to aid in the elimination of a habitual response; to keep well focused and reduce harmful distracters; and to maintain energy and "psych"

oneself up.

Inappropriate or erroneous thinking may lead to an unsuccessful performance. Athletes may discover that their mind is actually programmed for failure due to self doubt and negative statements. In this case, the body is merely performing what the mind was thinking. Rushall (1989) has described three types of self-talk statements which can lead to increased performance levels. The first, known as task-relevant statements, involve knowing the correct technical features involved in the particular sport. Mood words contain either a action or affective component that when said will cause a physical reaction in the body (e.g., the word, "pow", could mean to explode from the starting blocks). The final category of self-talk statements are positive self-statements. These are constructive phrases that help to build confidence and allow the athlete to persevere.

Sport Related Research on Personal Knowledge

The research reviewed so far has studied expert/novice differences in areas where problem solving is a factor. For example, as shown, chess experts have shown the ability to recall large amounts of meaningful information after a 5 second exposure to a slide. Some sports, for example basketball, also involve some problem solving in order to determine the best offensive and defensive strategy. However, not all sports contain this

element of problem solving and strategy development. Figure skating is one such sport. The emphasis here is on the correct performance of complex movements in a precise pattern. Stressed in figure skating is the consistency and accuracy of output of skating skills rather than on the selection of an appropriate strategy. In order to perform these skills properly, skaters must recall a large number of individual items that constitute a program.

In a series of experiments Deakin and Allard (1991) examined the skilled memory of expert and novice figure skaters to determine whether a domain-specific encoding advantage exists for expert skaters as has been shown in other fields. Results from this study indicate that expert figure skaters were able to recall more elements of a choreographed figure skating sequence, thus providing support for a domain-specific encoding ability in the skaters. When asked to perform a distracter task in between encoding and recall, no decrement in recall was found for either the novice or expert group. Therefore similar to other experts in skilled memory, long-term memory is implicated in learning the skating sequence. In addition experts were able to judge the similarity of two skating sequences faster than the novice skaters, thus lending support to the belief that experts appear to have faster access to semantic memory.

These researchers concluded that athletes in a domain where precision of execution is great show many of the same characteristics as experts in a domain where the cognitive component is of more importance (e.g., chess, basketball).

Martin (1989a) described a training program developed for figure skaters that has made extensive use of keywords as a way of improving performance. Although developed primarily for the performance of figures, this method can be extended for freeskating as well. Martin's method of mental training begins with the development of a series of keywords relating to difficulties with the specific skill in question. It is from coaches feedback that these keywords are first developed. The skater is then encouraged to individualize the coaches feedback into a series of keywords that have a personal meaning. During on ice practice the skaters are to use these keywords while performing the particular skill. Off ice skaters are to walk through the motions of the skill on the floor again reciting the keywords. For maximum benefit the skater is encouraged to walk through the skill at the same pace as the time it would actually take to skate the skill. In addition to improving performance of the skill, this technique is also believed to improve concentration and self confidence.

Palmer (in press) compared two different mental

training techniques that had been specifically developed for the practice and performance of figures in figure skating. In both techniques the skaters were asked to select words to help them concentrate on and correct specific elements of the figure that they were having the most trouble with. The two techniques differ in the following respect: the first procedure employed, the Martin Self Talk Technique (Martin, 1989a) is as described above. In the second technique, The Paper Patch, the skater was to trace the figure out on paper, instead of walking the figure out on the floor. While doing this workbook exercise each skater was to say their keywords out loud. The skaters were also asked to try to feel the correct response as they were drawing the figures and to keep the time required to trace the figure on paper comparable to the time actually taken to perform the figure on the ice.

Twelve matched skaters were asked to participate in the above study and were randomly assigned to the Martin group, the Paper Patch group, or a no treatment control group. In Phase 1 pretreatment assessment of each of two figures were rated by a qualified judge. At the end this first phase a second performance assessment was undertaken. Results indicate that only the Paper Patch group showed improved performance following this 4 week treatment period. Both the Martin group and the control

group showed a decrement in performance from the original assessment. In Phase 2, a multiple comparison across subjects design was employed. That is, skaters originally using the Paper Patch technique switched to the Martin technique and vice versa. The control group was divided in two, half using the Martin technique and the other half using Paper Patch. A third assessment of performance was taken at the end of this four week period. Results of Phase 2 indicate that a significantly greater number of skaters using the Paper Patch technique improved performance relative to those in the Martin group (9 vs. 3 respectively). Of the eight skaters who received training in both techniques seven replied that they preferred the Paper Patch technique. Reasons given for this finding included that it was more convenient, that they could see the whole figure, the skater to get a clear image of the circles etc. The Martin technique was criticised on a number of grounds, for example, movements performed are very different from those on the ice, it is also very difficult to keep balance when doing movements on the floor.

In order to assess the combined effects of mental imagery and personal knowledge, a training package was designed and implemented on novice level female figure skaters (Mack, 1990). Five matched pairs of skaters were selected to participate. A different skill was chosen

for each pair to perform. One member of each pair was randomly assigned to the experimental group, the other to a physical practice only control group. The experimental group was taught imagery skills through instruction, basic exercises, and video modelling, which emphasized the importance of vivid mental representation of internal kinaesthetic experiences in performance. Those in the experimental group were encouraged to modify technically phrased coaching input by translation into positive and personally meaningful keywords and phrases. Changes in personal knowledge were monitored through the skaters daily recordings in a log. The experimental period lasted ten intervention days over a three week period. Compared to the control group, the experimental group showed significant performance gains in the overall skating skill and in the component parts of each skating skill. Moreover, performance effects were obtained in the context of measurable improvements in the quality of imagery and personal knowledge.

In a recent, and quite similar study. the influence of imagery training on skating performance was compared to verbalization training on twenty-nine skaters over a sixteen week intervention period (Rodgers, Hall, & Buckloz, 1991). Verbalization in this case was described as "the attachment of useful or meaningful verbal descriptions to movements to be remembered or learned and

then using those descriptions to aid recall" (pp. 112). An eleven member no treatment control group was also included. The study attempted to measure the following: (1) whether imagery ability could be improved through systematic imagery training; (2) whether the imagery training will have any effect on the reported patterns of imagery use and; (3) the differential effect of imagery vs. verbalization training on skating performance. Figure skating performance was assessed across four measures. The first and most important was the number of Canadian Figure Skating Association (CFSA) tests attempted and passed by the skaters in each group. The second assessment was a percent elements completed score. This was an indication of the number of elements completed in the skater's program versus the elements planned in the program. The third index, the program score, was calculated by giving numerical values to the elements in the program which when summed together indicated the level of difficulty of the skater's program. The program score, the final indicator, was calculated by dividing the difficulty score for the elements completed in the program by the program score, thus giving the total difficulty planned in the program. During the training period the imagery and verbal groups received instruction and guidance in the use of their respective types of mental practice.

