2005

The effect of different imagery ratios on learning and performing a gymnastic floor routine

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THE EFFECT OF DIFFERENT IMAGERY RATIOS ON LEARNING AND PERFORMING A GYMNASTIC FLOOR ROUTINE

by

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Thesis

Submitted to the Department of Health Promotion and Human Performance

Eastern Michigan University

in partial fulfillment of the requirements for the degree of

MASTER OF SCIENCE

in

Physical Education with a concentration in Pedagogy

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May 26, 2005

ABSTRACT

The purpose of this study was to observe the effect of different imagery ratios to physical practice needed to learn and perform a gymnastic floor routine. It was assumed that an increase in imagery ability would reflect positively on the floor routine performance. Twenty-seven school-aged, male and female, skilled gymnasts participated in the study. They were randomly separated into four experimental groups: two groups received three imagery sessions per week and two groups received one imagery session per week. The only delimitation was the use of proficiency levels, the imagery ability levels, and gender to ensure the homogeneity of the four experimental groups.

After five-week imagery training for motor skill learning and performance, the overall imagery ability increased significantly. There were no significant differences in imagery ability with regard to the gender, proficiency level, and practice conditions. There was no significant difference in performance outcomes. Several possible barriers preventing the imagery ability increase from being translated into performance increase included a possible ceiling effect in performance, a short treatment period, and the subjective human factor occurring in scoring the gymnastics routines.

Dedication

I dedicate this to Ioana, who nourished my hopes and alleviated my anguishes over the past years.

Acknowledgements

This work came to an end only with the contribution of the following people:

Dr. Murali Nair, my graduate advisor: thank you for the countless hours spent with me.

I am indebted to Dr. Ian R. Haslam, Dr. Brenda A. Riemer, and Dr. Craig R. Hall (University of Western Ontario) who brought their expertise to this work.

Diane Haslam, you are my role model. God bless you.

My colleagues Michael Eccleston and Jaamal Perkins.

The Michigan Academy of Gymnastics head coach Douglas Rowe: I've learned a lot by merely watching you at work.

The wonderful coaches from the Michigan Academy of Gymnastics: Camelia Gotcheva, Carrie Thompson, Dian Kolev, Jeff Coulter, and Florin Vescan.

The young gymnasts who donated their time and spirit throughout the study: Niki, Jessy, Sarah, Sara, Autumn, Sharon, Katy, Sara, Sammy, Robin, Sammy Joe, Cassidy, Shannon, Cathy, Alex, John F, Dan, Andrew, Nick, Michael, John S, Chad, Colin, Matt, Brandon, Bryton, Jasper, and Richard: good luck to you all.

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Chapter 1

Introduction

The study of imagery and its effects on skill learning has been of interest since the beginning of the last century (Jacobson, 1930; Sacket, 1934). In the last 10-15 years, imagery related studies answered many questions; however, an equal number of questions still await definitive answers. The bulk of research in the realm of imagery for learning and performance of motor skills has produced inconsistent findings. This is the partial result of the multitude of variables involved: tasks, participants, statistics, and so on. The lack of sufficient data necessary to replicate the experiments was another major cause for inconsistencies as highlighted by Murphy (1990). In the same line only a small number of studies used postexperimental questionnaires in order to differentiate between participants who fail to comply with the experimental procedures. Over the years, several attempts were made to highlight the similarities and discrepancies between the numerous studies dealing with imagery (Driskell, Cooper & Moran 1994; Feltz & Landers 1983).

A terminology clarification must be made regarding mental preparation and mental practice. Mental preparation encompasses a variety of techniques such as relaxation, self-talk, positive imagery, and emotional preparation before performance. This is a broad term covering a variety of procedures with the purposes of enhancing performance. In contrast, mental practice refers only to “the cognitive rehearsal of a physical skill in the absence of overt physical movement; it can take the form of thinking about the cognitive or procedural aspects of a motor skill, or of engaging in visual or kinesthetic imagery of the performance of a skill or part of a skill" (Magill, 2004, p. 349). For the present study, the definition of imagery chosen was the one that closely reflects the purpose of the study: "Imagery is an experience that mimics the real experience. We can be aware of 'seeing' an image, feeling movements as an image, or experience an image of smell, tastes, or sounds without actually experiencing the real thing...It differs from dreams in that we are awake and conscious when forming an image" (White & Hardy, 1998, p. 389).

The framework proposed by Martin, Moritz, and Hall (1999) will be used as a basis for the study (Figure 1). As highlighted in the model, for this study imagery was used during practice and competition, employing cognitive specific and cognitive general types of imagery, with the purpose of skill and strategy learning.

Several theories were advanced in an attempt to explain how imagery actually works. "Not one of them is comprehensive enough to embody all the functions of imagery" (Hall, 2001). Psychoneuromuscular theory represents the first theory proposed. It is stated that during physical activities the central nervous system (CNS) constantly transmits nervous impulses to the skeletal muscles in order to generate movement.

The *psychoneuromuscular theory* postulates that similar nervous impulses are transmitted to the muscle during imagery processes as well. The nervous impulses are similar (same firing pattern) as in the real movements, but the intensity and frequency of those impulses are lower. Therefore no actual movements will occur. Practicing imagery will strengthen the muscle firing pattern in the absence of overt activity.

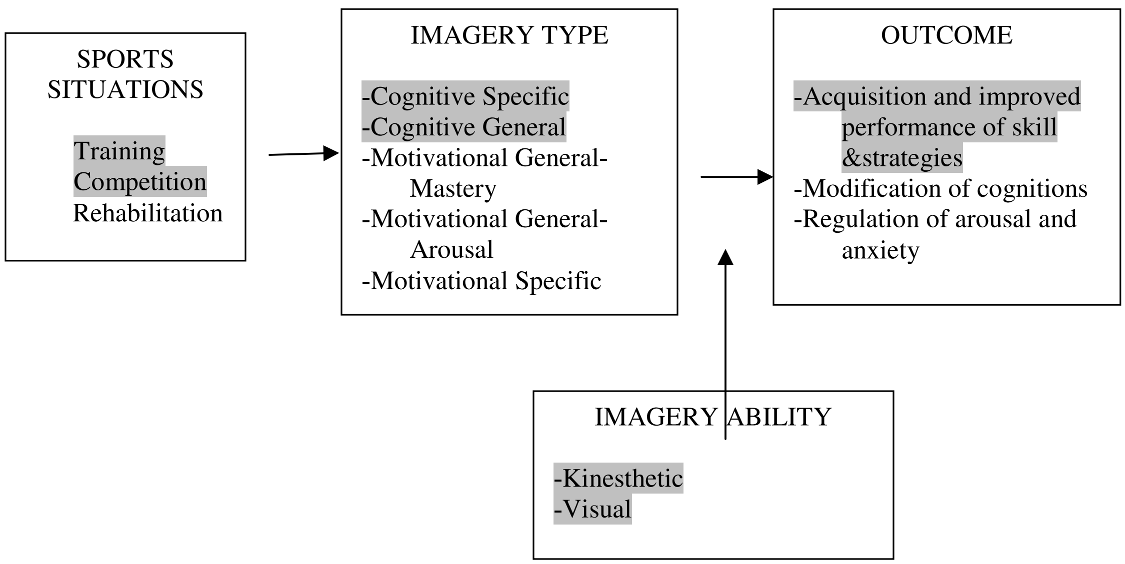

Figure 1. An applied model of imagery use in sport (Martin, Moritz and Hall, 1999).

From “Imagery use in sport: A literature review and applied model” by Martin, K.A., Moritz, S.E, and Hall, C.R., 1999, *The Sport Psychologist,* 13, p. 24

The second theory proposed is the symbolic learning theory. Before an actual performance there must exist a plan for the movement. This plan is encoded in the CNS and contains symbolic elements like temporal and spatial elements, sequencing of movement, decision making, and so on. The *symbolic learning theory* stipulates that imagery works at the cognitive level, permitting the athletes to mentally rehearse the symbolic elements of a task in their attempt to make the "mental blueprint" more automatic and the actual performance of the task more fluent. Another theory is the *bioinformational theory*. The assumption here is that mental image is an organized group of characteristics of the task to be performed. Those characteristics (propositions) can be separated into stimulus characteristics and response characteristics. The stimulus propositions are those describing the imagined scenario of the task (combination of information regarding external and internal environment). The response propositions will describe the specific response to the imagined scenario (the successful execution of the task). An effective imagery program must contain both of the propositions. By frequently accessing the response propositions for a particular scenario and modifying them in order to fit the best response possible, the actual performance will be enhanced. Taking this theory one step further, the *triple-code theory* suggests that there are three components of imagery: the image itself, the somatic response to that image, and the meaning of the image to a particular person. The first two components are similar to the bioinformational theory above, but the meaning of the image changes the entire scheme. That is, different people will have a different response to the same scenario (stimulus proposition) because of a different interpretation of the image based on their prior experience and personality. All in one, the neural mechanism seems too simplistic to cover the entire imagery process. The implications of cognitive processes are also present in this process, and, in addition to this, the personal subjective factor must be considered as well (Vealey & Greenleaf 2001; Cornelius, 2002; Weinberg & Gould, 2003).

Imagery can be used for various purposes. Paivio (1985) proposed a framework of how imagery effects can be classified. Imagery encompasses both motivational and cognitive roles; each of the roles acts at either a general or specific level (Fig. 2). Thus there are four imagery functions, each of them producing different effects on performance. At the cognitive specific level, imagery deals with rehearsal of skills, and at the cognitive general level, imagery deals with strategies of play or entire routine rehearsals. At the motivational specific level, imagery is goal-oriented, as opposed to the motivational general level where imagery involves arousal and emotional effects (Paivio).

Imagery Function

	Motivational	Cognitive
General	Arousal & Affect	Strategies
Specific	Goal-oriented Responses	Skills

Figure 2 Imagery Function Framework

From “Cognitive and Motivational Functions of Imagery in Human performance” by Paivio, A., 1985, *Canadian Journal of Applied Sport Science,* 10:4, p. 23S

This framework was revisited later (Hall, Mack, Paivio & Hausenblas, 1998) and another dimension was added. At the motivational general level, two specific components were isolated. The first one is the motivational general-arousal imagery, and it is associated with arousal and stress manipulations. The second component, motivational general-mastery, encompasses imagery for effective coping and mastery of challenging situations.

Several factors exert influences on imagery: imagery ability, nature of the task, the skill level of the performer, gender, and finally the combination of imagery with physical practice. The imagery ability is described in terms of vividness, controllability, correctness, imagery perspective, and use of kinesthetic sense. It is impossible to control all variables identified so far in the research literature to influence imagery, especially if an applied setting is considered. One variable that has been researched is the effectiveness of imagery combined with physical practice. Researchers also agree that only a covert rehearsal of a motor task will bring fewer improvements on skill performance in absence of the overt physical practice of the task (Hird, Landers, Thomas, & Horan, 1991). In other words, both imagery and actual practice are required for best results in skill learning and performance. Therefore, the ratio of imagery to actual practice of a skill or routine plus the duration and order of imagery sessions are responsible for producing the best results.

There are two different approaches regarding the combination of imagery with physical practice. One regards the duration of imagery sessions and also the order of presentation (imagery before or after the physical practice). The research literature supports the idea that longer imagery sessions do not guarantee better skill proficiency. It was found that imagery used before the actual rehearsal of the motor skill is better than no imagery or imagery used after the overt rehearsal of the motor skill. Also, imagery bouts of 1 or 3 minutes before the actual practice were proved to increase the skill proficiency as compared to 5 or 7 minutes imagery sessions (Etnier & Landers, 1996). These findings support the studies cited in Feltz & Landers' (1983) review of literature. As a general finding, they found that either 1 minute or between 15 to 25 minutes of imagery produced the best results in learning and performing motor skills. In the same line, another recent meta-analysis regarding imagery found that approximately 20 min. total duration may be the optimal duration of imagery intervention (Driskell, J. E. et al., 1994). The second approach considers ratios of imagery to physical practice by substituting actual physical practice with imagery out of a 100% learning and performance given time. It was found that a 25:75 ratio of imagery to physical practice was beneficial to motor skill learning and performance (Feltz, Landers, & Becker, 1988). Furthermore, similar findings as 25:75 or 50:50 ratio of imagery to physical practice were found beneficial for cognitive task, whereas a 50:50 or a 100% physical practice schedule alone was beneficial for motor tasks (Hird, Landers, Thomas, & Horan, 1991).

