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An examination of data supporting hypothesized mediational pathways underlying the relationship between mental imagery and motor skill performance: A meta-analysis

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ABSTRACT

Most sport psychologists have integrated mental imagery practice in their arsenal of cognitive strategies to enhance motor skill performance among athletes, however variable its influence. The variability of motor behavior seen when practicing mental imagery has evaded solid scientific explanation. Alternative interpretations abound with every experimental investigation realised. The present study was conducted to provide an explanation as to the mechanism in play that accounts for this variability in motor skill performance and show how mental imagery practice works. The primary method of this research was to synthesize pertinent mental imagery practice studies, used then to validate a set of model study relationships showing the mediational role of psychological variables. From an initial search of 2,160 primary studies from the literature, experimental primary studies including an implication of a mental imagery practice, a motor skill performance intent, and at least one measure of the following three psychological variables, arousal, state-anxiety and self-confidence, 47 primary studies were extracted. Using the format of a series of meta-analyses to integrate data points common in part or in whole from the 47 primary studies, converted to a total of 227 effect magnitudes (EM) and based on Paivio's Analytical Framework, the mediational model study relationships were tested. The results showed that 9 of the 10 model study relationship main effects were significant at .01. All of the model study relationships showed significant heterogeneity. Where data permitted, moderator subgroup multivariate analyses were conducted and a portion of the heterogeneity in 6 of the 9 significant study relationships was accounted for. Thus, in conclusion, the findings strongly suggest that mental imagery practice effects are mediated by the motivational variables arousal, state-anxiety and self-confidence, but the unexplained heterogeneity in the EM prevents further conclusions with any certainty. The results of the present study suggest however that Paivio's Analytical Framework offers a viable explanation at the motivational level of the

mechanism at play as to how an individual does enhance his motor skill performance when he practices mental imagery.

RÉSUMÉ

La plupart des psychologues du sport ont intégré la pratique de l'imagerie mentale à leur palette de stratégies cognitives malgré l'influence variable de cette pratique sur la performance motrice des athlètes. Les mécanismes par lesquels la pratique d'imagerie mentale exerce son influence ont échappé aux explications scientifiques rigoureuses. En effet, les recherches expérimentales donnent lieu à une multitude d'interprétations. Paivio (1985) propose un cadre analytique selon lequel la pratique de l'imagerie mentale jouerait un rôle tant sur le plan de la motivation que de la cognition. Il croit fermement que le rôle motivationnel de la pratique de l'imagerie mentale est relié à la capacité de coder symboliquement le comportement et les émotions. C'est-à-dire qu'une personne peut imaginer un but, le coder comme un comportement en plus d'en coder les conséquences. Selon la perspective générale de la motivation, le cadre analytique de Paivio supporte la prédiction que les variables affectives, telles que l'optimisation du niveau d'activation, le contrôle d'anxiété d'état et le rehaussement de la confiance en soi, augmente la performance motrice. Pour sa part, la pratique de l'imagerie mentale, dans le cadre analytique de Paivio, a une utilité démontrable quant au contrôle de ces construits pour effectuer le nécessaire en vue de rehausser la performance motrice. La présente étude vise à étudier comment l'imagerie mentale opère pour influer sur la performance motrice. Les fondements de notre recherche se composent principalement d'une synthèse des études pertinentes sur la pratique d'imagerie mentale utilisées pour valider une série de modèle démontrant le rôle de médiation des variables psychologiques. Cette étude veut d'abord examiner si le niveau d'activation, le contrôle de l'anxiété d'état et le rehaussement de la confiance en soi jouent un rôle de médiation sur la motivation d'une personne quand il pratique l'imagerie mentale afin d'améliorer sa performance motrice.

Pour la collecte de données nous avons répertorié la documentation disponible sur la pratique de l'imagerie mentale et la performance motrice en effectuant des recherches dans les

banques de références pertinentes: Medline, ERIC, PSYC, DISS, CD Thèse, Current Contents, Sports Discuss et Science Citation. Les dates de parution s'étendent de 1966 à mars 1999. Les critères de sélection de toutes les études sont: une pratique d'imagerie mentale, une intention d'effectuer un geste moteur, au moins une mesure d'une des variables médiatrices (activation, anxiété d'état ou confiance en soi) et finalement les données statistiques nécessaires pour calculer l'amplitude de l'effet (EM). La procédure s'appuyait sur le cadre analytique de Paivio(1985) et un modèle modifié lesquels ont été utilisés pour fournir l'information aux processus de méta-analyse. Les analyses finales portaient sur les études empiriques des relations entre les composantes du modèle modifié. Le regroupement des relations, élargi ou réduit au sein du modèle modifié, était basé sur la disponibilité des données. Une série de méta-analyses multivariées a été utilisée afin de vérifier le EM de chacune des relations du modèle modifié. Les données simples de 47 études empiriques, dont chacune a fourni une ou plusieurs mesures dépendantes, ont été analysées par la procédure de Hedges et Olkin (1985). Cette procédure nous a permis de corriger la dépendance entre les données et de vérifier si les EM's étaient homogènes (Q_E). L'intégration de 227 EM's a été effectuée.