As expected the results indicated that the imagery group improved in imagery ability and changed their use of imagery in several ways. For example, those in the imagery group reported that they were more likely to use imagery after practice sessions, they could visualize parts of their jumps, and they could "feel" themselves performing the jumps. In comparison to previous years and to the control group, more skaters from both training groups tried and passed CFSA tests. Fifty percent of those in the imagery group attempted a test with a success rate of 57% passing. Whereas, thirty-three percent of the verbal group attempted a test with a success rate of 80%.

Development of the Problem

Two themes of emphases are evident in the cognitive training techniques discussed to this point, one emphasizes non-verbal, imaginal practice, the other emphasizes verbal, symbolic representation. Although much of the above research was atheoretical, the two apparently different approaches to mental training may be accommodated by Paivio's Dual Coding Theory (Paivio, 1971, 1986). The theory holds that human cognition involves mental activity of two specialized systems: Verbal information is coded in a linguistic, conceptual system, while non-verbal information is coded in a non-linguistic, perceptual system which is called "imaginal"

because it's contents are images of sense perceptions. The theory further holds that ability to develop and utilize symbolic representation within either system depends on experience with the stimuli relevant to that system. Moreover, there is some evidence that when representations within a system have been developed, these can be "primed" by exposure to appropriate stimuli. This has implications for performance, since priming of a system appropriate to task demands could facilitate performance, while priming of an inappropriate system could impair performance.

Dual coding theory provides a framework to guide a systematic program of research for enhancing figure skating performance. A number of research questions need to be addressed including: Which representational system is most relevant to freeskating performance for young athlete's in our culture? and; How can this system be most effectively developed and primed prior to performance?

Another major emphasis in the literature reviewed was on the role of mental training in performing skating figures. Now, with the elimination of figures in national and international competition, the applied research challenge is to discover which mental training technique is best for freestyle. One study examined the effects of imagery and verbalization on freestyle

performance (Rodgers et al., 1991) but did not include a measure of skating performance prior to the mental training interventions.

Statement of the problem. This study was designed to examine the relative influence of mental imagery and personal knowledge training on the performance of a freestyle skating skill by young female figure skaters.

Method

Subjects

Subjects were 40 novice level female figure skaters. Eleven matched pairs were selected from the Nepean Skating Club, and four from the Minto Skating Club. One member from each pair was randomly assigned to the imagery group, the other member to the personal knowledge group. A quasi-control group was comprised of ten skaters from both skating clubs who were similar to experimental subjects in age, skating ability and who were working on the same skating skills as were those in the experimental groups. As seen in Table 1, the age of the subjects ranges from 10 to 15 years, years of experience from 5 to 10 years, their skating ability ranged from Junior Bronze to Gold freeskate, and all had competed at Sectional competitions, which includes skaters in the region from Oshawa to Ottawa..

Materials

Materials included a figure skating questionnaire, two mental training logs, a mental state questionnaire, and a judges scoring sheet.

Figure skating questionnaire. This questionnaire has three sections. The first section includes demographic and skating history items such as, age, number of years in skating and the amount and type of off-ice training. The second section is designed to assess the mental

imagery skills. Ten point rating scales are provided to evaluate the perspective, vividness, and control of the performance imagery. Imagery items were modified from a comparable questionnaire used with young female gymnasts. The items were found to have acceptable test-retest reliability ($r=.88$, $p<.01$) (Wilson, 1988). The final section provides information regarding the subjects' use of keywords and a personal script for their skating performance. Skaters are asked to develop a personal performance script of their own (See Appendix A).

Mental state questionnaire. This questionnaire provides an indication of the state of mind of the skater prior to each of the three video taping sessions. Questions focus on the physical and mental preparation prior to being videotaped and the athlete's degree of alertness and readiness to perform (See Appendix B).

Mental training log A. This log is designed for those in the imagery condition. The log represents six individual components of each prescribed element. A diagram which illustrates the entire movement is provided in each log. Within each of the six individual components three ten point scales are included to measure the perspective, vividness and control of the imagery for each individual element (See Appendix C).

Mental training log B. This log is designed for those in the personal knowledge condition. The log is

partitioned into the same six categories as that in the Mental Training Log A, however, the diagram is divided to represent the corresponding section of the element (e.g., the inflight section contained the image of a skater in the correct inflight position etc.). Each skater is instructed to develop personally meaningful keywords and other self cues, that correspond to each individual section of the skating movement (See Appendix D).

Judges scoring sheet. A score sheet was devised to enable the judges to assess each skaters performance. Each skater was assessed according to overall and component part performance of the element (See Appendix E).

Procedure

Figure skating coaches from the Minto and Nepean Skating Clubs were involved in order to aid in the selection of subjects for the study. Criterion for inclusion were that members of each pair must: (1) be of similar age; (2) be working on the same skating elements; (3) of similar skating ability and; (4) that one coach instruct both members of the prospective pair. In addition these coaches were asked to select a specific skill (i.e., jump or spin) for each pair to perform. It was emphasized that the skater must be familiar with the chosen skill, however, improvements are needed with respect to technical performance and consistency. From

this pool, one member of each pair was randomly assigned to the mental imagery experimental condition. Their counterpart was assigned to the personal knowledge experimental condition. Members for the control group were selected from an available pool of skaters according to their similarity to those in the experimental group on age, skating ability and skating skill currently being developed. These subjects are considered a quasi-control since they had different coaches from those in the experimental groups.

All skaters in the study completed the Figure Skating Questionnaire prior to the experimental treatment period.

Treatment groups were orientated to their mental training conditions through simialar means. Those in the mental imagery condition were assembled in order to watch the video, "Visualization, What You See Is What You Get" (Coaching Association of Canada, 1988). In this video athletes from various sports are shown to be discussing the importance of mental imagery to sport, and the impact of imagery on their athletic performance. An explanation of the concepts related to mental imagery were provided and discussed following the video presentation.

Similarly, the personal knowledge group were gathered to watch the video, "Sport Psyching for Figure Skaters" (Martin, 1989b). This video illustrates the way in which skaters are to incorporate the use of keywords into their

physical practice sessions. Keywords are developed in response to each skater's individual difficulties with a particular element. Each keyword carries with it a personal reminder to the skater of the technically correct way of performing each element. With the aid of their respective coach each skater was asked to design a personalized script suited to her individual difficulties with the preselected skills.

The experimental training sessions comprised a period of 20 consecutive practice sessions over a four to five week period. The experimenter worked individually with each of the skaters during regular physical practice sessions. To control for the amount of time each skater spent with the experimenter, each skater was allowed only four attempts at each jump.

The mental imagery group was taught to internally visualize and feel the skilled performance. The skater learned to imagine the prescribed element with attention being focused on the various separate components. These components are identical to those illustrated in Mental Training Log A.