Problem Statement

The aim of this study was to observe how imagery for enhancing learning and performance of motor tasks could be used in applied settings for young athletes. If mental practice is a significant factor that contributes to learning and performance of motor tasks, these guidelines can be employed not only by high performance athletes but also by school sports teams and equally during the regular physical education classes.

Purpose

The purpose of this study was to observe the effect of different imagery ratios to physical practice needed to learn and perform a gymnastic floor routine.

Significance of the Study

Many research papers are focused on using lab conditions to generalize the imagery effect on performance. However, it will be interesting to observe the results of imagery use in the motor skill learning and performance process in an applied setting. Thus this study was done in an applied setting.

Many studies have used convenience samples consisting of college students (Hird et al., 1991; White & Hardy, 1995) or top athletes (Hardy & Callow, 1999). Younger athletes at different proficiency levels could benefit as well by using imagery for skill acquisition and performance during the regular practice sessions in the gymnasium. This study will provide valuable information regarding the use of imagery for younger athletes in applied settings.

Finally, the research done in lab settings usually covers a short period of time. The present study will be carried out over a five-week period. This enables the participants to develop their imagery skills, which would help in future performances. This study will consider important factors influencing imagery, otherwise impossible to be considered during laboratory settings experiments.

Hypothesis

It was hypothesized that:

1. There will be no significant differences in imagery ability from the pretest to the posttest.
2. There will be no significant differences in imagery ability between different imagery ratio groups at the posttest.
3. There will be no significant differences in imagery ability between the two proficiency levels at the posttest.
4. There will be no significant differences in imagery ability between genders at the posttest.
5. There will be no significant differences in performance from the pretest to the posttest.
6. There will be no significant differences in performance between different imagery ratio

groups at the posttest.

7. There will be no significant differences in performance between the two proficiency levels at the posttest.
8. There will be no significant differences in performance between genders at the posttest.

Operational Definitions

"Imagery ability is an individual-difference characteristic that differentiates people who can imagine an action with a high degree of vividness and control from people who have difficulty imaging an action" (Magill 2004, p. 356).

"External imagery is a form of mental practice in which a person imagines viewing himself or herself performing a skill from the perspective of an observer" (Magill 2001, p. 321).

Chapter 2

Literature Review

The purpose of this study was to examine the relative effects of different ratios of mental imagery to physical practice on the learning and performing a gymnastic floor routine.

Theoretical Bases of Imagery

There are many theories that support the idea of imagery benefiting motor performance. Despite that, there is no such theory "comprehensive enough to embody all the functions of imagery" (Hall, C. R., 2001). Some of the theories related to the purpose of this study are briefly described as follows:

The Psychoneuromuscular Theory

Imagery facilitates the learning and performance of motor skills because it results in neuromuscular activity patterns. That is, during imagery, the muscles are innervating somewhat like when physically practicing the movements. During the imagined movements, the low-level of muscle innervation won't produce any physical movement. The muscles will fire in the correct sequence and thus the "muscles memory" could be strengthened by performing imagery training, despite no actual movement will occur (Vealey & Greenleaf, 2001). The first researcher to support this theory was Edmund Jacobson in the first third of the twentieth century. He demonstrated EMG activity in the biceps brachii muscle when participants only imagined bending the arm to lift a 10 lbs weight (Jacobson, 1932).

Symbolic Learning Theory

Before an actual performance, there must exist a plan for the movement. This plan is encoded in the Central Nervous System and contains symbolic elements like temporal and spatial elements, sequencing of movement, decision making, and so on. It is stipulated that imagery works at the cognitive level, permitting the athletes to mentally rehearse the symbolic elements of a task in their attempt to make the "mental blueprint" more automatic to target and, therefore, the actual performance of the task more fluent (Vealey & Greenleaf, 2001, chap. 16). This theory was first proposed by Robert S. Sacket (1934). In his doctoral dissertation, the author revealed the fact that mentally preparing (thinking through) a movement involving a high degree of symbolic control (i.e. a maze habit) will benefit learning.

Another early researcher supporting this theory was Horace M. Perry (1939) during his research for his doctoral dissertation. The purpose of his study was to determine the relative learning efficiency of actual and imaginary practice. The following tasks were used: a three-hole taping test, card sorting, a pegboard, the symbol digit substitution apparatus, and a mirror tracer board. The general conclusion was that imagery was more effective for learning tasks with a higher degree of cognitive involvement and less effective for those with a greater degree of motor involvement. That is, the peg board, symbol digit substitution, and card sorting tasks benefited more from imagery than mirror tracing and tapping tasks (Perry, 1939).

Bioinformational Theory

This theory was proposed by Lang (1979), and his assumption was that a mental image is an organized group of characteristics of the task to be performed. Those characteristics (propositions) can be separated into stimulus characteristics and response characteristics. The stimulus propositions are those describing the imagined scenario of the task (combination of information regarding external and internal environment). The response propositions will describe the specific response to the imagined scenario (the successful execution of the task). An effective imagery program must contain both of the propositions, because by frequently accessing the response proposition for a particular scenario and modifying them in order to fit the best response possible, the actual performance will be enhanced. In other words, response propositions must be activated during the imagery processes in order to be modified and improved. Once the response propositions can be controlled, so is the overt execution of a skill (Weinberg & Gould, 2003, chap. 13).

Triple Code Theory (ISM)

Taking the former theory one step further, the triple-code theory suggests that there are three components of imagery: the image itself, the somatic response to that image, and the meaning of the image to a particular person. The first two components are similar to the bioinformational theory, but the meaning of the image is added to the scheme. That means that different persons will have a different response to the same scenario (stimulus proposition) because of a different interpretation of the image based on their experience and personality. The initiator of this theory was Ahsen (1984). He proposed that "the idea in the context of the real universe works imagistically and somatically, and the activated connections it generates in the process establish its meanings" (Ahsen, p. 34). The three fundamental parts of imagery are the image itself, the somatic response to that image, and the meaning of the image to a particular person. The image can be defined as a "centrally aroused sensation" representing the real world with sensory realism, and at the same time it represents its own reality. One can represent and reconstruct the world through it. The second part is the somatic response. Seeing an image will automatically generate neurophysiological responses, and those responses can be further modified by manipulating the image (involving more sensory information to it). The third part consists of the meaning of the image. The significance represents the "stage of involvement" with the object, so each person will bring his experiences and personality input into the imagery process. This means that same instruction regarding imagery will generate various responses from different participants.

Mental and Physical Practice

There is abundant literature regarding the use of combined imagery and physical practice on learning and performing motor skills. Overall findings support the idea that imagery is a useful tool for learning and performance of motor skills when it is combined with actual physical practice. Several authors have employed a meta-analytical approach to statistically compare the result of numerous independent studies.

Feltz and Landers (1983) reviewed more than 100 studies on imagery and its effect on motor skill learning. They used a meta-analytical approach and incorporated only studies containing a group that received only mental practice (pre and post) and compared them to a control group that had no practice. Sixty studies that matched the criterion were selected and used. The results indicated greater benefits for cognitive tasks than motor tasks or strength tasks. Also the length of imagery sessions between 1 and 25 minutes produced the largest effects. In addition the most benefits were obtained by using either 6 or fewer trials or between 36 and 42 trials. The results are favorable to experienced rather than novice athletes. Cognitive tasks were associated with few trials and motor and strength tasks required more trials to achieve largest effect sizes.

Several years later Feltz and colleagues (Feltz, Landers, & Becker 1988) considered a reanalysis of imagery effects on motor skill learning and performance. The researchers incorporated studies that examined the combined treatment of imagery and physical practice as well; they used updated statistical analysis; and they broadened the scope by incorporating and measuring separately the effects of imagery groups, combined imagery and physical practice groups, control groups, and physical groups alone. Based on 55 studies, the overall results indicated that imagery does facilitate performance. It was found that learning was twice as great for the groups that used imagery than the control groups. On the other hand, learning in groups that performed only imagery was 41- 45% less effective than the physical practice groups. Regarding the combined groups, the treatment in those groups was less beneficial than the physical practice alone, unless the ratio of physical practice to imagery is at least 75:25.

Driskell, Cooper, and Moran (1994), wrote one of the most comprehensive, up-to-date literature reviews on imagery. In this meta-analytical integration, the authors used stricter selection criteria, involving delimitations between mental preparation and mental practice, and included the existence of a hypothesis test that compared the control group with the mental practice group. Thirty-five studies were reviewed with 100 separate hypothesis tests and more than 3200 subjects. The following results were found:

a) Mental practice is an effective way to enhance performance.

b) The effect of mental practice on performance was stronger when the task involved more cognitive elements.

c) The positive effect of mental practice declined over time.

d) Mental practice was more effective for experienced trainees than for novices.

e) More mental practice was not necessarily better in terms of total duration.

As mentioned earlier, the variability regarding the types of tasks, research design, participant's age, participant's former experience level, and so on. throughout the research, prevent the findings from being effectively generalized. That made it difficult to arrive at general conclusions regarding the effectiveness of imagery for the performance and learning of motor skills. Because of that, Paivio (1985) proposed a conceptual framework that would help evaluate and guide further the imagery research. In his study, the author separated the motivational and cognitive functions of imagery. Each of them has either a general or a specific level. Some of the factors influencing imagery were also identified. One such factor is the task itself: cognitive tasks are more prone to be influenced by imagery than motor tasks. The author acknowledged the previous findings of Feltz and Landers review (1983) on imagery and supported the idea that imagery is associated with the cognitive-symbolic components of the task rather than the motor components of it. Closed and serial skills can be more easily manipulated during the imagery process than the open, reactive skills to a moving target or a moving opponent. At least theoretically, a fixed routine seemed easier to be rehearsed in the absence of the unpredictable distracters encountered during open skills. Another factor considered was the participant's memory characteristics. From this perspective, two factors were considered. One is the memory base, meaning that a skilled performer has a larger and more accurate "data base" from which relevant information can be retrieved during imagery rehearsal. The second factor is the efficiency of retrieval of the memory base information's. A larger memory base and an effective information retrieval can be developed through direct practice or by observational learning. The language, which "provides the retrieval cue for the memories expressed as images," must be accounted for during the imagery process (Paivio, A, 1985, p. 27). The last factor to consider is the skill level as well as the imagery ability of the performer, directly related to the volume of memory base and the ability to retrieve the information contained. In order to observe the effect of imagery on motor skill acquisition and performance, all of the factors above must be carefully considered.

Rodgers, Hall, & Buckolz (1991) investigated the effect of two cognitive interventions on figure skating performance. Twenty-nine junior figure skaters were split into one imagery group and one verbal. In addition, eleven skaters were used as a no-treatment control group for comparison reasons. After a 12-week training period it was found that both imagery and verbal group exhibited improved performance results as compared to the control group. Furthermore, the participants in the imagery group improved their visual imagery ability; they used imagery in a more structured way during training, and they could also more easily visualize and feel parts of the routine overtime; the participants reported that mental training was beneficial and will be employed in the future.

In another study, the imagery effect on soccer skill performance was investigated in relation to the skill proficiency of the participants (Blair, Hall, & Leishon, 1993). Forty-four female college varsity soccer players were randomly separated into two imagery groups (skilled and novice) and two control groups (skilled and novice). After a six-week training period, the performance outcomes were recorded in terms of response time and accuracy. For the imagery groups, the results revealed significant increase in response time, but not in accuracy. Conversely, for the control groups there was no improvement in either response time or accuracy.

Based on anecdotal reports, athletes are using different types of imagery in a more or less formal manner. In order to investigate this phenomenon in a scientific manner, several authors managed to develop various instruments to research precisely the use of imagery by athletes and nonathletes. Starting from Paivio's framework, Salmon, Hall, & Haslam (1994) investigated the motivational and cognitive use of imagery by soccer players. Three groups of athletes participated in the study. Based on performance skill level, they were classified as national level players, provincial level players, and non-elite soccer players. A valid and reliable instrument was developed for this purpose. The Imagery Use Questionnaire for Soccer Players (IUQ-SP), consisting of four distinct sections (demographic, general use of imagery, Paivio's four types of imagery, and auditory section) was administered to 363 individuals. The analysis of the responses revealed the following: on most variables there was no difference between genders with regard to the imagery use; athletes of different skill levels can be separated according to their imagery use (that is, elite players used imagery more often than non-elite players). Finally, soccer players achieved high scores on both internal and external perspectives, with a preference for the internal perspective, and low scores on kinesthetic imagery despite the fact that controlling the ball requires a considerable amount of kinesthesia.