Dans cette étude de synthèse, il devient apparent qu'il existe une pénurie d'études. Cette pénurie se retrouvent surtout du côté de la performance motrice du modèle modifié. Il est aussi important de noter que 25% des EM proviennent de données corrélationnelles. Les résultats ont démontré que neuf sur dix des relations du modèle modifié étaient significatives à .01, mais aussi qu'elles étaient toutes hétérogènes. Les résultats appuient la théorie selon laquelle la pratique d'imagerie mentale peut rehausser l'activation, l'anxiété d'état et la confiance en soi. Par contre, elle est moins efficace quand elle est utilisée pour diminuer soit le niveau de l'activation ou le niveau de l'anxiété d'état. Du côté de la performance motrice du modèle modifié, seules l'auto-efficacité (i.e. une mesure spécifique de confiance en soi d'état) et une diminution du niveau d'activation influencent une augmentation importante de la performance motrice. Quant à elle, la confiance en soi générale n'exerce pas un effet significatif sur la performance motrice. Un niveau élevé d'activation a un effet faible et négatif sur la performance motrice et, compte tenu de la pénurie de données, le construit de l'anxiété d'état élevée regroupée a démontré un effet lui aussi négatif et faible sur la performance motrice.

En conclusion, les résultats de l'étude suggèrent que les variables *médiatrices activation, anxiété d'état* et *confiance en soi* (c.à.d auto-efficacité) servent d'intermédiaire psychologique motivationnel quand une personne pratique l'imagerie mentale afin d'améliorer sa performance motrice. En ce qui concerne l'hétérogénéité trouvée dans les effets principaux (e.g. EM), lorsque les données le permettaient, des analyses post hoc de méta-analyse multivariée ont été effectuées afin d'identifier des variables modératrices qui pourraient expliquer la variance présente. Une analyse de six des neuf relations du modèle modifié a pu être effectuée et en tout ou en partie l'hétérogénéité présente dans les EMs a pu être expliquée. Les variables modératrices qui ressortent le plus fréquemment sont le type de tâche et la durée de la pratique d'imagerie mentale. Néamoins, la pénurie d'études empiriques limite l'analyse post hoc des modérateurs et ne permet pas d'expliquer l'hétérogenité résiduelle et conséquemment la portée des résultats en est réduite .

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CHAPTER 1: Theoretical Framework

1.0 Introduction

The sport psychology literature attests to the positive influence mental practice plays in the enhancement of the motor skill performance of athletes. In the course of the last twenty years a growing number of researchers (Feltz & Landers, 1983; ; Hall, Rodgers & Barr, 1990; Mumford & Hall, 1985; Paivio, 1985) have investigated the potential role of mental practice as a complement to physical practice when learning and performing a motor skill. Amongst the many mental practice strategies advanced in the literature, mental imagery is very prevalent.

Although researchers in the field generally acknowledge the efficacy of mental imagery practice for improving motor performance (Feltz & Lander, 1983; Feltz, Landers & Becker, 1988), there is no clear-cut evidence as to how mental imagery practice actually works (Jowdy & Harris, 1991). The inconsistency of the mental imagery effect upon motor performance has stymied research in mental imagery. The mechanisms at play has yet to be identified. Although several hypotheses have been proposed in an attempt to shed some light on how mental imagery functions, little has been verified. Alternative interpretations abound with every experimental investigation conducted.

1.1 Problem

The mental practice literature presents mental imagery as a viable cognitive intervention to enhance motor skill performance. Feltz and Landers (1983) and Feltz, Landers and Becker (1988) have established this relationship, there is a substantive link. There may be several factors which could explain the mental imagery practice effect and as such explain its variable effect on motor skill performance. Sport psychologists are searching in effect for those factors.

Past outcome based meta-analyses (Driskall, Copper & Moran, 1994; Feltz 1984; Feltz *et al,* 1988; Hinshaw, 1991; Oslin, 1985) have all corroborated the mental imagery practice influence on motor skill performance, but the mechanism at play which could explain the effect has eluded any simple explanation. The variability alone across these studies would lead us to suspect that other forces other than mental imagery may be at work. An examination of the effect sizes (ES), the common metric used in synthesis analysis like meta-analysis to express the size of a treatment effect, range from .43 to .68. All moderate by convention and variable, lead us to the speculation that there may be something else influencing the mental imagery - motor skill performance relationship. It is unlikely that further study of performance based variables could serve to explain any more of the variability. Further descriptive and synthesis investigations of mental imagery practice main effects would also do little to explain the variability and to develop theory. Rather, theory building must come from another source. A more in depth scientific probing of the nature and function of mental imagery practice based on multi-pronged mechanistic explanations is needed.

In addition to the mechanisms based on information processing that render motor patterns more efficacious, other hypotheses of mechanisms have been advanced in an attempt to explain the influence of practicing mental imagery to improve motor skill performance. The motivational approach proposed by Wager & Sternberg, 1985, would advocate that practicing mental imagery contributes to the betterment of motor skill performance by optimizing certain psychological motivational determinants (e.g. arousal, anxiety and self-confidence). One important facet to this approach is the effect of a positive influence of mental imagery practice on the psychological well-being (i.e. anxiety levels or self-confidence levels) of athletes.