The skater was first asked by the experimenter to perform the specific element selected for her. Upon returning to the experimenter, she was asked to internally visualize the skating skill. While visualizing, the skater was encouraged to go through the

movements on the spot (i.e., when visualizing the inflight position to be turning on the ice in the same manner). After this imagery practice session, the experimenter would ask questions such as "Did you see the boards coming towards you?" or, "Did you feel the landing solidly?" or, "Did you complete the jump perfectly when visualizing it?". These questions were asked in order to guide the skaters toward practising imagery in the most effective way, which means representing and experiencing the action as of really doing it. The skaters were asked to imagine themselves doing the jump a second time and, if all was well, the skaters would physically perform the jump again. If observable improvement was not shown on the skill with respect to technical performance, concentration etc. the above procedure was repeated until the skater had completed four physical performances of the skill.

The personal knowledge group was encouraged to develop a simple script of meaningful keywords and other symbolic reminders to represent, in personal terms, the key elements of the motor plan necessary to accomplish their assigned skating element. The components of each element were devised according to the divisions found in Mental Training Log B.

As in the imagery condition, the first task of the skater while working with the experimenter was to perform

the chosen skill on the ice. The skater was then asked what keywords they were saying to themselves and what the meaning of each keyword was. Once again the skater was asked to perform the skill on the ice with a reminder to go through her script of key words prior to doing the jump. If the skill was not completed with observable improvement the second time the procedure was repeated until the skater had performed the skill four times.

Control subjects in both clubs received encouragement from the experimenter during their traditional physical practice. Time spent with these subjects was approximately the same as that with those in the experimental groups as they also had four attempts at the skill while with the experimenter.

Subjects in both the mental imagery and personal knowledge groups were asked to practice their mental training intervention program twice a day, before and after their physical practice session. After each training session, the imagery group was to record the effectiveness of their mental training on that day according to the rating scales in their Log. The personal knowledge group was asked to record keywords in their Log and whatever reminders they felt were necessary to accomplish a perfect execution of their assigned skating skill. The personal information could be in the form of keywords, self-commands, or graphical

representations (e.g., arrows or stick figures).

Performance data was obtained through three videotaping sessions conducted over the twenty practice days. The first taping occurred prior to any experimental manipulation on the first practice day; the second after ten practice days; and the final taping on the last practice day. Each skater in each group performed her respective element twice during each videotaping session in order to obtain a measure of consistency across trials. The affective state of each skater was measured immediately prior to the videotaping session through the administration of the Mental State Questionnaire.

All subjects were administered the Figure Skating Questionnaire after the final videotaping session on the last practice day.

Three Gold test figure skating judges rated the video performance of each skater independently. Judges were blind to the treatment condition of each skater. High inter-judge reliability has been found between judges when evaluating skaters performance on both overall measures of performance ($r=.96$, $p<.01$) and composite averages of performance ($r=.98$, $p<.01$) (Mack, 1990). The order of the tape presentation was systematically varied across the number of clips per trial, the trial itself and the subject.

Each performance was judged first as an overall element, and then according to its individual component parts. Each element was judged at the level corresponding to the individual pairs of skaters (e.g., Senior Bronze level, Junior Silver level, etc.).

Treatment of the Data

There are four dependent variables in the data set to be analyzed: Skating performance; pre-performance mental state; imagery; and personal knowledge.

(1) Judges rated each skaters' performance according to the overall appeal of the performed element and to the predetermined specific breakdowns. Judges affiliated with both the Minto and Nepean Skating Clubs were selected to eliminate the possibility that familiarity will influence their marking. Inter-judge reliability was assessed by using the Pearson Product - Moment Correlation Coefficient (Pearson's r) on both the judgement of the overall skill and composite averages of each component part. The marks given by the two judges with the highest correlation coefficient were retained for further analysis. Differences in skating performance was assessed by a 3*3 ANCOVA with repeated measures over time.

(2) Differences in mental state prior to video performance was assessed by a 3*3 ANCOVA.

(3) Imagery scores were represented by a combination

of the self-report scores on item 1 (feeling of each movement) and item 2 (internal view) from the Figure Skating Questionnaire. Imagery effects for the two treatment groups, and the control group, were assessed by a 3*2 ANCOVA with repeated measures over time.

(4) A quantifiable content analytical procedure was developed to provide an index of each subject's personal knowledge. The most effective log entries are believed to be: (1) positive; (2) specific to the intended component part (3) personalized translations from coaches feedback and (4) to be concrete, not laborious or confusing. Pre and post treatment performance scripts were assessed according to the above characteristics. Two raters, who were blind to the treatment condition and to which script was written prior to or following intervention, were asked to indicate the "superior" script from the pair. A Chi square will assess the percentage frequency of agreement on judgements. This index was used to assess treatment effects as was done for the imagery condition.

Hypotheses

(1) There will be no significant difference in post-treatment skating performance between the imagery and personal knowledge groups.

(2) Post-treatment skating performance of those in both mental training conditions will be significantly

better than that of control subjects.

(3) There will be no significant difference in pre-performance mental state between the imagery and personal knowledge groups.

(4) Post-treatment pre-performance mental state of those in both mental training conditions will be significantly better than that of the control subjects.

(5) Post-treatment performance imagery will be best for those in the imagery condition.

(6) Post-treatment sport related personal knowledge will be best for those in the personal knowledge condition.

Results

Performance

A high degree of inter-judge reliability was evident in judges ratings of skating performance ($r_{13} = .79$, $p < .05$; $r_{23} = .82$, $p < .01$; $r_{12} = .88$, $p < .01$). An ANOVA was conducted to determine whether groups differed prior to treatment (See Table 2). No such differences were found (Imagery group $\bar{X} = 6.9$, Personal Knowledge group $\bar{X} = 6.7$, Control $\bar{X} = 6.9$, $F(2,36) = .38$ ns.).

 Insert Table 2 about here

An ANCOVA was conducted on the post-treatment performance scores across groups with the pre-treatment scores serving as the covariate (See Table 3). A significant difference was found between groups (Personal Knowledge Group $\bar{X} = 7.7$, Imagery Group $\bar{X} = 7.3$, Control $\bar{X} = 6.8$ $F(2,36) = 4.88$, $p < .05$). Results of a Newman-Keuls post hoc analysis revealed that subjects in the personal knowledge condition performed significantly better than subjects in the imagery condition. Performance of the skating skill for both treatment groups was found to be significantly better than that of the control.

 Insert Table 3 about here

Imagery

An ANOVA was conducted to determine whether groups differed prior to treatment (See Table 4). No significant differences were found between groups on self-reported quality of imagery (Imagery group $\bar{X} = 6.3$, Personal Knowledge $\bar{X} = 6.1$, Control $\bar{X} = 6.0$, $F(2,36) = 1.39$ ns.).

 Insert Table 4 about here

An ANCOVA was conducted on the post-treatment scores assessing quality of imagery with the pre-treatment scores serving as the covariate (See Table 5). A significant difference was found on self-reported quality of imagery (Imagery group $\bar{X} = 8.1$, Personal Knowledge group $\bar{X} = 6.9$, Control $\bar{X} = 5.9$, $F(2,36) = 6.80$ $p < .05$). Results of a Newman-Keuls post hoc analysis revealed a significant differences between each of the treatment groups. Those in the imagery condition reported a significantly higher quality of imagery than did those in the personal knowledge condition. Similarly, those in the personal knowledge group scored higher than those in

the control group.