In 1998, a more comprehensive and accurate instrument was developed to assess the extent to which the five types of imagery are used: the Sport Imagery Questionnaire (SIQ), (Hall, Mack, Paivio, & Hausenblas, 1998). The instrument draws from Paivio's framework (1985) as well as the Imagery Use Questionnaire for Soccer Players (Salmon et al., 1994). The purpose was to measure individual differences regarding the extent to which imagery is used in relation with the functions proposed by Paivio (1995). Three separate experiments were conducted, with the aim of finding a final reliable and valid questionnaire. The resulting questionnaire consisted of 30 items, six for each imagery type:

a) cognitive specific (CS), imagery for specific sport skills (close or discrete skills);
b) cognitive general (CG), imagery used for entire strategies or routines (open and serial skills);
c) motivational specific (MS), imagery that represents specific goals and goal-oriented behaviors;
d) motivational general-mastery (MG-M), imagery incorporating effective coping and mastering of challenging situations;
e) motivational general-arousal (MG-A), imagery that represent feelings of relaxation, stress arousal, and anxiety relative to sport situations.

The results obtained were consistent with the previous findings. Athletes used imagery more for its motivational than cognitive functions; imagery was used more in relation with competition than practice; there is a clear distinction between MS and MG imagery use, but it is not as clear between CS and CG imagery.

The instrument developed above opened the gate for further investigations on how the use of imagery is changing over the sport season (Munroe, Hall, Simms, & Weinberg, 1998). They attempted to assess the influence of the season period and the type of sport on athletes' use of imagery. Varsity university athletes (N=350) participating in 10 different sports were assessed using the Sport Imagery Questionnaire (SIQ). The instrument was completed twice by the participants. The first time at the beginning of the season (T1), 1-2 weeks prior to any competition and the second time at the end of the regular season (T2), 1 week prior to the play-offs or championships. The following results were found, based on the answers related to the five imagery types. The cognitive specific (CS) imagery use increased from T1 to T2 for five of the sports analyzed. One explanation was that cognitive specific imagery is used also for focusing on the task at hand during competition. Cognitive general imagery (CG) significantly increased from T1 to T2 for nine sports. Similarly the motivational specific imagery (MS) use significantly increased for all ten sports used in this study during the period of the season. Finally, motivational general-mastery imagery (MG-M) and motivational general-arousal imagery (MG-A) usage did not fluctuate over the season time. The explanation offered is that those imagery types are equally important at the beginning and at the end of the season.

For the relationship between the use of imagery and the type of sport there were no systematic findings to attest differences in imagery use for different sports (i.e. individual and team sports). Similar imagery usage and characteristics were found throughout the sports considered in this study. Other factors that may influence athlete’s imagery use during the season might be the team’s perceived success (increase or decrease of MS imagery use) and the coaches’ vision regarding imagery and its implementation in the preparation plans.

Martin, Moritz, & Hall (1999) conceived a new model that incorporated the latest findings in the realm of imagery. The purpose of the study was to provide a guiding framework to describe how athletes could use imagery for various purposes across different sport situations. Taking into considerations the major theoretical explanations regarding imagery related to Paivio’s framework, a more comprehensive and up-to-date model was drawn. This new framework incorporated aspects of both Ahsen's Triple Code model (1984) and Lang's Bioinformational Theory (1979). The model's diagram was depicted in the introductory chapter of this study (see Figure 1). The models' aspects of particular interest for this study are briefly discussed below.

First the sport situation was considered. During training periods, novice and, occasionally, advanced athletes used cognitive specific imagery to learn skills and strategies and also to correct them. As part of the competition preparation, mostly motivational imagery was used. However, the results were not conclusive, and further research is needed in this direction. Second, the imagery type used was considered. To date, five types of imagery have been identified. Only two imagery types, CS and CG, were of interest in this study. One single function of imagery can be isolated during the imagery training, or, if required, different combinations can be targeted at the same time. Third, the study considered the outcomes of imagery use. The model had three outcomes: skill and strategy learning and performance, modifying cognition (positive visualization will positively reflect on self-efficacy and self-confidence), and regulating arousal and competitive anxiety (images elicit physiological arousal). The outcome of interest was the one pertaining to skill and entire routine learning and performance.

Finally the imagery ability was considered as well. In the model it was proposed that imagery ability was a moderator variable that will affect the direction and strength of the relation between the independent variable (CS and CG imagery) and the dependent variable (learning and performing a serial skill). In order to measure visual and kinesthetic imagery ability, the Movement Imagery Questionnaire - Revised (MIQ-R) was employed (Hall & Martin, 1997).

In another study the researchers used the same paradigm (Munroe, Giacobbi, Hall, & Weinberg, 2000). The purpose was to identify and describe the use of imagery by athletes in both practice and competition. Fourteen varsity athletes, both male and female, from seven different sports, volunteered to participate in this study. A guided interview approach was used to answer four fundamental questions regarding imagery. This study focused on the cognitive specific and cognitive general functions of imagery. The imagery function can specifically determine the outcomes. That is, using imagery for cognitive specific purposes will significantly reflect only on the skill acquisition and performance (Martin, Moritz, & Hall, 1999). On the other hand, imagery can serve more than one purpose at the same time. That is both cognitive and motivational outcomes can be targeted with different imagery strategies at the same time (White and Hardy, 1998). The researchers arrived at the following conclusions. Regarding the questions of "when and where" imagery was used, the answers revealed that imagery was utilized mostly during practice rather than competition, before competing and outside the practice, and competition before sleep. To a lesser extent, athletes use imagery before and after practice, and during and after competition, as well.

The reasons "why" athletes employed imagery are as follows. For the cognitive specific function of imagery, it was used for skill development (learning the technique and making the necessary corrections) as well as for skill execution (performing the best possible). The cognitive general function was used for the development and execution of strategies (game plans and routines).

As to the last question of "what," athletes reported the use of effective imagery during practice as well as precompetition. Mostly positive images were employed, in which the competition surroundings were incorporated. Despite the fact that controllability was reported only once, the vividness was highly influenced by using visual (both perspectives) and kinesthetic type of imagery predominantly with occasional auditory and olfactive sensory input.

So far in the literature it was revealed that imagery is supported from the theoretical point of view (the psychoneuromuscular theory, the symbolic learning theory, the bioinformational theory, and the triple code theory) and in equal measure from the applied point of view (empirical use of imagery by athletes). However, imagery can be used as a cognitive and a motivational tool outside the sport realm as well, especially in the exercise and regular physical education settings. Recent studies revealed the similarities and discrepancies between the sport, exercise and physical education settings, in terms of the effectiveness of imagery.

Hausenblass and colleagues researched the idea of imagery as used in the exercise setting (Hausenblass, Hall, Rodgers & Munroe, 1999). The purpose of their study was two-fold: to examine the nature of exercise imagery and to develop an instrument to assess it. A series of limitations were found with this study: the samples consisted largely of female college students, only aerobic exercise participants were included, the sample was self-selected and based on self-motivated participants, and, finally, the assessment was solely based on self-reports.

The results revealed that most exercisers use imagery. Those findings were based on an open-ended approach where, after a description of exercise imagery, the participants answered the questions relating to the when, what, and why they employ imagery. After analyzing the results, the researchers found that imagery was used most frequently before going to sleep, during class, when daydreaming, before and after exercising, while exercising, and so on. Regarding the motives to use imagery, the answers revealed that imagery was used frequently for body image, techniques and strategies, feeling good about oneself, motivation, goals, maintaining focus, and so on. Finally, the reasons to use imagery were for motivation, feeling good about oneself, body image, strategies and techniques, and stress relief.

Subsequently, an instrument was developed: Exercise Imagery Questionnaire-Aerobic Version (EIQ-AV). It was based on the open-ended questionnaire, which was developed around three factors that summarized the issue: energy, appearance, and technique. The instrument was proven to be both valid and reliable, with the reserve that was employed only on a specific population.

Beside benefiting athletes and exercisers, imagery would also benefit the regular physical education settings as well. There are many different objectives in Physical Education classes. The objectives can be separated into psychomotor, cognitive, and affective; however, all the objectives are interrelated during the process of teaching and learning. Cognitive and affective goals can be targeted either directly or indirectly, using as intermediary the psychomotor goals. “Psychomotor outcomes are the unique contribution of physical education to the education of the students” (Rink, 2003, p. 5). If for this reason only, each physical education teacher must excel in manipulating the practice conditions for the maximum benefit of the students. Logistically, imagery can be a used as a beneficial contributor to student success, both for motivational and cognitive reasons. Imagery can be employed during the resting periods, when pupils are waiting, or have a temporal medical restriction to physical involvement in class activities.

Short, Afremow, and Overby (2001), in a qualitative analysis, suggested that mental imagery could be successfully employed to enhance children’s motor performance. Reviewing the imagery literature, the researchers concluded that mental imagery could be implemented in schools during regular Physical Education. Four guidelines were suggested: imagery preceded by relaxation techniques is more effective; the sessions must be performed on a regular and structured base; the optimal length of session is between 3-5 minutes; simple exercise can be used to increase the vividness and controllability of imagery (use senses to describe objects, etc.). The researchers mentioned that the term “mental imagery” is used in this study in place of the broader context of mental practice, and “imagery for learning” is the synonymous term with mental practice as we defined it at the beginning of the chapter.

Haslam (1990) proposed a conceptual framework for imagery training for school aged athletes. The purpose of the paper was to outline a mental-training “curriculum.” The athletes were separated by growth and developmental characteristics in four groups and by level of performance in two groups. The framework for imagery training considered Paivio's 1985 structure of imagery functions: cognitive general and specific, and motivational general and specific. Each of those aspects occupies a certain percentage of time during the mental training system. The researcher suggested that mental practice time for the cognitive specific function was between 50 and 70% for developmental athletes and between 10 and 50% for elite athletes. Those percentages were higher for younger athletes and for those in the developmental stage regarding the skill level. A sample program was offered with the idea that the program needs to be personalized and integrated with the other training systems (physical, technical, and tactical), for individual better results.

In another study Haslam (2002) stressed the idea that physical education teachers and coaches should act as educational sport psychologists for the benefit of their students. A specially designed curriculum must incorporate both the performance aspects and knowledge supporting the performance. The scope of the curriculum should incorporate various psychological concepts including imagery. The curriculum sequence must be structured on three levels of difficulty: the generic level (describe the skills), the ordinative level (apply the concepts to sport and daily life), and finally the creative level (the skill is ingrained and transferable across a variety of sport and life situations). This approach will benefit school athletes with the knowledge and the practice necessary to apply the imagery for skill learning and performance, with the purpose of efficiently increasing the performance level.

Variables

There are quite a few variables that are held accountable for the effectiveness of imagery. From the literature reviewed so far, the following factors were identified: the nature of the task, the participant memory, retrieval cues for the images stored in the memory base (Paivio, 1985); type of task, retention interval, experience level, duration of practice, and type of control were the moderators accounted for in one recent literature review (Driskell et al., 1994); finally, the type of activity, participant's skill level, gender, and participant's imagery ability also influenced imagery use. To control all the variables during the experimental approach is not possible. Staying close to the purpose of this paper, the variables of interest were:

1. Nature of the task has a decisive role in the effectiveness of imagery on motor skill learning and performance. The research literature argues that the more cognitive a skill, the more benefit is derived from mental imagery rehearsal. Imagery helps skills in which perception and decision-making have an important role (Driskell et al., 1994; Feltz & Landers, 1983). The nature of the task dictates the imagery perspective, which can also influence the effectiveness of imagery on learning and performing motor skills. Internal perspective (first person) is often employed during open skill rehearsal, and it is used by high level athletes and associated with the use of kinesthetic imagery. On the other hand, external visual imagery (third person) is beneficial for skills where the form is more important than the environment, and it is not associated with kinesthetic imagery regularly. Despite this, if the participant is the "agent" of the external perspective instead of a third party, there is a significant correlation between external visual perspective and kinesthetic imagery. Considering that kinesthetic imagery will bring additional information to the imagery process (vividness), it is therefore desired that visual and kinesthetic imagery act together for the beneficial improvements that are likely to occur (Callow & Hardy, 2004; Hardy & Callow, 1999; White & Hardy, 1995).

2. The skill level of the performer is also crucial. In the early stages of learning, novice athletes can benefit more from imagery because of the high cognitive component. On the other hand, to be able to mentally rehearse a skill, one must be able to "picture it' accurately. Therefore, the better the proficiency level, the better the image is. Elite players reported an increased use of imagery than nonelite players (Salmon et al., 1994). A certain skill level is beneficial when using imagery because a

skillful athlete will incorporate additional kinesthetic information to the imagery process (Driskell et al., 1994; Hardy & Callow, 1999).