1.1.1 Situating the problem in relation to Paivio's « analytical framework »

Paivio (1985) believes the motivational role of mental imagery practice lies in its capacity to symbolically code behaviour. As individuals we are constantly coding or assigning symbols to represent incoming information, cognition and even emotions. What Paivio is alluding to is that an individual can actually imagine goals, code them as behaviours as well as code their corresponding consequences. Take for example, in a winning scenario for an athlete during competition, the goals, the act and the resulting success can all be represented symbolically through mental imagery practice. Intermediary variables as well are thought to be affected by such a cognitive intervention. Individual's perceived self-efficacy, a form of a situationally specific self-confidence is believed to be heightened after a mental imagery practice and by consequence produce an increase in motor skill performance (Feltz & Albrecht, 1986).

The investigation in the motivational realm of mental imagery theory, based on substantive psychological variables may put some order and give direction to investigators in the field. Our primary concern now would be the identification of psychological variables that would mediate this relationship and account for some of the variable effect of mental imagery practice. In short, we would like to show not that it works but rather, ***how*** it works.

Since 1986 the literature has supported the general notion that the practice of mental imagery influences positively variables like arousal, self-confidence and state-anxiety (GalOr, Tenenbaum & Shimrony, 1986). However, it has been difficult linking these psychological variables to motor skill performance when individuals practice mental imagery in any clear concise fashion. There are few experimental studies which have attempted to verify in a simultaneous fashion the influence of the practice of mental imagery on an athlete's arousal, self-confidence and state-anxiety as mediating variables and their respective effect on each other, as well as on motor skill performance.

A study aimed at synthesizing mental imagery practice studies involving psychological variables at a motivational level would be instrumental in the advancement of mental imagery practice theory. Based on the existing theory, for example, Paivio's analytical framework theory, (1985) and the already present empirical evidence, it is very plausible that variables such as arousal, self-confidence and state-anxiety could play a role in mediating the mental imagery practice - motor skill performance relationship. Identifying substantive links of the dependent and independent variables with mediating variables like arousal, self-confidence and state-anxiety would be an essential first step. The mediating variable in this instance acting as the intermediary in the generative process of linking the independent variable, mental imagery practice to the dependent variable motor skill performance. The mediating variable being so integral to the process, without it, the independent variable loses its influence. Explaining the variance found within these variable links would be a second culminating step in constructing an explanatory model. Variables external to the independent, mediating and dependent variable relationships, like gender, age, practice time, ability level and study quality for example, may come to modify the model. Their sub-group interaction (e.g. male/female, elite/nonelite, etc.) could explain the strength and variability found in the main effects of these study variables. Their identified moderating effect would further add to building a model that better explains the mechanism responsible and the associated variable effect found when individuals practice mental imagery to enhance their motor skill performance.

1.2 Theoretical Context

Jacobson (1930) first documented the practice of mental imagery as an independent factor affecting motor performance. It is only in the last three decades however that the research has really intensified. In the course of recent years, a growing number of researchers (e.g. Epstein, 1980; Hall *et al,* 1990; Mumford *et al*, 1985; Oxendine, 1969; Paivio, 1985; Ryan & Simons, 1981) have investigated the potential positive influence of mental imagery. These studies and many others have led to a general acceptance amongst researchers in the field as to the efficacy of mental imagery practice in the enhancement of motor skill performance. Even more conclusive are cumulative studies where many studies in the field are synthesized and these studies as well have clearly established that the systematic use of mental imagery induces a significant learning and performance effect on motor skill performance (Felts & Landers, 1983).

However, despite significant advances, more questions than answers have arisen from efforts to investigate this phenomenon. Some confusion stems from the wide application and the corresponding erratic motor skill performance effects following the use of mental imagery practice as a cognitive mental practice strategy. At one extreme of its application, within the most controlled of circumstances, mental imagery practice effects are inconclusive to say the least (Epstein, 1980). By contrast, there have been studies reporting significant effects of mental imagery use, in some instances almost as effective as physical practice alone (Clark, 1960).

This variability in treatment effect of mental imagery practice could be in part explained by the atheoretical, unidimensional nature of the primary studies conducted in recent decades. These studies tend to focus on performance variables. Consequently, enhancement of motor skill performance has been sometimes confounded by a multitude of substantive and methodological variables. Any clear explicit relationship between mental imagery practice and motor skill performance has thus been compromised.

Historically we have seen a prolific number of experimental studies in sport psychology pertaining to the practice of mental imagery as a cognitive strategy to improve motor skill performance. These primary experimental studies conducted in the initial stages of mental imagery research served to supply some rudimentary evidence of the phenomenon. At this stage, the number of studies had grown quite large and the focus, unidimensional and atheoretical at this point in time, was motor skill performance based. The need for cumulative analysis in the mental imagery domain became essential if some order and direction was to be established. The purpose was descriptive in nature, painting a broader more general picture of the mental imagery practice - motor skill performance paradigm. This type of descriptive analysis was very evident in the early mental imagery cumulative studies in the literature (Driskell, et al., 1994; Feltz *et al,*, 1983; Feltz et al, 1988; Hinshaw, 1991; Meyers, Whelan & Murphy, 1991, Oslin, 1985;).