 Insert Table 5 about here

Personal Knowledge

A high degree of inter-judge reliability was evident in judges ratings of personal knowledge ($r = .93$, $p < .05$). A Chi-Square was performed on pre vs post personal knowledge ability for both mental training groups (See Table 6). Results reveal a significant difference between groups $\chi^2 (1, N = 30) = 21.4$, $p < .01$. A significantly higher proportion of those in the personal knowledge group improved in their personal knowledge reports than was the case for those in the imagery condition.

 Insert Table 6 about here

Mental State

The Mental State Questionnaire measured each skaters affective state along three dimensions: alertness; confidence; and energy level (See Table 7). On the firstideo trial no difference was reported between groups across all three measures (alert/well-focused: Imagery Group $\bar{X} = 6.3$, Personal Knowledge Group $\bar{X} = 6.5$, Control Group $\bar{X} = 6.6$, $F(2,36) = .81$ ns; energized/ready to

perform Imagery Group $\bar{X} = 7.0$, Personal Knowledge Group $\bar{X} = 6.8$, Control Group $\bar{X} = 7.0$ $F(2,36) = .62$ ns. and; confidence Imagery Group $\bar{X} = 7.4$, Personal Knowledge Group $\bar{X} = 7.5$, Control $\bar{X} = 7.1$, $F(2,36) = 1.12$ ns.).

Insert Table 7 about here

Subjects in the treatment groups rated their mental readiness for the final videotaped performance significantly higher on two of the three scales (See Table 8). Reported levels of alertness on the video trial following the intervention period revealed significant differences between groups (Imagery Group $\bar{X} = 7.5$, Personal Knowledge Group $\bar{X} = 7.6$, Control $\bar{X} = 6.8$, $F(2,36) = 4.12$, $p < .05$). A Newman-Keuls post hoc analysis revealed significant differences between both treatment groups and the control. No significant differences were found between the imagery and personal knowledge groups on measures of alertness.

Reported levels of confidence on the video trial following the intervention period revealed significant differences between groups (Imagery Group $\bar{X} = 8.1$, Personal Knowledge Group $\bar{X} = 8.3$, Control $\bar{X} = 6.4$, $F(2,36) = 4.71$, $p < .05$). A Newman-Keuls post hoc analysis revealed significant differences between the treatment and control groups. No significant differences were

found between either the imagery or personal knowledge groups on measures of confidence.

Insert Table 8 about here

Qualitative Results

Beyond the objective performance and rating results in support of the utility of mental training for these figure skaters, a number of subjective indices were observed which indicate that the interventions were well received by both skaters and coaches. For skaters this impression was gained was gained from evidence of their adherence to the program, written comments added to their Figure Skating Questionnaire, and from the skaters wish to continue working on their mental training following the termination of the study. Typical of the written comments are the following: "I enjoyed learning about mental training." and "...felt as though my skating improved while you were here.". Coaches support was shown through their interest in having other students involved in mental training after the study was completed.

Discussion

The purpose of the present study was to compare the effects of two alternative approaches to mental training relative to traditional physical training. Specifically, the study examined effects on skating performance of traditional physical training combined with systematic mental training, which either emphasized improving selected qualities of the experience of mental imagery, or emphasized the development of personal action knowledge. Both mental training approaches were compared to a control group which used only a traditional physical training program.

Results of changes in a targeted freestyle skating skill following a twenty day intervention period indicated that the personal knowledge approach enhanced skating performance significantly more than either the systematic imagery approach or traditional physical training alone. Furthermore, performance improvement of skaters in the mental training groups which, combined physical and mental training, was greater than that observed for those in the physical training control group. It should also be noted that none of the skaters in the mental treatment groups evidenced post-treatment performance decrements. In contrast, there was greater variance in the post treatment scores of the untreated control subjects, with some skaters evidencing slight

improvement and others slight performance decrements.

The differential changes in skating performance observed among the various groups in this study are considered valid for several reasons. First, the obtained differences between the mental training treatment groups and the physical training control groups substantiate those reported in the literature in support of the hypothesis that a combination of physical and mental training is better than either alone (Feltz & Landers, 1983; Suinn, 1984; Garfield, 1984); Second, the groups were comprised by initially matching subjects having similar performance on several criteria relative to skating potential, and any possible sampling artifacts were statistically removed. Third, Hawthorne effects were minimized by ensuring that the experimenter spent an equal amount of time with each skater in each group across the 20-day period. This was accomplished on each occasion by the experimenter remaining with the skater during four consecutive attempts of the skill. Finally, the possibility of sequential rating effects by the judges was controlled by counterbalancing the video presentations. A high degree of reliability was found for the ratings made by the experienced Gold test skating judges.

An additional reason for confidence in the present findings may be inferred from the differential changes in

assessed mental skills relative to the objectives of the two treatment conditions. Those in the imagery group reported greater improvement in the targeted qualities and experiences of skating imagery than did skaters in other groups; similarly more of those in the personal knowledge group evidenced qualitative changes toward more personalized representations of skating knowledge than was the case in the other groups.

As has already been stated, performance of those who received personal knowledge training was found to be superior to skaters in either the imagery or the control group. This result is consistent with the finding that task-relevant statements, which involve knowing the correct technical features involved in a skill, lead to improved performance (Rushall, 1989).

The results obtained in the present study can be explained by reference to Dual Coding Theory which hypothesizes two specialized symbolic representational systems, i.e., a verbal and a non-verbal (Paivio, 1971). The relevance of this for sport psychology is that the non verbal system of an athlete may be primed by mental imagery, whereas, the verbal system may be primed by the athlete's use of keywords and other self-commands derived from his or her store of personal knowledge. One possible reason for the superior performance of athlete's in the personal knowledge condition, over those in the

imagery training condition, could be the differential importance placed on these systems by the educational system in our society. It is obvious that the verbal system is activated more frequently in school life than is the non-verbal system. For example, the school curriculum reinforces verbal learning through classes such as english, math and science. In fact all required courses, at the high school level, involve verbal material and verbal instruction. In contrast, the low frequency optional courses such as shop, art and sewing appear to rely more on the non verbal system than on the verbal. For example, in courses such as these one must imagine what the finished product will look like from its component parts. It is obvious that required courses consume a substantially greater proportion of class time then do courses that are considered optional. Therefore, systematic training with personal knowledge may activate parts of the brain with which a person has already considerable experience. This means that a major benefit inherent in the personal knowledge approach to mental training is that it is more specific to the developed characteristics of athletes in our society.