3. Gender has a controversial role as a variable regarding imagery. Several authors reported insignificant differences between males' and females' imagery ability levels (Salmon et al., 1994; Munroe et al., 1998; Callow & Hardy, 2004). On the other hand, there were reported significant differences between male and female on the visual imagery when the MIQ instrument was tested and retested for reliability, $t = 2.35$, $p < .05$ (Atienza, Balaguer, & Garcia-Merita, 1994). Hall, Pongrac, and Bucholz (1985) found significant differences between genders and visual scores ($F = 4.36$, $p < 0.01$). Those results are consistent with the former findings regarding the relation between gender and imagery ability. However, no significant differences between genders were reported regarding kinesthetic imagery.

4. The fourth factor is the ratio between imagery and physical practice. If physical practice ratio is increased so does the learning (Hird et al., 1991). The order of mental imagery and physical practice as well as the duration of mental imagery are important variables. Etnier and Landers (1996) argued that one or three minutes of imagery prior to the actual performance of the task showed best results for closed motor skills. There are two different approaches: first, using combinations of proportions between mental and physical practice; second, that mental practice comes in addition to a constant physical practice routine.

5. Imagery ability varies between different persons. There is a direct relationship between imagery ability and the effectiveness of imagery. Also this "ability" can be improved over time with practice (Rodgers, Hall, & Buckolz, 1991). There are two keys that define a good image: vividness and controllability. Vividness represents the involvement of many senses to create or recreate accurate mental images (visual, kinesthetic, auditive, etc). Controllability represents the capability to

manipulate the images once formed. It has been demonstrated that negative imagery triggers a debilitating effect for performance (Beilock, Afremow, Rabe, & Carr, 2001).

Singer (1986) started from the assumption that best results are obtained when a balance between emotions, thoughts, and performance is present. He proposed an effective mental strategy for the execution of the self-paced skills. His qualitative research was based on the findings from athletes' interviews, personal experience, and research on selected strategy aspects. Following a five-step mental approach, regardless of the type of sport or skill level, participants will attain an improvement in performance. The five components of the sequence were reading, imaging, focusing, executing, and evaluating. They all are part of the broad term of mental preparation, but the second step is the focal point of this review: imagery. Imagery can be developed separately from the other steps to create "a clear and vivid picture of the act and its outcome." Used in conjunction with the other steps, this would result in a well-rounded mental preparation and increases the chances of success.

Hird, Landers, Thomas, and Horan (1991) differentiated between different ratio of physical to mental practice on performance of two different tasks, essentially classified as cognitive and motor. The authors used lab-research instruments and had as participants undergraduate college students. They were divided into six groups: physical practice group, 75:25 combined practice, 50:50 combined practice, 25:75 combined practice, mental practice group, and motivational control group. The results indicated that physical practice was more effective than mental practice in both tasks. Also, as the physical practice ratio increased, so did the performance level. Regarding the mental practice effect on performance, there was a significant difference between mental practice and control groups; that is, combined imagery and physical practice presented better results than no practice groups.

A different approach was used by Etnier and Landers (1996). In contrast with the study above, the researchers considered different imagery durations prior and after a constant period of physical practice of the skill. The purpose of the study was to examine the influence of the order of presentation of mental practice (MP) and physical practice (PP) and the duration of MP on performance using as criterion a 3-minute basketball shooting task (shooting as many as possible shoots behind a baseline set at 15 feet from the basket while retrieving their own rebounds). College students, both male and female (N=153), with basketball experience ranging from no experience to recreational and college level, volunteered to participate in this study. The imagery ability was assessed using VVIQ and VMIQ questionnaires. The participants were randomly separated into nine groups: one minute imagery group, 3 minutes imagery group, 5 minutes imagery group, and 7 minutes imagery group; all were using MP before the constant 3 minutes PP. Similar correspondent groups were formed to use MP after the constant 3 minutes PP. Finally the control group did not use MP but only 3 minutes of PP. Three trials were performed with a 1 min. rest period in between. The data analysis showed that performing MP prior to the task was more beneficial than either performing MP after the task or only physically practicing the task. This occurred because participants are asked to recall the motor program underlying the skill and subliminal activating the muscles. Regarding the MP duration, the groups that received 1 or 3 minutes of MP improved significantly more than the other groups.

Studies were conducted to contrast the relative effect of kinesthetic and visual image on motor performance. Fery and Morizot (2000) applied both imagery visual perspectives techniques to observe the effect of imagery on closed motor skill (tennis serve) in a real setting environment this time. During learning skills, the performer would not observe him/her during their execution because they stood outside their own field of vision. Therefore, kinesthetic imagery had to be employed. Fifty male university students volunteered for the experiment. After assessing their imagery ability and skill levels, four experimental groups were formed according to the imagery and skill ability: kinesthetic modeling and kinesthetic mental practice, visual modeling and visual metal practice, kinesthetic modeling and control, and visual modeling and control. The results showed that imagery had a beneficial effect in terms of form and speed. The kinesthetic model had better results than the visual model. On the precision criterion, imagery was also beneficial, but no difference was found between visual and kinesthetic mental rehearsal. In conclusion, modeling has beneficial effect on learning tennis serve only when the learner has the opportunity to rehearse the model cognitively, and modeling with kinesthetic imagery is more efficient than visual imagery alone.

Fery (2003) conducted another study, which focused on the effect of different imagery perspectives on learning closed motor tasks performed in predictable environmental settings. Two different experiments were conducted. The first experiment utilized a form reproduction task in a lab-setting approach. The second experiment kept the same form to be reproduced in the lab-setting environment but was altered in order to use both hands in controlling the position of a stylus in a path. Therefore, more motor coordination was needed for the second task. Three groups were formed: visual imagery group, kinesthetic imagery group, and control group. Each participant was trained individually to adopt the appropriate representations. Two criteria were measured: form and duration. The results confirmed the hypothesis that mental imagery groups outperformed the control group and that visual image was more appropriate in the attempt to replicate the form of the task, while the kinesthetic image was better when the movement's duration is important. In conclusion the beneficial effect of mental practice was revealed: the use of visual imagery is better for learning a motor skill whose salient parameter is a form to be reproduced. On the other hand, kinesthetic imagery is a better representation in order to acquire the duration character of the movement.

Using the same design, Gordon, Weinberg, and Jackson (1994) used different imagery perspectives. Sixty-four participants (eighth, ninth, and tenth-grade students) completed six training sessions of forty-minute each, on an outswing bowling in cricket, over a 3-week period. The participants were separated into three groups after the imagery ability was assessed: control group, external imagery, and internal imagery group. Results revealed that the overall performance level was improved across all six training sessions with no significant differences between all three groups. The results did not demonstrate the superiority of internal imagery over external imagery.

A similar study was conducted by White and Hardy (1995). The purpose of the study was to compare the effect of internal and external mental imagery perspectives for learning and performing of two lab-based tasks: a canoe slalom event and a gymnastic routine. Forty-eight able-bodied, first year, sport, health and physical education university students participated in this study as part of their course requirement. Two tasks were used: first, a dry land slalom course with fourteen skittles, negotiated by manually operating a wheelchair; second, a movement sequence composed of ten static positions using a pair of rhythmic gymnastics clubs while seated in a wheelchair. Two random groups were formed based on the results on VMIQ questionnaire: external visual imagery and internal visual imagery groups. Both groups performed both tasks within a two-week interval. Prior to each of five blocks of five trials, imagery was used with respect to the specific perspective of the group. The results demonstrated that different aspects of motor performance can be enhanced using different imagery perspectives. The relative effect of kinesthetic imagery appeared to be independent relative to EVI and IVI. The following conclusion was stated: EVI enhanced early learning and retention of the gymnastic skill (static environment); EVI was superior to IVI during learning the slalom (dynamic environment), but for transfer IVI was more appropriate.

Hardy and Callow (1999) conducted a study differentiating between internal and external visual imagery perspectives relative to motor skill learning. In contrast to the experiment mentioned earlier, this was a real life setting, and both highly skilled athletes and Physical Education college students participated. The authors ran three different experiments to examine the efficacy of different imagery perspectives on the performance of tasks in which form was important. The first one involved 25 participants (17 men, 8 women) who were experienced members of a karate club. The task was to learn a new karate kata consisting of 52 separate movements. The participants were separated into three groups using stratified random sampling (gender and ability level): external visual imagery, internal visual imagery, and control. The authors concluded that external visual imagery is superior to the internal visual imagery for learning the general shape of the kata, and that kinesthetic imagery can be used equally in conjunction with either of them.

The purpose of the second experiment (Hardy and Callow, 1999) was to examine the effects of both external and internal visual imagery combined with kinesthetic imagery on acquisition and retention of a simple gymnastic floor routine. Seventy-six undergraduate students in Health and Physical Education were recruited during an imagery workshop (they could gain course credit for participation). The task was to learn a five-element gymnastic sequence. The participants were randomly assigned into one of the four treatment groups: external with kinesthetic imagery, external visual imagery only, internal and kinesthetic imagery, and internal visual imagery only. The results confirmed the hypothesis that external visual imagery is appropriate to use on form-based tasks in both acquisition and retention phases. The kinesthetic imagery wasn't assessed due to statistical error and/or participants' inexperience in using such imagery techniques.

The third experiment (Hardy and Callow, 1999) replicated the second one using 20 professional rock climbers. The task consisted of four 10-move boulder climbing in an indoor artificial climbing wall, each of them designed to be impossible to climb in the first attempt. For each boulder, 15 minutes of practice was allowed and then 2 minutes of mental practice before the attempt. The general conclusion was that for the criterion tasks dependent on form, the external visual imagery in more efficient, and kinesthetic imagery brings additional benefits to performance.

Callow and Hardy (2004) examined the correlation between the internal and external visual imagery with kinesthetic imagery. In the first study, 56 participants, both male and female college students, were recruited after an imagery workshop. Their imagery ability was measured using both the Movement Imagery Questionnaire (Hall and Pongrac, 1983), and the Vividness of Movement Imagery Questionnaire (Isaac, Marks, and Russell, 1986). Both instruments provide separate scales to measure visual and kinesthetic imagery. After assessing the imagery ability, no difference was found between genders on either questionnaire. External visual imagery wasn't correlated with kinesthetic imagery, and the relation between internal visual imagery and kinesthetic imagery only approached significance. A second experiment used a different sample consisting of 64 college students, both male and female, who attended the same imagery workshop. The very same two instruments mentioned above were employed; however, the instructions for the external perspective on the VMIQ were changed from "watching someone else" to "watching yourself" maintaining the external visual perspective. The gender analysis failed to find significant differences. When the instructional set was changed, there was a significant correlation between external visual imagery and kinesthetic imagery, but the internal visual imagery and kinesthetic imagery correlation was not significant. The study demonstrated a correlation between external visual imagery and kinesthetic imagery when the participants imagined themselves perform; therefore, this type of combination will bring more sensory information, which will increase the image vividness.

Imagery Validation

Despite the fact that imagery was proved helpful for skill learning and performance, it is practically impossible to determine with certitude if the participants are indeed performing imagery as directed, during the imagery sessions. Two solutions to this problem were proposed: first the congruence between the imagined time and the time actually required to perform the skill and second the cognitive interference between a pair of perceptual task and an imagery task when both use the same sensory modality (Lavallee et al., 2004, chap. 3). The cognitive interference solution could be hindered by two factors: the difficulty to find same sensory modality for perceptive and imagery tasks, and the fact that a vivid imagery episode is a multi-sensorial experience, thus involving many senses at the same time. Therefore, for an applied setting, the onset time congruence check seems more appropriate.

Moran and MacIntyre (1998) investigated the kinesthetic imagery processes, among World Cup competitors in canoe-slalom. To assess the kinesthetic imagery processes, the following instruments were employed: a semi-structured interview, the MIQ-R (Martin &Hall, 1997), and an imagery experience validation method, namely the time congruence between the real movement and the imagined time. The overall conclusion was that the visual and kinesthetic imagery were perceived to be more important that the images derived from the other senses. Furthermore, the kinesthetic imagery was not synonymous with the use of internal visual imagery. When the athletes were asked to imagine themselves competing in a recent major race, imagery duration was timed and compared with the actual race times. A strong significant positive correlation ($r = 0.78$, $p < 0.5$) was found between the self-reported imagery duration and the race time.