Clearly, research synthesis has established that practicing mental imagery does affect, however variable, motor skill performance in a positive fashion. What has been impossible to discern to date is the contribution of various elements that are, in isolation or in combination, potentially mediating or moderating the relationship. This change of focus, is now moving the research from a descriptive level of the influence of mental imagery practice for the enhancement of motor skill performance to research synthesis for explanation. More sophisticated and subtle ways of using cumulative analyses have been developed to allow researchers today to investigate more in depth analyses of the phenomenon in question. How is motor skill performance achieved, has now become the focus of our inquiry.

The goal of cumulative research is to reach better conclusions than those reached in individual experimental studies. To make further advances as to how mental imagery practice functions much more has to be explained, more pointed questions must be asked if in-depth understandings and parallel theory development is to be achieved. Cook et al., (1992) explain: 'Having established that interventions produce robust effects that are nontrivial leads to such questions as to what types of interventions work best and what causal mechanisms are at work. These questions move beyond description to explanation.' (p.283)

There was therefore a need for meta-analysis, a methodology which allowed researchers to integrate studies which attempted to answer the same questions. The first in the mental imagery domain and the most significant and comprehensive of the day was published by Felts and Landers in 1983. Despite some methodological shortcomings, this initial meta-analysis, descriptive in nature for the most part, was able to establish unequivocally that mental imagery practice influenced motor skill performance better than no practice at all. As well, for the first time in research synthesis in the mental imagery domain, Feltz and Landers (1983) attempted to identify other variables which moderated the mental imagery practice - motor skill performance relationship. In so doing they succeeded in explaining some of the variability of the mental imagery practice effect on motor skill performance. Recognizing methodological deficiencies of the day, Feltz and Landers (1983) were still able to identify two variables: one substantive, cognitive content of the skill, and the other methodological, publication status, as significant moderators.

However, as recent meta-analyses go (e.g. Driskell et al., 1994; Feltz *et al,* 1988; Hinshaw, 1991; Meyers *et al,* 1991; Oslin, 1985) their contribution to the pool of knowledge in explaining mechanisms involved when we practice mental imagery to enhance motor skill performance is modest. Further advances would require the use of another type, a meta-analysis for explanation (Cook et al., 1992).

1.3 Literature review of mental imagery theory

The origins of mental imagery and of motor skill performance theory, which forms the basis for most sport psychology theories, are embedded in general cognitive psychology. In order to give some perspective to our assertions, a definition of mental imagery is presented and in-depth discussion of mental imagery theory will now be undertaken is ellaborated.

1.3.1 Definition

Mental imagery distinguishes itself from other types of mental practice in that one's thought processes are represented by a visual or a kinesthetic image as real as an image perceived by a retinal and-or a sensory receptor. The practice of mental imagery transcends all sensory modalities and, as we shall demonstrate in a further discussion, has strong links with memory. The type of mental imagery pertinent to our research as identified by Richardson (1983) is known as thought imagery. It refers to an active type imagery which may evoke past, present and future anticipatory processes. When practicing thought imagery, an individual is able to recall images from long term memory, symbolically code present perceptual imputs and transform past images symbolically, all based on anticipatory cognitions. The individual is able to transform voluntarily his own images through these interactive processes. Thought imagery is the type of imagery most characteristically exploited in relation to motor skill performance when an individual practices mental imagery.

1.3.2 Mental imagery perspective

Generally speaking one can practice mental imagery in one of two styles: externally or internally. For example, one is said to be practicing mental imagery externally when an individual is observing one's own performance from an external perspective, that is to say outside of the body. It is often referred to as third person imagery. The classic example of this style of mental imagery is that of observing your own image on a television screen.

Conversely, when the image originates from within, as does a kinesthetic sensation, this style of mental imagery is said to be internal. An individual tries to obtain sensations similar to those experienced during the actual execution of the motor skill. Internal mental imagery emanates from the performer's perspective and is often referred to as first person imagery (Mahoney & Avener, 1977).

1.4 Motor skill performance

By and large, performance in sport psychology entails motor skill performance, which for the most part arguably may be identified as being composed of varying levels of cognitive and physical content. Mental practice studies especially, have tried to taxonomize motor tasks symbolic in nature as cognitive tasks and those of a neuro-muscular sensory nature as physical tasks (Driskell *et al,* 1994). For example, cognitive rating tasks would include perceptual inputs, mental operations and output and response whereas physical rating tasks would include muscular strength, endurance and coordination. Traditionally researchers have tried to examine to what extent mental imagery practice was moderated by a task that was either cognitive or physical in nature. Mackay's (1981) top-down hierarchy theory, defines motor skill performance as the activation of an organizational sequence of mental nodes followed by a sequence of muscle nodes. According to this author, no matter what the cognitive-neuromuscular content of the motor performance skill, all motor skills possess mental and muscle contributions. Mackay (1981) contends that mental imagery practice, being a cognitive intervention, is only effective at the mental node level, the top half of the hierarchy. This would mean that only tasks of a cognitive nature would benefit from mental imagery practice.