Several additional reasons for the superior performance of those in the personal knowledge condition is that the athlete's involvement in the intervention can be more easily monitored than is the case for those in

the imagery training condition. Since much of personal knowledge is coded verbally, one can infer whether the athlete is utilizing the training successfully. For example, in asking the athlete to recite her "script" for a particular jump the coach/psychologist can provide instant feedback. If the "script" includes negatives, is too wordy, or is faulty with respect to the technical corrections needed, then modifications to the script can be made immediately. In contrast, when a coach asks an athlete to engage in imagery training, one can only assume that the athlete is performing it correctly. The athlete may not even be performing imagery at all, but just going through the physical motions.

It is not that systematic imagery training cannot be monitored, but very few athlete's, coaches, or sport psychologists have made this effort. One possible method of monitoring an athlete's imagery is by the use of self report rating scales, such as used in the present study, designed to measure perspective, kinaesthetic feeling, and control of the image. A second method of monitoring imagery is through the use of electromyography which assesses activity in various muscle groups (Hale, 1982). A third technique would be to develop the skill by walking through a sequence of moves that mimic the desired skating skill (Martin, 1989). Through the use of a stopwatch, one could determine the time difference

between the actual physical performance of the skill and the skill while being imagined. The goal is to make imagined performance time equal to real performance time of the skill.

There are at least two additional reasons for the superior performance of those in the personal knowledge condition over those in the imagery condition in this study, one relates to type of coaching feedback, and the other to the different ways in which the two conditions are monitored. Concerning coach feedback, it is still unfortunately more often the case that coaches "tell" rather than "show" . Their inputs are largely given in verbal terms rather than through more kinaesthetically relevant alternatives such as body moulding, and active motor moulding. Since the personal knowledge condition in this study involved translations of what coaches said it is no wonder that the present results were obtained. One can only speculate how much more effective the imagery condition may have been, had coaches provided more kinaesthetically relevant cues in their feedback.

It is also possible that the method by which each mental training procedure was recorded may have contributed to the results obtained. Those in the personal knowledge condition were asked to write their keywords in their Mental Training Log, whereas skaters in the imagery condition were asked to circle a number that

corresponded to their imagined perspective, feeling and control of the skill. The task required of those in the imagery condition was somewhat removed from the experience being portrayed and therefore, perhaps it was less meaningful to the skater than that which was asked of those in the personal knowledge condition. That is, you don't use numbers and rating scales when you represent your performance imagery, but you do use words and symbols derived from your personal knowledge to guide you when thinking about executing your skill.

The next part of the discussion is relevant to the study findings on mental state. To reiterate, the Mental State Questionnaire, in the present study, provides an index of mental readiness to perform. Mental states measured by this questionnaire included perceived confidence/anxiety levels, alertness/focus, and readiness to perform, "dull, lazy, not ready vs. energetic, wired, ready". Results revealed that skaters in the mental training groups reported increased confidence and more alertness and better attentional focus compared to skaters in the control condition. No difference was found across groups for the question concerning readiness to perform. This finding may in fact be viewed as evidence for discriminant validity of these rating measures for two reasons. First, neither of the experimental interventions were directed toward arousal.

Second, consider that the readiness measure was defined along a continuum of dull vs. wired". If these skaters had already discovered through experience their optimal level of arousal, then they would not want this to change. This reasoning appears plausible given that their reported readiness scores were around "7" on a ten-point scale, consistent with the traditional inverted-U hypothesis.

The beneficial consequence of anxiety reduction from mental training, has been acknowledged by many sport psychology investigators (e.g., Mahoney & Avenier, 1977; Paivio, 1985). High levels of anxiety may interfere with performance by causing attentional focus to narrow and through loss of flexibility in the muscles and joints. Anxiety reduction techniques must be incorporated into training programs so as to enable the athlete to perform at her optimal level of arousal. Paivio (1985) has stated that increased confidence levels result from the practice of success imagery. Success imagery involves imagining the attainment of goals as well as the consequences to follow (e.g., to see oneself reaching the finish line first and/or receiving the medal).

The study focused on performance imagery to improve physical skills rather than on success imagery to improve confidence. Skaters in the imagery and personal knowledge condition gained confidence in the realization

that they had better control and consistency with their selected skill.

The observed performance effects in the present study were obtained in the face of simulated competition pressures. Skaters in both mental training conditions successfully performed their assigned skating skill knowing that they were being monitored by video and that their performance would be evaluated by qualified judges. The condition was not simply the usual video practice session. Thus the present findings have particular significance since there are very few published mental training effect findings for sport performance under competitive conditions (Kendall, Hrycaiko, Martin & Kendall, 1990).

Information found in the Mental Training Log provides some understanding of the connection and developmental path between physical performance and mental training. A review of the athletes' log entries and the statistical analyses of their self-ratings for the internal, feeling experience in their imagery suggests that this intervention did affect both the personal knowledge of these athletes, as well as how they represented physical performance. As has been previously indicated, the imagery group improved not only in visual imagery, but also improved in kinaesthetic imagery. No trend towards improvement of imagery ability was apparent for those in

the personal knowledge or control groups. From this, it can be reasonably concluded that the improvements shown by the imagery group were not merely a consequence of physical training itself.

Similarly, skaters in the personal knowledge group showed significant improvement in their performance script compared to skaters in the imagery group. Scripts of those receiving imagery training were found to be more ambiguous, wordy, and at times negative with respect to content. The control group was not included in the analysis because the majority of skaters in this condition failed to complete this section at one time or another. These results were obtained despite the fact that observed feedback from the coaches were comparable for each matched pair of skaters. Each pair of skaters was taught by the same skating coach, therefore the instructional style, and characteristics of that coach, would be comparable for each skater.

Despite these, and other impressive results in support of mental training, there is still some mixed feeling about this approach among coaches (Cosgrove, 1979). There are those like Debbie Muir, Canada's highly successful National Coach of Synchronized Swimming, who firmly believes that the effectiveness of mental training for athletic performance cannot be ignored. In the video, Visualization: What You See Is

What You Get (Coaching Association of Canada, 1987), Debbie is shown instructing a swimmer to spin down into the water, "like a barber's pole," or to close her legs, "like two steel doors." Debbie is so convinced about the value of vivid imagery in her corrective feedback that she regularly records the best images in her log for future reference.

In contrast, Kerry Leitch, coach of numerous World and nationally ranked competitors, admits to being skeptical towards the beneficial role of psychology and its impact on a skater. Leitch believes that psychologists should be confined to seminars and should not be allowed in the competitive environment where the athlete has enough distractions with which to cope.

Strong inferences about the coach's role in mental training may be derived from this study. The role of the coach must be expanded to include attention to the psychological aspects of sport. The coach must recognize, accept, and prepare for his/her role in mental training. The role of the coach, to be inferred from this investigation, must include the responsibility to provide personally meaningful feedback and vivid images to help athletes internalize what is necessary for them to complete the skill consistently, correctly, and artistically. The message in the findings of this study is quite clear. If specific mental improvements are

desired, then specific consideration to mental coaching is required, just as is the case for coaching to improve specific aspects of physical performance.