In a recent study, Guillot and Collet (2005) reviewed 25 articles dealing with mental chronometry. As a general conclusion, the researchers found that the temporal equivalence between imagined and actual movement suffers influences from different factors involved in the imagery process. The following conclusions were stated:

a) The imagery duration obeys the biomechanical characteristics of the movement in terms of displacement, velocity, and weight. That is, the longer the distance, the slower or heavier the actual movement becomes, and the longer the imagery duration.

b) For highly automatic movements, the imagined and the real time are systematically close.

c) For closed skills and serial skills, the imagery duration is similar to the actual movement time.

d) Imagery duration increases with the task difficulty.

e) For rapid and complex attention-demanding movements, the imagery time overestimates the actual performance time.

f) Time constraints will shorten the imagery duration (i.e. prior to competition).

g) The performer skill level influences the imagery duration such that less experienced athletes require more time to imagine skills, for they are not accurate in representing complex movements, whereas the more experienced athletes exhibited a better timing congruence.

h) The instruction given to the performer greatly influences the imagery duration. Therefore, either the temporal organization of the movement (when competition is mimicked during the practice sessions or during the real competition) or accuracy of the movement (during regular practice sessions) would be preserved.

The purpose of the present study was to examine the relative effects of different ratios of mental imagery to physical practice on the learning and performing a gymnastic floor routine. Young athletes were chosen to use imagery in an applied setting. For movements in which the form is important, there is a stronger relationship between external visual imagery and kinesthetic imagery when the participant is the agent of the image. Therefore this type of imagery was encouraged without placing any restriction on the participant's choice.

To better control the experiment, during the training sessions the participants could signal the experimenter about possible distractions during the imagery sessions, in order to be able to start a new imagery session. During the time when some participants did not follow the imagery routine, they were engaged in another cognitive task used as a distracter. This way the amount of imagery was better controlled. The imagery was included in the regular routine without making any modifications but using the required resting periods for this purpose. At the end of the experiment, a team of professional referees assessed the participant’s routines without any knowledge of the treatment they received. In addition, during the first postexperimental practice session, the participants were asked to participate in a semi-structured interview. This way some of the uncontrollable factors could be accounted for: the meaning of the imagery program, the adherence to it, and possible future plans.

It was hypothesized that:

1. There will be no significant differences in imagery ability from the pretest to the posttest.

2. There will be no significant differences in imagery ability between different imagery ratio groups at the posttest.

3. There will be no significant differences in imagery ability between the two proficiency levels at the posttest.

4. There will be no significant differences in imagery ability between genders at the posttest.

5. There will be no significant differences in performance from the pretest to the posttest.

6. There will be no significant differences in performance between different imagery ratio groups at the posttest.

7. There will be no significant differences in performance between the two proficiency levels at the posttest.

8. There will be no significant differences in performance between genders at the posttest.

Chapter 3

Methods

The purpose of this study was to examine the relative effect of different ratios of mental imagery to physical practice on learning and performing a gymnastic floor routine.

Participants

Twenty-seven young gymnasts from Michigan Academy of Gymnastics participated in this study. These included 13 males (mean age 13.38, SD ± 1.93) and 14 females (mean age 13.00, SD ± 2.03). None of them had received formal cognitive specific or cognitive general imagery treatments before. Their skill levels ranged between level 7 and level 10 as determined by United States Gymnastics Association.

The skill level was assessed prior to this study based on competition ratings and during the practice sessions. In addition to the proficiency level, mental imagery ability of each participant was assessed using the Mental Imagery Questionnaire - Revised (Hall & Martin, 1997). Based on the results of this questionnaire, the gymnasts were classified as high visual/high kinesthetic, high visual/low kinesthetic, low visual/high kinesthetic, and low visual/low kinesthetic subgroups. The skill level, imagery ability level, and the gender were used to randomly place participants into four homogeneous experimental groups.

Instruments and Task

The instrument employed in the present study, MIQ-R, was meant to measure the ability of imagery (see Appendix C). The instrument consists of eight separate statements that separately measure both visual imagery and kinesthetic imagery. The participants were required to read the instructions carefully. Each of the eight statements describes a specific movement that one needs to actually perform accurately. Immediately after the actual performance of the movement, participants were required to form mentally either a visual image (four of the items) or attempt to feel what performing that particular movement is like (the other four items). Only four different movements were described, but the order of forming the visual or kinesthetic representation of the movement was alternated throughout the questionnaire. For each movement, both visual and kinesthetic representations were required. After the mental performance was terminated, the participants rated the ease or difficulty of the task on a seven point Likert scale (Hall & Martin, 1997).

The MIQ-R questionnaire is a relatively new instrument. Its psychometric properties were compared with the former Movement Imagery Questionnaire (MIQ) to establish its reliability and validity (Atienza, Belaguer & Garcia-Merita, 1994). The MIQ is reported to have a test-retest reliability coefficient of $r = 0.83$ for a 1-week interval. Regarding the internal consistency $r = 0.87$ for the visual scale, and $r = 0.91$ for the kinesthetic scale were found (Hall, Pongrac, & Buckoz, 1985). Later on similar internal consistencies were reported: $r = 0.89$ for the visual subscale and $r = 0.88$ for the kinesthetic scale (Atienza, Belaguer & Garcia-Merita, 1994). Because of some weaknesses identified during its usage, the MIQ was subject to a revision. When the subscales of the MIQ and MIQ-R were compared, a correlation of - 0.77, $p < .001$was found for the visual scores and a correlation of - 0.77, $p < .001$ was found for the kinesthetic scores. The MIQ-R thus can be successfully employed to assess visual and kinesthetic movement imagery ability. The task employed in the present study consisted of learning and performing a complete floor routine.

Each participant had a different number of elements and a different choreography that suited his/ her individual capabilities. Everyone participated in the regular practice routine with their regular coach. No separate groups were formed other than the existing ones in terms of skill proficiency.

Procedure

Proficiency levels were determined through prior competitions and practice. Participants were assigned levels that ranged from 1 to 10, based on the United States Gymnastics Association. However, only participants who were judged to be at level 7 and above were selected to participate in this study. In addition to the skill level, the imagery ability of each participant was assessed using the MIQ-R questionnaire. This was done after the participants had the opportunity to familiarize themselves with the imagery practice. One week prior to the beginning of the experiment, all the participants were debriefed on the imagery topic. Simple pilot imagery exercises were rehearsed during the regular practice sessions in the warm-up part of the class. During the second and third week, each participant, according to his/her own abilities, followed an individual progression from visualizing simple objects to visualize themselves, from a third person perspective, performing the entire floor routine. The kinesthetic portion was easily grafted on the visual sequence due to the previous experience with the mental simulation with movement or "dynamic kinesthetic imagery" (Holmes & Collins, 2001; Holmes & Collins, 2002). This way the afferent information from the body segments can reinforce the cognitive part from visual imagery. It is known that among other athletes, gymnasts largely use the simulation of the skills shortly before the actual performance. During the fourth and fifth week on top of the combination described above, external visual imagery and kinesthetic imagery, individual imagery scripts were employed. The imagery scripts consisted of three parts: an individualized part meaning propositions; a generic part of stimulus propositions for all the participants in the study; and an individualized part of response propositions (Smith et al., 2001; Lang, 1979). A detailed description of the progression sequence used during the treatment is presented in the Appendix D. An example of an imagery script is provided in Appendix E.

The proficiency levels, the imagery ability levels, and gender were used as criteria to randomly place participants into the four experimental groups. In addition, further imagery exercises were provided to the participants who had a low initial imagery level. This was only for the participants who scored below the group average imagery ability, with the purpose to increase their imagery ability to a similar level as compared to other members in the groups.

The experimental groups were composed as follows:

Group 1 was composed of students from the 9 and 10 proficiency level. They trained five times per week (three times for the floor routine) and they received imagery during three training sessions. The total number of students was seven (4 boys and 3 girls from levels 9 and 10).

Group 2 was composed of students from the 9 and 10 proficiency level. They trained five times per week (three times for the floor routine) and they received imagery during one training session. The total number of students was five (3 boys and 2 girls from levels 9 and 10).

Group 3 consisted of students from the 7 and 8 proficiency level. They trained five times per week (three times for the floor routine) and they received imagery during three training sessions. The total number of students was eight (3 boys and 5 girls from levels 7 and 8).

Group 4 was composed of students from the 7 and 8 proficiency level. They were trained five times per week (three times for the floor routine) and they received imagery during one training session. The total number of students was seven (3 boys and 4 girls from levels 7 and 8).

The imagery treatment was applied shortly before the actual routine rehearsal. Each participant received the same treatment; the only difference was the frequency of imagery sessions during the week: one session for groups two and four, and three sessions for groups one and three. Also the boys groups practiced for the floor routine on different days (Tuesday, Wednesday, and Friday) than the girls (Monday, Thursday, and Saturday).

The floor routine section workout used the structure below:

- Practicing isolated gymnastic skills;
- Practicing serial gymnastic elements, resembling the difficult pass;
- Rehearsing the entire routine three times: one full routine, one tumbling passes alone, and one dance routine.

The imagery treatment consisted of rehearsing mentally the isolated gymnastic elements (cognitive specific imagery) and the diagonals or entire routines (cognitive general imagery) before every actual rehearsal and was accomplished in real time. That means the length of the imagery rehearsal matched the length of the actual practice. To ensure the congruence of imagined and real time, each imagery session was timed and verbal feedback was provided for further adjustments. In addition to the time length of the routine, for the imagery validation the “dynamic kinesthetic imagery” movements were closely observed. To make sure that the imagery was successfully completed on set, an adherence signal was employed as well. Each time the participant could not mentally rehearse the routine, he/she raised a hand to signal that and a new attempt was then granted. The imagery perspective wasn’t accounted for onset, but the participants were encouraged to use a third person imagery perspective. It was suggested that an external visual perspective of the own person performing the routine in conjunction with kinesthetic imagery is most beneficial in gymnastics where the skill form is an important factor (Hardy & Callow, 1999). Groups 1 and 3 received imagery treatment all the time the floor routine was practiced (three times per week), and groups 2 and 4 received the imagery treatment only once per week. During the other two sessions without imagery treatment, the students in groups 2 and 4 performed a cognitive task preventing them from using imagery. Each participant in these groups attempted to solve a puzzle; that is, during the treatment period and during the days without imagery training, a ring chain puzzle was employed as a distracter task. Each time the puzzle was solved, a new one with an increased difficulty level was given to the successful participant to solve.

The gymnastics regulations are limiting the floor routine time to maximum 1½ minutes. This time length resembles the recommended length of imagery sessions found in the research literature that benefits the motor skill learning and performance (Feltz & Landers, 1983; Etnier & Landers, 1996). At the end of the five-week period of treatment, all the students attended the major invitational competition of the season. During the competition all the students, groups 1, 2, 3, and 4, were encouraged to use the mental imagery rehearsal during the warm-up period and before actually competing on the floor routine. The tournament's official judges graded the athletes according to the Federation Internationale de Gymnastique's code of points. The judges had no knowledge of the treatment groups to which the gymnasts actually belonged. The results were compared with the ones collected from the previous two major competitions in terms of proficiency level.

After the competition, during the next practice sessions, imagery ability was retested using the MIQ-R instrument to observe the possible variations in imagery ability. Also a postexperimental semi-structured interview was employed in order to observe the meaning of the imagery program, the adherence to it, and possible future plans. Each participant in the experiment, regardless of the experimental groups he/she belonged, was asked to answer several open-ended questions regarding the imagery program (see Appendix F).

Data Analysis

A 2 x 2 x 2 x 2 (Practice condition by Proficiency level by Gender by Time) ANOVA design was performed on each of the two dependent measures: imagery ability and performance outcome. An alpha level of .05 was used for all statistical tests.

Chapter 4

Results

For the purpose of this study, imagery was defined as “the cognitive rehearsal of a physical skill in the absence of overt physical movement; it can take the form of … engaging in visual and kinesthetic imagery of the performance of a skill or a part of a skill” (Magill, 2004, p. 349). The research literature supports the idea that imagery for skill learning and performance is a useful tool for improving the performance outcomes. The purpose of this study was to observe the effect of different imagery ratios to physical practice needed to learn and perform a gymnastic floor routine. It was assumed that an increase in imagery ability would positively reflect on the floor routine scores. Therefore, two dependent measures were used: imagery ability and performance outcome, before and after treatment.