Alternatively, are the general motivational overtones mental imagery may have, as a result of its involvement in information processing, on motor performance. Schmidt (1982) maintains that mental imagery practice sets arousal at an optimal level in view of a general preparedness for the athlete to perform. If in fact mental imagery is able to activate muscle nodes by lowering muscle tension as Schmidt (1982) contends, it is conceivable that behaviors, beliefs and affects can all be coded from the mental nodes down to the muscle nodes. Characteristics like arousal, state-anxiety and self-confidence, once coded for, could mediate the mental imagery - motor performance relationship. If indeed coding penetrates the muscle node level, this would only amplify the influence of these mediating variables. Now we must prove it!

1.5 General overview

Before discussing the intricacies of the theoretical constructs and functional mechanisms, an overview of the broader theoretical network from which they stem will be presented. The study of mental imagery can be partitioned in two distinct parts: nature and function (Chevalier, Hall & Nadeau, 1990). An examination of Finke's (1989) underlying principles of equivalence will initiate the discussion of the ***nature*** of mental imagery. A brief historical account of the general psychological foundations upon which theories of mental imagery are based will then follow. The final section on the nature of mental imagery will include a description of the dual code and the triple code theories. The ***function*** of mental imagery will be examined within the theoretical context of the analytical framework theory. There are two broad-based theoretical paradigms within this framework which best illustrate the functional influence exerted by the practice of mental imagery: 1) the information-processing or cognitive paradigm; and, 2) the self-regulating or motivational paradigm. The first paradigm discussed, information processing based, includes the cognitive symbolic theory (Sackett, 1934) and the psycho-neuromuscular theory (Jacobson, 1934; Suinn, 1976). In the second, the self-regulating or motivational paradigm, theories discussed will pertain to relevant psychological variables and their theoretical support accounting for the motivational influence of mental imagery practice. Theories presented here include the inverted 'U' theory (Spencer & Spencer, 1966), the drive theory (Yerkes & Dodson, 1908) and the social cognitive theory (Bandura, 1986). Finally, a discussion implicating integrative theories like the psychophysiological theory (Lang, 1979) and Mackay's top-down hierarchy theory , 1981), two theories who's origins are firmly embedded in the information-processing paradigm but also extending into the motivational sphere will be initiated. These theories have integrated plausible explications for imagery effects from both the cognitive (i.e., learning) and the motivational (i.e., arousal, state-anxiety, self-confidence) perspectives.

1.5.1 Nature of mental imagery

The first aspect of mental imagery theory focuses attention on the nature of the image itself. Past research has contrasted perception with mental imagery to a great extent (Farah, 1985; Cooper, 1975; Thompson & Klatzky, 1978). Perception, a subjective view of reality, is concerned with recognition whereas *mental imagery* is symbolically coded information. Nowhere is this more evident than in sports psychology, where the practice of mental imagery of a task is continuously compared with one's perception of an actual motor skill performance.

Finke's principles of equivalence

Finke (1989), has identified general characteristics common to both perception and mental imagery. By relating a wide range of findings, mostly neurological in nature, Finke identified the underlying connections to both concepts. He then used these connections to elaborate principles of equivalence between actual perceptions and images, revealing the dynamic nature of mental images. Parameters describing temporal, spatial, and segmental aspects of images, as well as the quality of images, (i.e., the exactness and wholeness of images) are identified to explicate the true nature of mental images. He preferred the use of principles to the development of models, finding that models were to restrictive and limiting. Elaborating principles, Finke thought was a more flexible way of incorporating new developments as theory evolved. There are five general unifying "principles of equivalence": a) the implicit encoding principle; b) the principle of perceptual equivalence; c) the principle of spatial equivalence; d) the principle of transformational equivalence; and e) the principle of structural equivalence.

Implicit encoding principle

The implicit encoding principle implies that information is unintentionally retrieved from our images. Finke cites the obvious example of incidental learning. As explained by

Paivio (1969; 1979), incidental learning can occur in the context of verbal learning. Because there are both verbal and imagery codes associated with verbal learning, retrieving information from memory via the complementary route of imagery codes is possible even when this information has not been explicitly learned.

Principle of perceptual equivalence

The principle of perceptual equivalence depicts images as being functionally equivalent to perception. Finke cites the work of Farah (1985) who demonstrated that subjects were quicker to visually recognize letters when they had been previously imagined. The logic here is that similar mechanisms were activated during both imagery and actual perception. As a result, reaction times were decreased when subjects were asked to recognize these same objects or events.

Principle of spatial equivalence

The principle of spatial equivalence purports that spatial relations among objects are preserved during imagery. The equivalence of spatial relations between perception and imagery was illustrated by an experiment on cognitive maps (Levine, Jorkovic & Palij, 1982). Subjects were first required to walk a path while blindfolded. When asked to successfully attain the same destination from the starting line after removal of the blindfold, they took short-cut direct routes to the end locations, which demonstrated that the spatial relations had been preserved. The subjects had symbolically coded internal spatial maps and then from memory retrieved this information in order to take short-cuts.

Principle of transformational equivalence

The principle of transformational equivalence implies that transformations (e.g., mental rotations of objects) during imagery are as whole and complex as they are in real life.

Cooper (1975) showed that, when rotated mentally, both complex and simple polygons could be recognized quickly, the complexity of objects not affecting the mental rotation ability of the subjects.