From the perspective of the present study, the importance of the role of the coach in determining the success of mental training has already been discussed. However the athlete must also play a major role in his mental training. Specifically, the athlete's major challenge is to understand what he or she has to do, not just in the coaches words, but in personal terms in order to land after a jump, or to recover from a spin, etc. Athletes must be made aware of the technical corrections necessary to complete the skill successfully. Associated with this technical awareness should be a script of intentions and self-commands comprised of whatever verbal and nonverbal cues are required to facilitate performance. This is accomplished through a means of translating the technical knowledge into personal intentions necessary to guide the required actions.

The practice of self-monitoring can help athletes to take a more active role in their training. For example, Hume, Martin, Gonzalez, Cracklin & Genthon (1985) combined coaches' feedback and an athletes' self-monitoring program to determine its impact upon the frequency of desirable practice behaviours and

performance. Skaters were asked to record the frequency of jumps and spins performed, as well as the number of times they ran through their solos. Through this self-monitoring, skaters were able to take a more active role in their training. Skaters received feedback from their coach regarding the recorded frequencies. Results indicate that subjects worked harder, and the quality of their performance improved with the implementation of a self-monitoring program.

In the present study, the athletes mental training was self-monitored through entries in their Mental Training Logs. The experimenter gave feedback to the skaters with respect to the number and quality of entries. An argument could be made that the more active an athlete becomes in the individual training, the more attention will be given to instructional cues by the coach or psychologist. Perhaps athletes deserve to be more than just passive recipients of feedback. In a sport such as figure skating, where the athlete is not under constant supervision of a coach for the majority of their practice time, a simple self-monitoring program such as the one that is described may be what the skater needs to remain motivated and focused.

The finding that imagery training in combination with physical training did not enhance performance to the same extent as the combination of personal knowledge and

physical training has already been discussed at length. However, the purpose of the present study is not to denigrate mental imagery training, nor is it the purpose to aggrandize training in personal knowledge. Systematic imagery training is a viable, beneficial mental training technique. The self-report of elite athletes, in addition to empirical research reports, have demonstrated quite conclusively that physical performance can be enhanced through imagery training. However, the results of the present study suggest that imagery training may not be the best option in all circumstances. The athlete who is inexperienced with any form of mental training, such as those selected to participate in the present study, will profit more through personal knowledge training. As has previously been stated, coaches more often use verbal feedback (i.e., words only) than other less efficient channels, and verbal learning is more predominant within the educational system than is psychomotor learning. It follows that the method of choice for the athlete unfamiliar with mental training techniques should be one in which the verbal system is emphasized (i.e., personal knowledge). However, when the athlete has become experienced and has gained the capacity to connect words with actions through personal knowledge training then additional mental training techniques such as systematic imagery can be incorporated

into her training schedule. Coaches input that would facilitate the development of imagery would include not only verbal feedback, but actual modelling by the coach and hands on body moulding. It has already been shown that performance enhancement can be found when mental training consists of both systematic imagery and personal knowledge in conjunction with physical training (Mack, 1990). Through combining both mental imagery and personal knowledge both the verbal and non verbal systems are being incorporated into the training and the benefits that can be derived from each will be maximized.

Three problems for future research develop directly from this study. The first is to replicate the present design with procedural improvements to ensure that the log participation of those in the imagery condition will parallel that of subjects in the personal knowledge condition in terms of more faithfully sampling the experience of imagery. A second study, again involving a replication, would address the issue of differential readiness for personal knowledge and imagery training at various levels of cognitive/motor development, including pre-novice, novice, junior and senior skaters. Finally, a third replication is in order to examine the role of motivation which may have played a part in the findings of the present study. Specifically, some small part of the experimental vs. control differences may have

resulted from the experimental subjects being motivated by their log involvement. Thus a replication study is warranted which would control for this by providing control subjects with a log participation situation similar to that reported by Hume et al. (1985).

Evidence from the present study indicates that the sport psychologist must carefully decide which mental training approach is most suitable to the athlete in question. It is not acceptable to implement one training package just because it has received the most exposure within the literature, or has traditionally been the technique of choice. First, it is necessary to examine the requirements of the athlete's particular sport. For example, while the personal knowledge approach was found to be more beneficial than imagery for the young figure skaters in this study, the question remains whether these results would apply to team sports in which the result of the athlete's performance is not solely dependent upon her own actions. Perhaps athletes in team sports would benefit more from a type of mental imagery in which the various counter-moves of opponents could be represented.

In addition, the psychologist must consider other characteristics of the athlete including age and experience with mental training prior to deciding which training technique would be most beneficial. For the

athlete with little or no experience with formal mental training it would be most beneficial to adopt a learning format with which the athlete is familiar. In our culture, school-age athletes are more familiar with verbal instruction; therefore, mental training according to the personalized knowledge approach may be of greater benefit and perhaps easier for them to incorporate into their training program than would be mental training involving imagery which seems removed from the more traditional verbal channel.

Conclusion

The outcome of this study demonstrates that systematic mental training programs in conjunction with physical practice can improve both motor performance and the quality of mental skills in young female figure skaters. Personal knowledge was found to be superior to both imagery training and physical practice alone. It was hypothesized that this result was obtained because personal knowledge is more consistent with common methods of instruction that is imagery. The importance of the mutual involvement of the coach and athlete to mental training is essential for maximum performance gains.

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Footnotes

¹

A Gold test judge is qualified to judge at the highest possible test level. This does not necessarily mean that he/she are qualified to judge at the highest competitive level, although this is usually the case.

Appendix A

Figure Skating Questionnaire

Name:

Date of Birth:

When did you begin figure skating?

Who is your figure skating coach?

Test passed: Figure:
 Freestyle:
 Dance:

OFF-ICE

(A) PHYSICAL PREPARATION

Aerobic training (e.g., running, Yes____ No____
biking, etc.)

Strength training (e.g., weights) Yes____ No____

Flexibility training (e.g., Yes____ No____
stretching, complete warmup)

Expressiveness training (e.g., Yes____ No____
ballet, dance, etc.)

(B) MENTAL PREPARATION

Do you and your coach discuss training and competitive goal setting? Yes _____ No _____

Do you ever imagine yourself winning a medal? Yes _____ No _____

Do you ever imagine yourself doing some figure skating move/ jump/spin/sequence? Yes _____ No _____

Do you talk to yourself and use a series of keywords to guide your performance? Yes _____ No _____

Do you practice getting yourself in the right feeling to perform? (e.g., cooling out or pumping up) Yes _____ No _____

Do you practice getting yourself alert and well-focused? (e.g., practice thinking about what you are going to do and avoiding distractions) Yes _____ No _____

Do you plan some training sessions to be like a competition? Yes _____ No _____

Do you try to learn from your mistakes and successes by careful discussion of video or coach feedback? Yes _____ No _____

Do you keep a training log or diary? Yes _____ No _____

COMPETITIVE EXPERIENCE

Describe your competitive experience by checking:

- (1) Non-competitive skater: _____
- (2) Club competition: _____
- (3) Interclub competition: _____
- (4) Sectional competition: _____

Personal performance skating goals for this season:

Personal competitive goals for this season:

What are your daily training goals? (e.g., to be alert)

CURRENT STATUS

What two skating jumps/spins are you currently working on right now?