Twenty-seven gymnasts from the Michigan Academy of Gymnastics, 13 males (mean age 13.38, SD ± 1.93) and 14 females (mean age 13.00, SD ± 2.03) with skill levels between 7 and 10 (according to USGA), were involved in the study. Gymnasts were randomly separated into four homogeneous experimental groups based on gender, skill level, and imagery ability level.

All groups trained five times per week (three times for the floor routine) and they received imagery treatment as follows: groups 1 and 3 performed imagery three times per week (every time they were performing floor routines), whereas groups 2 and 4 performed imagery only once per week during the floor routine practice. To ensure compliance with the treatment, time congruence was observed for imagery validation; a chain puzzle was used as a distracter cognitive task for groups 2 and 4 during the non-imagery floor routine practice times; and finally an adherence signal for successful onset imagery was used to ensure that the sessions were not disturbed in any way.

The task consisted of mental rehearsal of the entire floor routine in “real time” by using external visual imagery combined with kinesthetic imagery. Nothing was changed from the gymnasts’ regular routines (groups, schedule, coaches, etc.), but the imagery treatment before the actual floor routine execution. That is, imagery was added on top of the regular practice schedule. It was assumed that other variables from the applied setting were equally affecting the participants.

At the end of the five-week treatment period, the entire cohort of gymnasts participated at the State Meet Competition. The tournament’s official judges, who were blind regarding the experimental treatment, scored the floor routines in compliance with the Federation Internationale de Gymnastique’s code of points. The results were compared with the previous scores obtained during the fall major competition. In addition, during the following practice sessions, the imagery ability level was reassessed using the MIQ-R (Hall & Martin, 1997).

To test the hypotheses, a 2 x 2 x 2 x 2 (Practice condition by Proficiency level by Gender by Time) ANOVA design was performed on each of the two dependent measures: imagery ability and performance outcome. An alpha level of .05 was used for all statistical tests. The Microsoft Office SPSS for Windows 12.5 program was used for statistical analysis.

Imagery Ability

To examine the differences in imagery ability, results were analyzed with regard to practice condition (imagery ratio), proficiency level, and gender. The results were summarized in Table 1. A statistical analysis of the data showed a significant main effect of treatment on imagery ability, $F(1, 25) = 36.49$, $p < .000$. With the alpha level set at .05, the effects of imagery ratio [$F(1, 25) = .012$, $p = .915$], proficiency levels [$F(1, 25) = .000$, $p = 995$], and gender [$F(1, 25) = .772$, $p = .406$] on imagery ability were not significant. The influence of imagery ratios on imagery ability for the groups receiving imagery treatment three times per week ($M = 51.00$) and the groups receiving one imagery treatment per week (M = 50.16) were significant for alpha set at .001 (Table 2). However, no significant effect of proficiency level 9 and 10 on imagery ability (M = 49.33) or proficiency level 7 and 8 on imagery ability (M = 51.66) was recorded (Table 3). Similarly, gender had no significant effect on imagery ability (M = 49.57) for female gymnasts or (M = 51.76) for male gymnasts (Table 4).

Table 1

Analysis of Variance for Imagery Ability

Source of Variation	Sum of Squares	df	Mean Square	F	p
Between Subjects					
Practice condition (frequency)	17.43	1	17.43	.208	.653
Proficiency level	124.01	1	124.01	1.48	.238
Gender	218.42	1	218.42	2.61	.123
Practice condition x Proficiency level	28.12	1	28.10	.336	.569
Practice conditions x Gender	11.80	1	11.80	.141	.711
Proficiency level x Gender	17.43	1	17.43	.208	.653
Practice condition x Proficiency level x Gender	3.82	1	3.82	.046	.833
Error	1590.01	19	83.68		
Within Subjects					
Time	704.22	1	704.22	36.49	.000***
Time x Practice condition	.225	1	.225	.012	.915
Time x Proficiency level	.001	1	.001	.000	.995
Time x Gender	13.92	1	13.92	.722	.406
Time x Practice condition x Proficiency level	6.94	1	6.94	.360	.556 Time x
Practice condition x Gender	24.17	1	24.17	1.25	.227
Time x Practice condition x Gender x Proficiency level	8.59	1	8.59	.445	.513
Error	366.68	19	19.29		

Note *** p < .001

Table 2

Means and Standard Deviations for Imagery Ratios on Imagery Ability

	Pre Test		Post Test	
	M	SD	M	SD
Groups 1 & 3 (Three times per week)	43.46	9.69	51.00	4.24***
Groups 2 & 4 (One time per week)	42.58	6.82	50.16	4.85***

Note *** $p < .001$

Table 3

Means and Standard Deviations for Proficiency Levels on Imagery Ability

	Pre Test		Post Test	
	M	SD	M	SD
Level 9 & 10	41.91	8.45	49.33	5.28
Level 7 & 8	44.00	8.52	51.66	3.51

Table 4

Means and Standard Deviations for Males and Females on Imagery Ability

	Pre Test		Post Test	
	M	SD	M	SD
Female	40.85	10.33	49.57	4.83
Male	45.46	5.02	51.76	3.87

Performance Outcome

For performance outcomes, the results were analyzed with regard to practice condition (imagery ratio), proficiency level, and gender. The results were summarized in Table 5. There was no significant main effect of treatment on performance outcome, $F(1, 25) = 1.36$, $p < .05$. With the alpha level set at .05, the effects of imagery ratio [$F(1, 25) = .826$, $p = .375$], proficiency levels [$F(1, 25) = .539$, $p = .472$], and gender [$F(1, 25) = .030$, $p = .836$] on performance outcome were not significant.

The influence of imagery ratios on performance outcome for the groups receiving imagery treatment three times per week ($M = 8.70$) and the groups receiving one imagery treatment per week ($M = 8.57$) were not significant (Table 6). Similarly, no significant effect of proficiency level 9 and 10 on performance outcome ($M = 8.63$) or proficiency level 7 and 8 on performance outcome ($M = 8.65$) was recorded (Table 7). Gender produced no significant effect on performance outcome ($M = 8.77$) for female gymnasts or ($M = 8.51$), for male gymnasts (Table 8).

Table 5

Analysis of Variance for Performance outcome

Source of Variation	Sum of Squares	df	Mean Square	F	p
Between Subjects					
Practice condition (frequency)	.119	1	.119	.574	.458
Proficiency level	.071	1	.071	.344	.564
Gender	.694	1	.694	3.35	.083
Practice condition x Proficiency level	.192	1	.192	.928	.348
Practice conditions x Gender	.031	1	.031	.148	.704
Proficiency level x Gender	.049	1	.049	.235	.634
Practice condition x Proficiency level x Gender	.111	1	.111	.536	.473
Error	3.93	19	.207		
Within Subjects					
Time	.180	1	.180	1.36	.257
Time x Practice condition	.109	1	.109	.826	.375
Time x Proficiency level	.071	1	.071	.539	.472
Time x Gender	.004	1	.004	.030	.836
Time x Practice condition x Proficiency level	.000	1	.000	.003	.954
Time x Practice condition x Gender	.017	1	.017	.130	.723
Time x Proficiency level x Gender x Practice condition	.415	1	.415	3.15	.092
Error	2.50	19	.132		

Note: No significance was found for $p < .05$

Table 6

Means and Standard Deviations for Imagery Ratios on Performance Outcome

	Pre Test		Post Test	
	M	SD	M	SD
Groups 1 & 3 (Three times per week)	8.75	0.33	8.70	0.35
Groups 2 & 4 (One time per week)	8.75	0.33	8.57	0.47

Table 7

Means and Standard Deviations for Proficiency Levels on Performance Outcome

	Pre Test		Post Test	
	M	SD	M	SD
Level 9 & 10	8.65	0.46	8.63	0.37
Level 7 & 8	8.82	0.33	8.65	0.44

Table 8

Means and Standard Deviations for Males and Females on Performance Outcome

	Pre Test		Post Test	
	M	SD	M	SD
Female	8.85	0.35	8.77	0.37
Male	8.63	0.42	8.51	0.41

Chapter 5

Discussion

The purpose of this study was to observe the effect of different imagery ratios to physical practice needed to learn and perform a gymnastic floor routine. It was assumed that an increase in imagery ability would positively reflect on the floor routine performance.

Hypothesis

There will be no significant differences in imagery ability from the pretest to the posttest. The MIQ-R scores at the end of the treatment period showed a significant increase in imagery ability from the pretest to the posttest. This finding is consistent with the findings of the study done on the ice skaters (Rodgers, Hall, & Buckolz, 1991). The participants in that study had a comparable age and skill level with the participants in this study. After a 12-week imagery training program they improved their imagery ability.

Because participants had no previous exposure to a formal imagery training program for skill learning and performance, the relatively short treatment period was enough to create a significant increase. It is possible that continuing the treatment, the curve of improvement in imagery ability will be less steep or even reach a temporary plateau. Consequently, having better imagery ability skills improvement can be expected in the performance of motor skills as well.

There will be no significant differences in imagery ability between different imagery ratio groups at the posttest. Both treatment groups, the three times per week treatment group and once per week treatment group, significantly increased their imagery ability over the treatment period. Despite this, there was no significant difference in imagery ability between the treatment groups. That is useful for coaches because even if imagery for motor skill learning and performance is used only once per week, there will be a significant increase in imagery ability, which in time will translate into better performance outcome. Changing the weekly ratios of imagery to further increase the gap between them (say one versus five or six) could provide a different perspective on the effects on imagery ability.

There will be no significant differences in imagery ability between the two proficiency levels at the posttest. It was argued that novice athletes would benefit more from imagery because the initial stage of learning relies heavily on the cognitive component. On the other hand, the more skillful the person is, the better the skill details can be pictured and appropriate correction made if required. Although the participants in this study were skilled gymnasts, their proficiency levels separated them. However, no significant differences were recorded with respect to the skill level and imagery ability. The findings support the previous research by Blair, Hall, & Leyshon (1993). The general findings that more skillful athletes make more benefits from imagery use (Feltz & Landers, 1983; Driskell et al., 1994) were not supported. It is possible that the proficiency level gap between the experimental groups was too narrow to reveal significant differences in imagery ability.

There will be no significant differences in imagery ability between genders at the posttest. The treatment did not reveal gender differences in imagery ability. This finding is consistent with previous research (Salmon, Hall & Haslam, 1994; Munroe, Hall, Simms, & Weinberg, 1998). The gymnasts are separated for training purposes according to the skill level and gender. Since no differences were linked to proficiency and gender with regard to imagery ability outcome, the same generic imagery training program can be used for all at the beginning. Further fine adjustments can then be made to suit each individual, and then grafted on the basic program.

There will be no significant differences in performance from the pretest to the posttest. The imagery research literature supports the fact that imagery training will significantly increase the motor skill learning and performance under certain conditions (Feltz & Landers, 1983; Driskell, Cooper, & Moran, 1994). This study found no significant performance increases after the treatment period. The participants in this study were skilled gymnasts, and one reason for this lack in performance improvement can be the ceiling effect. That is, the participants were reaching the top limit of their performance, and further improvements are hard to detect. A larger sample or a longer treatment period was necessary to make such fine performance improvements tangible and consistent.

Gymnastics is a very subjective sport in terms of assessment. Professional judges assessed the floor routine performance, and the scores were awarded in concordance with the Federation Internationale de Gymnastique's scoring procedures. In addition, more than one individual will score the gymnast's performance. At the National and Olympic level, providing a full panel of judges reduces the human error. The final score is the average score after eliminating the lowest and the highest score. However, in our case only two judges were officiating at the State Meet. Therefore the possible human error was added to the very small scores' distribution (less than .5 points).

There will be no significant differences in performance between different imagery ratio groups at the posttest. The statistical analysis of the data showed no significant differences in performance between the different imagery ratio groups. However, the difference in performance between the two imagery ratio groups was close to significance. Again, using a comparable sample but changing the length of the treatment period and/or widening the gap between the experimental groups, the results could possibly offer more concluding facts regarding the influence of the numbers of imagery sessions on skill performance.

There will be no significant differences in performance between the two proficiency levels at the posttest. The treatment failed to reveal significant changes in performance outcome for the two proficiency levels. As the imagery ability did not change over the treatment period with regard to the proficiency levels, no significant changes in performance were expected either. In other words, if any significant changes in performance would occur, those could not be attributed to the imagery training since the imagery ability was stable over time with regard to the proficiency levels.

There will be no significant differences in performance between genders at the posttest. The statistical analysis of the data showed no significant differences in performance between genders. However, the difference in performance between genders approached significance. Since the treatment did not reveal gender differences in imagery ability, the cause that generated differences in performance gender-wise cannot be attributed to the treatment. It seems logical that other factors, not accounted for in this study, are responsible for such influences.