Principle of structural equivalence

The principle of structural equivalence simply postulates that images are structurally coherent and organized as they are during actual perception. As such, these images can be similarly reorganized and reinterpreted. This principle was demonstrated during mental synthesis studies in which subjects were able to mentally fuse spatially distributed parts to make a complete pattern (Thompson & Klatzky, 1978).

Finke emphasizes that the empirical studies which separately lend support or contest these five unifying principles, contribute to an overall convergence of the scientific knowledge which describes mental imagery as having demonstrable, functional properties. (Finke, 1989). By representing principles of equivalence of mental imagery in relation to perception, Finke (1989) attempts to explain the nature of mental imagery as dynamic and open-ended. The similarities evidenced between perception and the principles of equivalence of mental imagery are striking. Their application to sport psychology, in the mental imagery practice domain, as it relates to thought imagery as active and dynamic, and the attainment of mature imagery (explained later in the text) as defined by Paivio (1971), have important implication to using mental imagery practice more efficaciously to enhance motor skill performance.

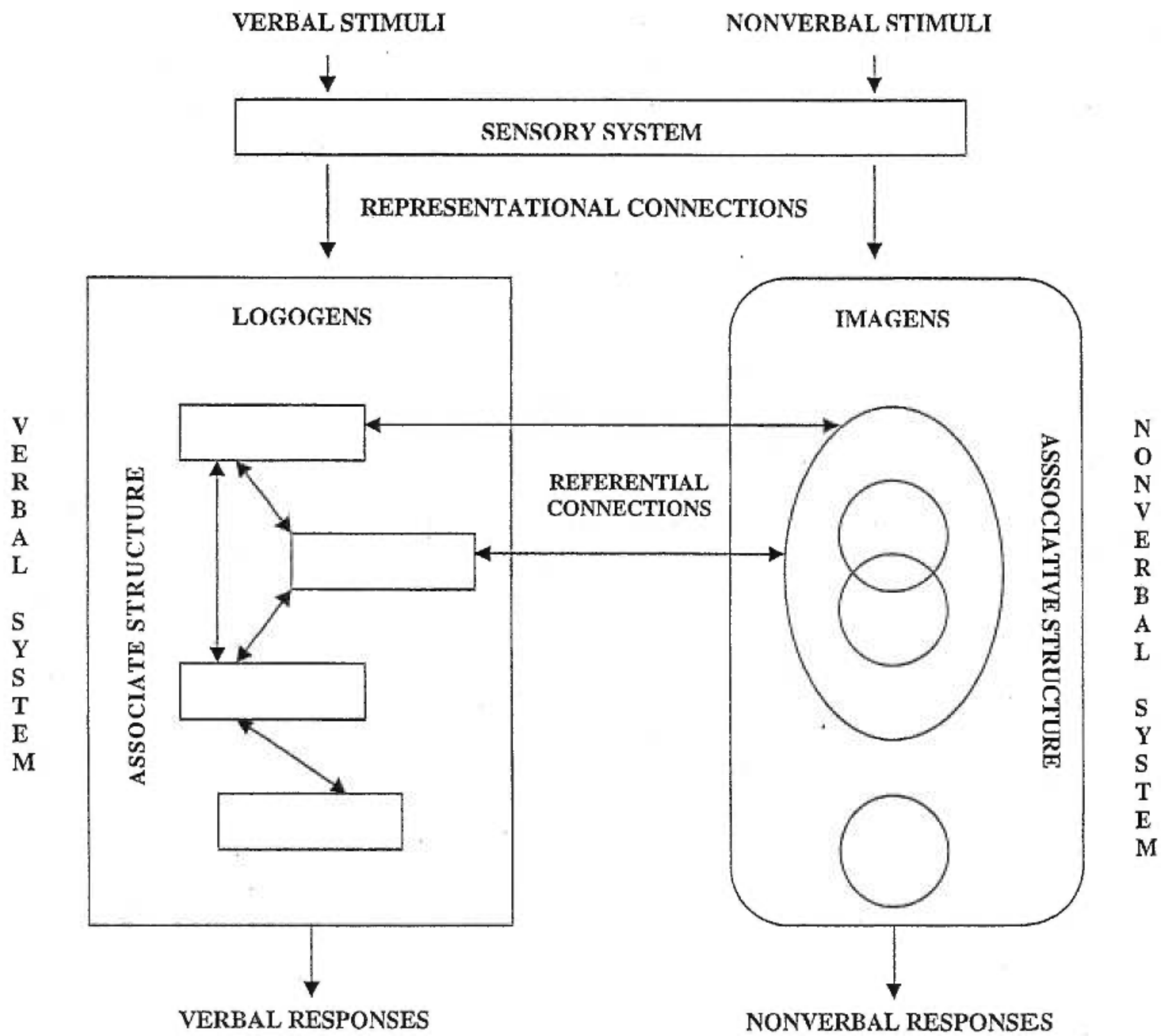
Dual code theory

In the field of psychology, theorists like Piaget (1936), Bruner (1964), Paivio (1971) and Ahsen (1984) particularly, have all made significant contributions to the elaboration of theory pertaining to the nature of the mental imagery phenomenon. It is pertinent to first consider from a historical perspective, earlier works from which theories in sport psychology were inspired. Thus, a brief exposé of the theoretical research background leading to Paivio's (1971) dual code theory and Ahsen's (1984) triple code theory of mental imagery is presented.