(1) _____

(2) _____

(A) IMAGERY QUESTIONS

What is it like when you imagine yourself doing one of the skating moves that you are currently working on? When you are doing the _____ (name the move)

Can you feel the movements as though you are actually doing them?

I don't feel anything in my body

I feel it in my body like it is

0 1 2 3 4 5 6 7 8 9 10

Do you have an inside view (seeing things as they are when you are skating) in contrast to seeing yourself on video from the outside?

Not like it really is when I skate

I see it like it really is

0 1 2 3 4 5 6 7 8 9 10

Can you control your imagery so that you can imagine yourself doing it perfectly?

I can't create a perfectly clear image

Consistent clear image

0 1 2 3 4 5 6 7 8 9 10

(B)SCRIPT QUESTIONS

Whether or not you have ever practised using keywords to aid your performance, try to imagine yourself doing the _____ (name the move) that you are working on now. Take a minute to get yourself well-focused. You might want to walk yourself through the move first.

For the move you are currently working on, my "script" or what I could try to say to myself is as
f o l l o w s :

In your on-ice practising, what element, or part of the skating move is giving you the most trouble? Why do you think your not getting it every time?

Entry: _____

Inflight: _____

Landing: _____

Figure Skating Questionnaire 2

IMAGERY QUESTIONS

What is it like when you imagine yourself doing one of the skating moves that you are currently working on?

When you are doing the _____ (name the move)

Can you feel the movements as though you are actually doing the

I don't feel
anything in
my body

I feel it
in my body
like it is

0 1 2 3 4 5 6 7 8 9 10

Do you have an inside view (seeing things as they are when you are skating) in contrast to seeing yourself on video from the outside?

Not like it
really is when
I skate

I see it
like it
really is

0 1 2 3 4 5 6 7 8 9 10

Can you control your imagery so that you can imagine yourself doing it perfectly?

I can't create
a perfectly
clear image

Consistent
clear
image

0 1 2 3 4 5 6 7 8 9 10

SCRIPT QUESTIONS

Whether or not you have ever practised using keywords to aid your performance, try to imagine yourself doing the _____ (name the move) that you are working on now. Take a minute to get yourself focused. You might want to walk through the move first.

For the move you are currently working on, my "script", or what I could try to say to myself is as follows: _____

In your on-ice practising, what element, or part of the skating move is giving you the most trouble? Why do you think you are not getting it every time?

Entry: _____

Inflight: _____

Landing: _____

Appendix B

Mental Training Log A

Obviously, now that you have seen the video you know that you are in the mental imagery group. The test given to you a few days ago showed that you all have done mental imagery before, and some of you seem to be quite good at it. In the next few weeks we want to help you to develop really good imagery skills. That is because, like Brian Orser, we believe that it is very, very important. We can help you to become a much better skater through better imagery. Read below what Brian has said:

" It was through actually feeling it in my mind that I started to make all my jumps consistent... I can remember one specific jump, the triple toe loop. I was thinking about it in bed and when I went to the rink the next day I was thinking about the feeling, and all of a sudden I landed the first one. The night before I had the feeling of it. I couldn't wait to get to the rink the next day so I could try it, to see if it would work. There was a certain feel I was thinking of, and I said, I will try that tomorrow, and it worked... My imagery is not so much visual. It is more just feel, I don't think it is visual at all. When I'm watching it on video, I look visually at it and then I get this internal feeling. When I'm actually doing it I get this feeling that is hard to

explain. You have to experience it, and once you do, then you know what you are going after." (Orlick & Partington; excerpt from *Psyched: Inner Views of Winning*, pp.142-143)

It is clear from the above that the key to make imagery effective for improving performance is to be able to imagine feeling your skating movements as vividly as possible, just like when you are skating. This skill takes lots and lots of practice and concentration. Do one little practice right now. Stand up, get relaxed...now do a spiral and hold for about five seconds... You probably felt the following:

- a shift in your centre of balance
- a tightening in your neck, bum, and toes
- your arms and legs stiffening

Okay. Now stand up again, and imagine doing a spiral. You can keep your eyes open or closed. The important thing is to imagine feeling exactly how you just felt when you actual'y performed the spiral.

This simple exercise is like what you will have to do for each of the movements in your assigned elements. Try to become very aware of your body when you are skating, and then practice, practice, practice to imagine feeling those movements in your imagery.

This log will help you to keep a record of your progress. Below is an example of how a fictional subject

rated her imagery on a scale of 1 to 10 (with a 10 being a perfect score).

(1) Build up to jump

Can you mentally
feel the movements? 7

Can you mentally "see"
exactly what you see
when you are skating? 6

Can you control
your imagery of
this part of the
movement so that
you can imagine
yourself doing it
perfectly? 5

Mental Training Log A

Please rate the following questions on a scale of 1 to 10 with 10 being a perfect score.

0 1 2 3 4 5 6 7 8 9 10

(1) Build up to jump

(2) Entry to jump

Can you mentally feel the movements? _____

Can you mentally feel the movements? _____

Can you mentally "see" exactly what you see when you are skating? _____

Can you mentally "see" exactly what you see when you are skating? _____

Can you control your imagery of this part of the movement so that you can imagine yourself doing it perfectly? _____

Can you control your imagery of this part of the movement so that you can imagine yourself doing it perfectly? _____

(3) Takeoff

(4) Preparation to land

Can you mentally feel the movements? _____

Can you mentally feel the movements? _____

Can you mentally "see" exactly what you see when you are skating? _____

Can you mentally "see" exactly what you see when you are skating? _____

Can you control your imagery of this part of the movement so that you can imagine yourself doing it perfectly? _____

Can you control your imagery of this part of the movement so that you can imagine yourself doing it perfectly? _____

(5) Landing

(6) Exit from jump

Can you mentally feel the movements? _____

Can you mentally feel the movements? _____

Can you mentally "see" exactly what you see when you are skating? _____

Can you mentally "see" exactly what you see when you are skating? _____

Can you control your imagery of this part of the movement so that you can imagine yourself doing it perfectly? _____

Can you control your imagery of this part of the movement so that you can imagine yourself doing it perfectly? _____

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Appendix C

Mental Training Log B

Obviously, now that you have seen the video you know that you are in the mental script group. The test given to you a few days ago showed that you all have some ability to write a script of your performance, and some of you seem to be quite good at it. In the next few weeks we want to help you to develop a really good personal understanding of what cues to use in your script. That is because, we believe that a personal script is very important to guide your performance. We can help you to become a much better skater through developing a better performance script. Mental scripts have been used by many Olympic gold medallists, as seen from the following quotations:

Sylvie Bernier - 1984 Olympic Gold Medal - Diving

"My coach wrote up every single one of my dives, all the bad things about my dives and all the good things. I read his corrections everyday, before every workout. I set a goal to change something on that piece of paper everyday."