Postexperimental interview

During the length of the study, researchers sought to control as many as possible of the extraneous variables. In this respect the training environment was not changed at all; the experimenter got acquainted with the gymnasts and coaches and observed many training sessions before the starting date of the experiment. Therefore it could be stated that the participants suffered no other influences during the training sessions but the ones from the treatment.

During the time spent outside the gymnasium (school, home, other extracurricular activities, etc.), many factors could intervene and influence the variables at interest in this study. A semi-structured postexperimental interview was employed to identify such possible factors. The data below does not include the first week of training, when the participants were familiarized with imagery and had regular imagery homework assignments. Due to objective causes, one participant could not be interviewed. The highlights of the interview were:

- Seventeen participants (65.3%) perceived imagery to be a useful tool to improve performance, and eight participants (30.7%) found imagery somewhat helpful in enhancing performance. Only one participant considered imagery not helpful at all to improve the floor routine performance.

- Sixteen gymnasts (61.5%) performed a complete imagery session before competing on the floor routine. Six participants (23%) performed only a partial imagery session due to time constraints, and three participants (11.5%) used imagery for another event (rings or beam). One gymnast did not use imagery during the competition at all.
- The imagery use outside the gym (informal imagery) during the treatment period was distributed as follows: nine individuals (34.6%) did not use imagery outside the gymnasium; twelve individuals (46.1%) used imagery once per week during the treatment period; two individuals (7.6%) used imagery twice per week during the treatment period; and three individuals (11.5%) used imagery three times per week during the treatment period. Given the percentages above regarding the imagery on the criterion task outside the practice sessions, it was assumed that no significant influence was transferred toward the experimental dependent variables.
- Twenty-two gymnasts (84.6%) reported that they would use imagery regularly in the future along with their regular practice routines. The remaining four gymnasts (15.3%) reported that they would use imagery only if regular practice is not helpful enough to achieve best results or during future competitions.

The findings above support the former findings regarding the perceived influence of imagery upon skill learning and performance. In their study regarding the influence of the order of presentation of imagery practice, Etnier & Landers (1996) reported that 76% of participants found imagery helpful or very helpful. Without quantifying the data, Rodgers, Hall, & Buckolz (1991) reported that participants, coaches, and parents felt that imagery was beneficial, and they chose to pursue the training program after the termination of the study. In another study involving skilled and novice soccer players, Blair, Hall, & Leyshon (1993), again without reporting quantified data, found similar results on the questionnaire administered at the end of the study. The postexperimental interview information was used to assess compliance with the formal imagery treatment during the practice sessions and not to infer any effects of imagery on skill performance.

Imagery Validation

The time congruence has been successfully achieved, despite the fact that the participants received no prior formal training in imagery for skill learning and performance. The gymnastic floor routine consists of highly automatic, serial skills. The participants were skilled gymnasts, and during regular practice sessions the training focus was on the accuracy of the movement (form and timing). Therefore, the duration of the imagery session must closely resemble the duration of the actual performance in order to validate the imagery session. Beginning with the middle of the second week of treatment, when entire floor routines were mentally rehearsed, close attention was paid to timing. When the kinesthetic imagery was added to the visual imagery, the timing of imagery sessions was matching the real performance time within a margin of ± 4-5 seconds. The female participants exhibited even a more precise timing. The female floor routine in gymnastics is accompanied by music. Besides the emotional and esthetic load added to the routine, the rhythm is preserved as well. It was assumed that the difference in imagery timing between the male and their female counterpart was made by the music. Thus, the study supported the previous findings with regard to imagery timing (Moran & MacIntyre, 1998; Guillot & Collet, 2005).

Summary

The purpose of this study was to observe the effect of different imagery ratios to physical practice needed to learn and perform a gymnastic floor routine. It was assumed that an increase in imagery ability would reflect positively on the floor routine performance. Twenty-seven school-aged, male and female, skilled gymnasts participated in the study. They were randomly separated into four experimental groups: two groups received three imagery sessions per week and two groups received one imagery session per week. The only delimitation was the use of proficiency levels, the imagery ability levels, and gender to ensure the homogeneity of the four experimental groups. After five-week imagery training for motor skill learning and performance, the overall imagery ability increased significantly. There were no differences in imagery ability with regard to the gender, proficiency level, and practice conditions. There was no significant difference in performance outcomes. Several possible barriers preventing the imagery ability increase from being translated into performance increase included a possible ceiling effect in performance, a short treatment period, and the subjective human factor occurring in scoring the gymnastics routines.

Recommendation for further research

More tangible results will probably occur if a larger sample size is used from several different clubs. A longer treatment period will probably bring significance, where the results in this study only approached significance. It will also be interesting to use a larger gap between the skill levels and the imagery ratio. A larger gap in proficiency level (say observing levels 7 and 10) and in imagery sessions per week (1 versus 5) will probably better clarify the discussion regarding the imagery ability and its influence on performance outcome.

The competition environment differs significantly from the training environment: more tension, many distracters, and time constraints. It is expected that imagery will suffer significant changes to suit the needs. However, the time spent during training with regard to imagery is much longer than the time spent during competition with regard to imagery. It will be interesting to separately compare the effectiveness of imagery during training and competition.

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Appendix A

EASTERN MICHIGAN UNIVERSITY

Request for Approval of Research Involving Human Subjects

EASTERN MICHIGAN UNIVERSITY

Request for Approval of Research Involving Human Subjects

Date Submitted: ___11/25/2004___ Due Date of Proposal ______________________

Principal Investigator: ____Adrian Popescu____

Co-PI/Project Director: _________Dr. Murali Nair___________
Title of Project: "The effect of different imagery ratios on learning and performing a gymnastic floor routine"
From what sources are funds expected for this project? ___No external funds are expected for this project________
Department: ____HPHP_____________ Telephone_________(734) 487 - 7120_________

I. Is this application: New___X__ Renewal_____ Modification_____

If Renewal or Modification:

a. Date of last approval by this Committee: ___________________
b. Principal Investigator previous research: ___________________
c. Describe any modifications in the in the previously approved research protocols:
d. Were any human subjects encountered in previous research? If yes, how were they handled?

II. Numbers, Types and Recruitment of Subjects

a. Numbers and characteristics of subjects (e.g., age, ranges, sex, ethnic background, health status, handicapping conditions, etc.):

Fifteen males and 12 females, students of the Michigan Academy of Gymnastics, will participate in this study. They are healthy teenagers between the age ranges of 11 and 18.

b. Special Classes. Explain the rationale for the use of special classes of subjects such as pregnant women, children, prisoners, mentally impaired, institutionalized, or others who are likely to be particularly vulnerable:

The reason for selecting teenager athletes is because gymnastics generally involves younger participants. In addition imagery plays a crucial role in gymnastics.

c. How is the individual subject to be recruited for this research? Is it clear to the subjects that participation is voluntary and that may withdraw at any time negative consequences?

The participants will be recruited on a voluntary base from the skill groups already participating in the regular training program. The regular training routine will not be modified. The treatment provided is in addition to the regular practice sessions. At any time during the experiment the participants are free to withdraw without suffering any kind of negative consequences.

III. Informed Consent

a. To what extent and how are the subjects to be informed of the research procedures before their participation?

At the beginning of the season (during one of the regular practice sessions), all the students will be debriefed on the topic of imagery for motor skill learning and performance, the methods to be used and the benefits resulting from the experiment. It will be emphasized that participation is voluntary.

b. Attach a copy of written "Informed Consent Form" or a written statement of the oral consent.

IV. Risks Involved in the Research

Does the research involve any of the following procedures?
Deception of the subject……………………………………………yes no (X)
Punishment of the subject…………………………………………yes no (X)
Use of Drugs in any form………………………………………… yes no (X)
Electric Shock……………………………………………………….. yes no (X)
Deliberate production of anxiety or stress…………………………… yes no (X)
Materials commonly regarded as socially unacceptable…………….. yes no (X)
Use of radioisotopes………………………………………………. yes no (X)
Use of chemicals…………………………………………………. yes no (X)
Drawing of blood…………………………………………………. yes no (X)
Any other procedure that might be regarded as
including in the subject any altered state or condition
potentially harmful to his/ her personal welfare…………………. yes no (X)
Any other procedure that might be considered as an
invasion of privacy………………………………………………. yes no (X)
Disclosure of name of individual subjects
participating in the research……………………………………... yes no (X)
Any other physically invasive procedure………………………….. yes no (X)

a. If the answer to any of the above is 'YES", please explain this aspect of the research in details:

b. Describe the procedure for protecting against or minimizing any potential risk:
This study does not add any additional risks or discomforts. There will be no interference with the regular practice routine other than incorporating imagery, which is a mental process.

V. Confidentiality

a. To what extent is the information confidential and to what extent are provisions made so that subjects are not identified:

The results will be reported as groups and not as individual participants. No records will be kept regarding individual information. The sole reason to assess individuals is to form the experimental groups and to observe eventual improvements at the end of the treatment.

b. What are the procedure for handling and storing all data so that the confidentiality of the subjects is protected (particular attention should be given to the use of photographs, video, and audio recordings):

There will be no photographs, video or audio recordings. All the recordings (paper based or digital) will be privately stored for the duration of the investigation. When the project is concluded, all the recordings will be destroyed.

c. By what means will the results of the research be disseminated? Will the subjects be informed of the results? Will confidentiality of subjects or organizations be protected in the dissemination?

The name of the organization will appear on the final report but, not the participant's names. The results will be reported as experimental group's achievement levels. Therefore only group results will be reported and no participant identity will be singled out. The results of this research will appear in a thesis format and may be published.

VI. Describe any anticipated benefits to subjects from participation in this research:

From this experiment participants will be provided with an imagery program. The participants will develop their imagery ability as well. Both the program and the ability level will further help them in learning and performing gymnastics skills.

VII. Attach a copy of the full research proposal including copies of all instruments or tests to be used. If instruments are not fully developed attach drafts and so indicate.

Principal Investigator Signature ____________________ Date _________________

Appendix B

Informed Consent for Research Involving Human Subjects

Eastern Michigan University
Informed Consent for Research Involving Human Subjects

Title of Project:

"The Effect of Different Imagery Ratios on Learning and Performing a Gymnastic Floor Routine"

Principal investigator: Adrian Popescu
padrian@emich.edu
Thesis advisor: Murali Nair PhD
mnair@emich.edu

Methods

Your child has been invited to take part in a study examining the effect of imagery on learning and performance of motor skills. For this purpose, the entire group of athletes forming the skill level groups 7, 8, 9 and, 10, of the Michigan Academy of Gymnastics, will be asked to participate in this study. The role of imagery in gymnastics is critical to skill learning and performance. The existing research favors college aged participants and athletes, during lab settings approaches. In contrast, this study will involve an applied setting (in gymnastics) and skilled participants with no prior experience in imagery for skill learning and performance.

The treatment will consist of short imagery sessions during the regular training sessions. The regular training routine will not be changed at all. The athletes' imagery ability will be assessed using the Mental Imagery Questionnaire-Revised instrument (Hall & Martin, 1997). This instrument consists of a set of eight statements. Each statement requires the participant to perform a simple movement. Immediately after, each participant will either form a clear and vivid visual image or attempt to feel the movement that was performed, and rate the ease/difficulty with which the task was accomplished. The reason for this is to form homogeneous experimental groups and to observe possible improvements during the training session.

There will be four experimental groups. During the regular practice periods, two of the groups will receive imagery treatment prior to the floor routine (three times per week). The remaining two groups will receive the imagery treatment only once per week. For the remaining two sessions without imagery treatment, a simple cognitive task will be used as a distracter instead.

At the end of the three-week period of treatment, all the participants will attend the regular major invitational competition of the season. During the competition, and regardless of the treatment groups they belonged, everyone will be encouraged to use imagery during the warm-up period and before the actual performance on the floor routine. The tournament's official judges will grade the athletes without any knowledge of the treatment they received. The results will compared with the ones collected from the previous two major competitions in terms of proficiency level to observe eventual improvements.

Risks:

This study may involve minor risks or discomforts to the regular practice schedule. There will be no interference with the regular practice routine other than incorporating imagery, which is a mental process. Therefore no additional foreseeable risks or discomforts are expected from this study.

Benefits:

The purpose of the research will eventually lead to a fruitful imagery training program for gymnastics considering the particular setting and skill level of the participants. Imagery training combined with physical practice of the skill can benefit athletes during the process of motor skill acquisition and performance. That is during a shorter period of time the skill proficiency will be improved with less physical effort compared to physical training alone.