Piaget (1936) subscribed to the notion of the complimentarity of images and words as a representation of our perceptual world. He claimed that from birth, an infant's knowledge base is inundated with information stemming from interaction with the environment. The resulting sensory and motor inputs help form schemata and, by extension, thought. These thoughts are symbolically coded. First images are formed and then language, all interacting in order to deal with the perceptual world. In this context, Piaget's emphasis is also on the development of abstraction and by extension, language.

Another important influence to the development of the dual code theory is Bruner's work (1964). Like Piaget, he also emphasized the importance of abstraction, demonstrating that a child's world begins with the concrete to become gradually more abstract with time. Bruner uses terms like enactive mode, ikonic mode, and finally, symbolic mode. The child evolves from the enactive mode of action, e.g. sucking reflex to the ikonic mode which is characterized by mentation, e.g. tactual image and finally to the symbolic mode. By the time he has reached this final mode, the child has become mostly independent, thinking in abstract terms, and can then, progressively develop language.

Paivio's dual code theory (1971) incorporates some of both Piaget's (1936) and Bruner's (1964) views. Paivio maintains that imagery, initially in its concrete form, eventually gives way to language. Language is attained by the progressive symbolic coding of objects and events. Thus, as a person's thought processes evolve, so do these two symbolic coding systems: 1) the non-verbal; and, 2) the verbal. Paivio emphasizes that the two systems are not mutually exclusive but rather, complementary. During the progression to abstraction, an individual develops the verbal system that eventually becomes autonomous while maintaining its ability to interact with the non-verbal system. Thus, Paivio's (1985) concept of an image includes both verbal (i.e., language) and nonverbal (i.e., imaginal) representations. There exists a dynamic interdependence between language and the image which plays a critically important role in memory, retrieval of information, and future motor skill performance behavior.



gure 1. Dual Code Theory

According to the theory, as incoming stimuli are matched to referential picture units called «imagens» and word units called «logogens», a threshold is attained and representational codes are made available. As illustrated in the figure 1, p. 17, referential interconnections then take place, meaning that words can be imaged and pictures can be named. As well, there are associated connections that can be made both intra-verbal and intra-imaginal. Therefore, there are two associative links, one as logogens and the other as imagens, and a third as a referential link between both systems making up a tri-level interactive unit.

For Paivio, the development of language is not the only objective; the attainment of abstraction in imagery is also sought. «Mature imagery» is attained once the verbal and the non-verbal systems have reached their highest levels of abstraction (Paivio, 1971). When mature imagery has been attained, both non-verbal and verbal systems are then autonomous and thus capable of interacting with each other to the highest degree. He describes the relationship as: «.... from concrete to more abstract imagery, overlapping with the emergence of verbal symbolic processes, which in turn become more abstract »(Paivio, 1979, p. 27).

The relevance of Paivio's (1971) dual code theory of mental imagery is well illustrated by the tri-level interaction evidenced in a Housner and Hoffman (1981) study. Upon investigating imagery ability, high and low imagers were tested in retention of end locations and distances. They found that high imagers were able to reproduce end locations of cognitive maps better than low imagers. These cognitive maps included presentations of locations and distances from starting to finished positions. The high imagers were able to trace a path or route to these final destinations and to reproduce end locations because they related imagens with logogens through the referential connections available to them, something the low imagers were not able to do. Having only developed mature logogens, low imagers were not able to interact the two associative systems through referential connections. These results support the contention that visuo-spatial relations are processed by both non-verbal and verbal systems. No differences were apparent between low and high imagers in recall of distance. The temporal information is primarily reproduced by the verbal system alone.

In another study where novice and experienced dancers were compared on their mental imagery ability, visual-spatial evaluations differed between the two groups. Overby-Young (1990) found that, when compared to novice dancers, experienced dancers were significantly more verbal and more evenly visual and verbal in their information processing. These findings might lead to the speculation that experienced dancers had attained a certain level of «mature imagery» whereby both systems, the non-verbal and the verbal, were interacting. The novice dancers on the other hand, by relying solely on the non-verbal mode were unable to profit from the use of the verbal system for information processing, which resulted in less effective imagery.

Recently, Doheny-O'Bryan (1993) found learning differences between high and low imagers. Using imagery questionnaires called the vividness of movement imagery questionnaire (VMIQ) and the vividness of imagery questionnaire (VVIQ), he found that high imagers were more abstract in their thinking. Low imagers, by contrast, used more concrete and logical sequential methods of study.

These studies only serve to illustrate the strong association language has to mental imagery and the different facets that can be exploited by their close collaboration. Paivio (1986) stipulates that sports psychologists must recognize the importance of language during imagery rehearsal. The development of language and the subsequent meaning that permits access and control of the past relevant imaginal experiences are crucial to the mental imagery rehearsal processes and its impending influence on motor skill performance.

Finally, although the dual code theory outlines the importance of both the non-verbal and the verbal coding systems to the imagery process, it has been criticized for its inability to account for the somatic response associated with imagery (Ashen, 1984). In an effort to remedy this shortcoming, Ahsen proposed the triple code theory.