Kelly Kryczka - 1984 Olympic Gold - Synchronized Swimming

"Sharon & I wrote out our own script using very descriptive words...I can picture almost anything, but to sit down and write it makes you think more. You just feel much more prepared."

Linda Thom - 1984 Olympic Gold - Sport Pistol Shooting

"I mentally go through my shot-plan checklist before I shoot. This strategy started out very mechanically with a checklist of words which I read exactly. These words represented every single step involved in shooting. I reduced these keywords so that I could go through the list faster. Finally, I would usually write one word to emphasize what I wanted, such as "*trigger*" or "*smooth*."

In order to be an effective script writer it is necessary for you to be able to break down a single element into its component parts. For example, a jump can be broken down into the entry, inflight, landing, etc. Every element can be broken down this way. Do one little practice right now. Stand up, get relaxed...now do a spiral and hold for about five seconds... You probably felt the following:

- a shift in your centre of balance
- a tightening in your neck, bum, and toes
- your arms and legs stiffening

Okay. Now what do you have to think about when performing a spiral? It is important for you to HOLD your position steady, for you to TIGHTEN your arm and leg muscles, and for you to enter and exit the spiral SMOOTHLY. The above capitalized words are cues or reminders which could be written or even drawn into a script. It is important to remember that the keywords

YOU choose to be positive and remind you of the way you want to feel in order to perform the element properly. Each reminder in your script should come from how you feel when skating well, and also from your coaches feedback. For best results, you should choose the actual keywords, phrases, symbols, or drawings to use in your script.

The simple spiral exercise is an example of what you should do for each of your assigned elements. Try to become very aware of your body when you are skating. This will help you to describe how you want to cue each key movement when you prepare your script. After you develop a preliminary script, look at it before skating, and try to say your keywords to yourself while practising your specified element.

This log will help you to keep a record of your own personal understanding about how to skate the element perfectly. No doubt you will find yourself modifying your script as your ability and consistency improves.

Mental Training Log B

Build up to jump

Entry to jump

Inflight

Preparation to land

Landing

Flow from jump

Appendix D

Mental State Questionnaire

What did you just do in your warm up?

Physical warm up (e.g., stretching, stroking, etc.)

Mental warm up (e.g., what were you thinking about)

On the following scales circle a number to show me exactly how you are just before your video trial.

Distracted, mind
wandering

Alert and well
focused

0 1 2 3 4 5 6 7 8 9 10

Dull, lazy, not
ready to perform

Energetic, wired
ready to perform

0 1 2 3 4 5 6 7 8 9 10

Appendix E

Judges Scoring Sheet

Build up to jump

Entry

Inflight

Preparation to land

Landing

Flow/positioning
out of jump

Table 1

Matching of Subjects

Group	Age	Years Exper.	Same Coach	Figure Passed	Free Passed	Compet Exper.
Imagery	12	7	Yes	2	J. Bron.	Sect.
P. K.	11	6	Yes	2	J. Bron.	Sect.
Imagery	15	10	Yes	6	Gold	Sect.
P. K.	16	9	Yes	5	Gold	Sect.
Imagery	15	8	Yes	4	S. Sil.	Sect.
P. K.	16	9	Yes	6	S. Sil.	Sect.
Imagery	14	7	Yes	4	J. Sil.	Sect.
P. K.	14	7	Yes	4	J. Sil.	Sect.
Imagery	14	7	Yes	4	J. Sil.	Sect.
P. K.	13	7	Yes	3	J. Sil.	Sect.
Imagery	14	8	Yes	5	J. Sil.	Sect.
P. K.	15	8	Yes	5	S. Bron.	Sect.
Imagery	11	6	Yes	2	S. Bron.	Sect.
P. K.	12	6	Yes	3	S. Bron.	Sect.
Imagery	11	6	Yes	3	S. Bron.	Sect.
P. K.	12	6	Yes	2	S. Bron.	Sect.
Imagery	11	5	Yes	1	J. Bron.	Sect.
P. K.	11	5	Yes	1	J. Bron.	Sect.
Imagery	12	8	Yes	2	J. Bron.	Sect.
P. K.	12	8	Yes	2	S. Bron.	Sect.
Imagery	15	8	Yes	3	S. Bron.	Sect.
P. K.	14	8	Yes	2	S. Bron.	Sect.
Imagery	16	7	Yes	5	S. Sil.	Sect.
P. K.	16	8	Yes	5	S. Sil.	Sect.
Imagery	15	8	Yes	6	Gold	Sect.
P. K.	16	7	Yes	6	Gold	Sect.
Imagery	14	6	Yes	5	S. Sil.	Sect.
P. K.	14	7	Yes	5	S. Sil.	Sect.
Imagery	13	6	Yes	4	J. Sil.	Sect.
P. K.	13	6	Yes	3	J. Sil.	Sect.

Table 2

Judgement of Pre-Treatment Performance

Source	X	SD	F
Imagery Group	6.9	2.4	
Personal Knowledge	6.7	2.6	.38 ns.
Control	6.7	2.9	
F(2,36)			

Table 3

Judgement of Post-Treatment Performance

Source	X	SD	F
Imagery Group	7.3	3.2	
Personal Knowledge	7.7	3.4	4.88*
Control	6.8	2.8	
F(2,36)			
*p<.05			

Table 4

Pre-Treatment Imagery Skill

Source	X	SD	F
Imagery Group	6.3	4.4	
Personal Knowledge	6.1	3.6	1.39 ns.
Control	6.0	4.2	
F(2,36)			

Table 5

Post-Treatment Imagery Skill

Source	X	SD	F
Imagery Group	8.1	2.7	
Personal Knowledge	6.9	3.1	6.80*
Control	5.9	4.3	
F(2,36)			
*p<.05			

Table 6

Judgements of Personal Knowledge

Group	Better	Same
Personal Knowledge	14	1
Imagery	8	7

$X(1) = 21.4^{**}$

$^{**} P < .01$

Table 7

Pre-Intervention Mental State

Alert/Well-Focused

Source	X	SD	F
Imagery Group	6.3	1.9	
Personal Knowledge	6.5	2.0	.81 ns.
Control	6.6	1.9	
F(2,36)			

Energized/Ready to Perform

Source	X	SD	F
Imagery Group	7.0	1.3	
Personal Knowledge	6.8	1.6	.62 ns.
Control	7.0	1.3	
F(2,32)			

Confidence

Source	X	SD	F
Imagery Group	7.4	1.9	
Personal Knowledge	7.5	1.5	1.02 ns.
Control	7.1	1.6	
F(2,36)			

Table 8

Post-Intervention Mental State

Alert/Well-Focused

Source	X	SD	F
Imagery Group	7.5	2.2	
Personal Knowledge	7.6	2.0	4.12*
Control	6.8	2.1	

F(2,36)

*p<.05

Confidence

Source	X	SD	F
Imagery Group	8.1	1.7	
Personal Knowledge	8.3	1.6	4.71*
Control	6.4	1.9	

F(2,36)

*p<.05

END

27 05 93

FIN