Eastern Michigan University
Informed Consent for Research Involving Human Subjects

Title of Project:

"The Effect of Different Imagery Ratios on Learning and Performing a Gymnastic Floor Routine"

Principal investigator: Adrian Popescu
padrian@emich.edu
Thesis advisor: Murali Nair PhD
mnair@emich.edu

I, ____, hereby give my consent for my minor child to participate in the research study entitled "The Effect of Different Imagery Ratios on Learning and Performing a Gymnastic Floor Routine". I have been provided all the details regarding this project, the risks and potential benefits.

I understand that participation is under a voluntary base. I can withdraw my consent and discontinue my minor child participation in this research at any time without the occurrence of any negative consequences.

I understand that the results of this research will appear in Adrian Popescu Master's thesis and may be published as well. My child's name or identity will not be revealed. Only group results will be reported and no participant identity will be singled out.

I understand that Eastern Michigan University doesn't provide financial compensation for my child participation in this research.

____
Parent/Legal guardian Signature

I hereby certify that I have given complete information about my project and I explained the risks and the possible benefits for the project.

____
Principal Investigator Signature

Eastern Michigan University

Department of Health Promotion and Human Performance

Minor Child Assent Form

I, ___________________________________, understand that my parents have given permission for me to join the group involved in the research project concerning the use of imagery for learning and performing gymnastics skills. This project is done by Adrian Popescu.

I am part of this project because I want to. I have been told that I can stop at any time during the course of the project without suffering any negative consequences.

____
Signature

Appendix C

Movement Imagery Questionnaire – Revised

MIQ-R (Hall & Martin, 1997)

Movement Imagery Questionnaire – Revised
MIQ-R (Hall & Martin, 199_)

Instructions

This questionnaire concerns two ways of mentally performing movements which are used by some people more than by others, and are more applicable to some types of movements than others. The first is attempting to form a visual image or picture of a movement in your mind. The second is attempting to feel what performing a movement is like without actually doing the movement. You are requested to do both of these mental tasks for a variety of movements in this questionnaire, and then rate how easy/difficult you found the tasks to be. The ratings that you give are not designed to assess the goodness or badness of the way you perform these mental tasks. They are attempts to discover the capacity individuals show for performing these tasks for different movements. There are no right or wrong ratings that are better than others.

Each of the following statements describes a particular action or movement. Read each statement carefully and then actually perform the movement as described. Only perform the movement a single time. Return to the starting position for the movement just as if you were going to perform the action a second time. Then depending on which of the following you are asked to do, either (1) form as clear and vivid a visual image as possible of the movement just performed, or (2) attempt to feel yourself making the movement just performed without actually doing it.

After you have completed the mental task required, rate the ease/difficulty with which you were able to do the task. Take your rating from the following scale. Be as accurate as possible and take as long as you feel necessary to arrive at the proper rating for each movement. You may choose the same rating for any number of movements "seen" or "felt" and it is not necessary to utilize the entire length of the scale.

RATING SCALES

Visual Imagery Scale

7	6	5	4	3	2	1
Very easy to see	Easy to see	Somewhat easy to see	Neutral (not easy not hard)	Somewhat hard to see	Hard to see	Very hard to see

Kinesthetic Imagery Scale

7	6	5	4	3	2	1
Very easy to feel	Easy to feel	Somewhat easy to feel	Neutral (not easy not hard)	Somewhat hard to feel	Hard to feel	Very hard to feel

Scoring instructions:

Odds numbered items represent Kinesthetic imagery, evens Visual imagery. Both are scored out of a total of 7 x 4 = 28. Higher the score = the better the ability.

1. ***STARTING POSITION*****:** Stand with your feet and legs together and your arms at your sides.

ACTION**:** Raise your knee as high as possible so that you are standing on your left leg with your right leg flexed (bent) at the knee. Now lower your right leg so that you are again standing on two feet. Perform these actions slowly.

MENTAL TASK**:** Assume the starting position. Attempt to feel yourself making the movement just performed without actually doing it. Now rate the ease/difficulty with which you were able to do this mental task.

RATING**:** _____________

2. ***STARTING POSITION*****:** Stand with your feet slightly apart and your hands at your sides.

ACTION**:** Bend down low and then jump straight up in the air as high as possible with both arms extended above your head. Land with your feet apart and lower your arms to your sides.

MENTAL TASK**:** Assume the starting position. Attempt to see yourself making the movement just performed with as clear and vivid a visual image as possible. Now rate the ease/difficulty with which you were able to do this mental task.

RATING**:** _____________

3. ***STARTING POSITION*****:** Extend your arm of your nondominant hand straight out to your so that it is parallel to the ground, palm down.

ACTION**:** Move your arm forward until it is directly in front of your body (still parallel to the ground). Keep your arm extended during the movement and make the movement slowly.

MENTAL TASK**:** Assume the starting position. Attempt to feel yourself making the movement just performed without actually doing it. Now rate the ease/difficulty with which you were able to do this mental task.

RATING**:** _____________

4. ***STARTING POSITION*****:** Stand with your feet slightly apart and your arms fully extended above your head.

ACTION**:** Slowly bend forward at the waist and try and touch your toes with your fingertips (or if possible, touch the floor with your fingertips or hands). Now return to the starting position, standing erect with your arms extended above your head..

MENTAL TASK**:** Assume the starting position. Attempt to see yourself making the movement just performed with as clear and vivid a visual image as possible. Now rate the ease/difficulty with which you were able to do this mental task.

RATING**:** _____________

5. ***STARTING POSITION*****:** Stand with your feet slightly apart and your hands at your sides.

ACTION**:** Bend down low and then jump straight up in the air as high as possible with both arms extended above your head. Land with your feet apart and lower your arms to your sides.

MENTAL TASK**:** Assume the starting position. Attempt to feel yourself making the movement just performed without actually doing it. Now rate the ease/difficulty with which you were able to do this mental task.

RATING**:** _____________

6. ***STARTING POSITION*****:** Stand with your feet and legs together and your arms at your sides.

ACTION**:** Raise your knee as high as possible so that you are standing on your left leg with your right leg flexed (bent) at the knee. Now lower your right leg so that you are again standing on two feet. Perform these actions slowly.

MENTAL TASK**:** Assume the starting position. Attempt to see yourself making the movement just performed with as clear and vivid a visual image as possible. Now rate the ease/difficulty with which you were able to do this mental task.

RATING**:** _____________

7. ***STARTING POSITION*****:** Stand with your feet slightly apart and your arms fully extended above your head.

ACTION**:** Slowly bend forward at the waist and try and touch your toes with your fingertips (or if possible, touch the floor with your fingertips or hands). Now return to the starting position, standing erect with your arms extended above your head..

MENTAL TASK**:** Assume the starting position. Attempt to feel yourself making the movement just performed without actually doing it. Now rate the ease/difficulty with which you were able to do this mental task.

RATING**:** _____________

8. ***STARTING POSITION*****:** Extend your arm of your nondominant hand straight out to your so that it is parallel to the ground, palm down.

ACTION**:** Move your arm forward until it is directly in front of your body (still parallel to the ground). Keep your arm extended during the movement and make the movement slowly.

MENTAL TASK**:** Assume the starting position. Attempt to see yourself making the movement just performed with as clear and vivid a visual image as possible. Now rate the ease/difficulty with which you were able to do this mental task.

RATING**:** _____________

Appendix D

Time line of imagery sessions

Time line of imagery sessions

None of the participants in this experiment had prior formal training in imagery for skill learning and performance. After a one session debriefing on imagery use in sports for skill learning and performance, all participants in this study followed the same training for about one week period. During a one on one, 2-3 minute sessions, all participants followed a similar sequence

1. The first step consisted of simple imagery exercises. The participants visualized abstract geometrical forms and then familiar objects (fruits, cars, houses etc.). They were asked to manipulate them once “seen” to change the color and size, to add sounds, taste, and haptic information to them. These exercises were extended to homework like assignments, and discussed afterwards during the next regular practice session privately with the investigator.

2. The second step in progression was to visualize static gymnastics skills (i.e. the handstand, the scale, the landing position etc.) insisting in adopting an external visual perspective with the express request to try hard to visualize their own bodies performing the skills. Exactly like before, the onset sessions were extended to home assignments.

3. At the end of the first week the participants’ imagery ability was assessed using the Movement Imagery Questionnaire – Revised (Hall & Martin, 1997).

4. During the second week of training one entire pass (easiest pass) was visualized using imagery. As mentioned earlier, each participant had an individualized floor routine suiting his/her abilities. The pass approached first during imagery, generally consisted of an approach run, hurdle, round-off, back handspring, back tuck, and landing. Starting with this phase of the program the

imagery sessions were rehearsed onset only. The home take routines were optional and freely reported on the next day of practice.

5. Each pass was separately visualized afterwards. It was recommended that a third person perspective must be adopted since the form of the movement is crucial for gymnastics. However, imagery was not restricted in any way, and later all gymnasts reported they used external visual imagery for their imagery sessions.

6. The entire floor routine was visually rehearsed starting with the third week of training. The kinesthetic part was brought in at this point. The gymnasts performed imagery from a standing position, with their eyes closed, while sketching body segments movements corresponding to the visual imagery. The literature defines it as "mental simulation with movement" (Holmes & Collins, 2001).

8. During the fourth and fifth week of training the competition setting was modeled with imagery. This coincided in time with competition modeling for the actual practice rehearsals of the floor routine (limited time of warm-up period on the official floor, a single scored performance during the practice session etc.). At this point in training, individualized imagery scripts were provided to the participants. The scripts contained a generic stimulus proposition section, an individualized response proposition section and an individualized meaning propositions section (Smith et al, 2001; Lang, 1979). The specific individual response, and the meaning proposition key words were collected during the daily discussions episodes.

9. After the competition, the imagery ability was reassessed using the MIQ-R.

10. After the competition, and during the regular practice sessions, an interview was conducted as well. During private discussions it was investigated how imagery for skill learning and performance was perceived by the participants (see Appendix 5).

Appendix E

Imagery Script

Imagery Script

To physically dissociate the gymnasts from the busy environment, a “quiet” place was found. Facing away from the apparatus, the participants adopted a standing position with the feet slightly apart and the hands at their sides. In order to achieve a “quiet” mind, a breathing technique was employed. Participants entered a fictitious room, detaching themselves from the environment, and through one or more deep breaths they attempted to put their mind at rest.

The following approach was used:

- The imagery session started with generic stimulus propositions: “You find yourself at the State Meet; you hear your number called by someone and you start to approach the floor apparatus. You can “see” the crowd in the stands waving their banners and you can “hear” them cheering for the competitors. You can clearly “hear” your teammates cheering for you. You can feel the carpet texture with your bare feet, as you stand ready to begin your floor routine.”
- The response propositions were individualized in accordance with the participants’ previously collected statements. The key words used here, resembled their unique physiological and psychological responses to the competition.
- The meaning propositions were, as well, individualized according to the participants’ statements.
- “Finally the judges are giving you the OK sign. You salute them and start with your routine.”

- At this point the participant started the visual imagery combined with kinesthetic imagery session. The duration of the imagery session was timed and the body segments movement was closely examined in order to validate the imagery session.
- Shortly after the imagery completion, the participants approached the apparatus and performed the actual floor routine.

Here is the example of one of the imagery scripts, the way it was conceived for one of the participants:" Maria, you find yourself at the state meet; you hear your number called by someone and you start to approach the floor apparatus. You can "see" the crowd in the stands waving their banners and you can "hear" them cheering for the competitors. You can clearly "hear" your teammates cheering for you. You can feel the carpet texture, as you stand bare feet ready to begin your floor routine. You know that the meet is important to you and you are thinking how to improve your performance compared with the former gymnast you observed. You feel nervous and you have butterflies in your stomach. You are excited. You have sweaty feet and you can feel the chalk on your palms. You bounce on your feet and fix your sleeves. The judges are giving you the "OK" sign; you salute them and start your floor routine…"

Appendix F

Postexperimental interview

Postexperimental interview

1. Was imagery helpful or detrimental regarding your skill level improvement? How did, or did not, imagery helped you to improve performance?

2. Did you perform imagery before competing for the floor routine at the State Meet? How was it?

3. During the last month of imagery training did you use imagery outside the practice sessions as well? Please provide some details regarding where, when and how did you use imagery.

4. Do you plan to use imagery in the future? If the answer is yes, please explain how you plan to do that. If the answer is no, then please explain why is that.