Triple code theory

According to Ahsen (1984), the somatic response is an essential element linking the image to the meaning during the imaginal process. Like Paivio (1971), Ahsen contends that the first element in imagery is the Image (I) which represents the concrete. The second element is the meaning (M), whereby language represents the abstract. A third element proposed in Ahsen's model is the somatic response (S). Taken together, these elements are known as the «ISM» code.

To Ahsen (1984), the child is somatic before any development of abstraction. The ISM exists simultaneously and does not emerge sequentially as Paivio(1971) might argue. As a person evolves, language and imagery may not pre-empt the somatic experience but, in fact, develop concurrently and globally as one entity with all aspects of the ISM present during the make-up of the imagery. Bugelski (1986) supports the contention of the existence of a somatic response in imagery when he says: «....our anxieties and hopes, considered bodily reactions, are constantly at play and anyone hoping to account for behavior on a purely cognitive basis is not likely to present an acceptable theory» (p. 41). He goes on to make a reference to Russian chess players who, suffering from fatigue of the higher mental processes, rest for months after chess competitions.

In a study with bilinguals, Bugelski (1977) found that words learned in childhood in one language did not evoke the same somatic response and meaning as did the same words learned during adulthood in another language. As an adjunct to this work came research on hemispheric imagery demonstrating the importance of the S factor during imagery (Ahsen, 1977a; 1977b; Marks, 1985; Molteno,1984). By exploiting the position of parents in the image of the subjects during hemispheric imagery, the resultant manipulation of the feelings associated with such positional changes of the parents (placing the one in front of the other) caused or alleviated body discomfort. The I of the parents is altered by a physical, motor or somatic (S) response of the subjects and as a result there is a change in the meaning of the image (M). This completes what Ahsen identifies as the ISM code. This evidence lends support to the triple code theory by reinforcing the principle that the physical world is linked to our perception of it through the somatic response. Ahsen (1984) explains the significance of one's I, S and M by their reintegration into the definition of the imaginal experience. Ahsen's promotion of the ISM code reflects the most useful and natural application of the triple code theory.

In its application to sport, use of the ISM by athletes has been in evidence in the production of most powerful images for relaxation and concentration (Murphy, 1990). A runner's image description might include the following representation: «You feel the cold bite of the air in your nose and throat as you breathe in gulps of air» Horn (1992, p.238). This imagery script expounds the use of psychophysiological response propositions as important aspects to imagery practice.

In a meta-analysis on mental imagery use, (Feltz *et al,* 1983) researchers suggested that the cognitive component of motor skills was the most affected by the practice of mental imagery. Accordingly, Bird and Wilson (1988) present an interesting argument from psychomotor performance in support of Ahsen's triple code theory. They suggest that other variables like the imagery ability and the stages of learning play an important role in determining imagery effectiveness upon motor skill learning and performance. For example, in the initial stages of learning, the cognitive schema is rough and the motor response is weak, but as a person practices a physical skill the feedback builds a cognitive and motor program. As a person automates a skill, the motor responses increase. Yet, it is at this very stage that experienced athletes are better imagers and use mental imagery, kinesthetic imagery in particular, to a greater extent (Doheny-O'Bryan, 1993; Overby-Young, 1990). The better imager an athlete becomes the more he/she reinforces the somatic link (the motor response) between the meaning of the image and the image itself. Thus the EMG readings become more prominent during kinesthetic imagery, a mental imagery practice predominantly employed by higher level athletes. The somatic response measured electromyographically substantiates the link between the image and the meaning in imagery.

Our review of the most noteworthy theories originating in general psychology pertains to the *nature* of mental imagery. These theoretical constructs have served as the foundation for a body of research and theory-building specific to mental imagery practice as it applies to sport psychology.

1.5.2 Function of mental imagery

There are two broad-based theoretical paradigms that best illustrate the functional influence exerted by the practice of mental imagery: 1) The information-processing (or cognitive) paradigm; and, 2) The self-regulating (or motivational) paradigm. Paivio (1985) developed a framework to describe the functional aspects of mental imagery. The great variability of performance effects being reported from the use of mental imagery inspired his theory. In developing the framework, Paivio helped redirect future research, which at the time had been mainly limited to cognitive imagery. Less attention had been devoted to the motivational function of mental imagery (Salmon, Hall & Haslam, 1994). Figure 2, P. 23, illustrates the analytical framework theory's four cognitive and motivational fields commonly targeted by most of the contemporary research in mental imagery.

Imagery Function

	Motivation	Cognition
General	Arousal and affect	Strategies
Specific	Goal-oriented responses	Skills

Figure 2. Analytical Framework Theory

Paivio assumed a motivational function to imagery as well as a cognitive function that may operate through imaginal or verbal processes at a general or specific level.The relation is represented as a 2 x 2 orthogonal model with the motivational - cognitive contrast as one dimension and the general - specific contrast as the other Hall et al. (1998) p. 74

From an overview of the literature on mental imagery practice, clearly until recently, the cognitive functional aspect of mental imagery practice occupied the larger part of the scientific investigative efforts in psychology and especially in sport psychology. This concentration of research spawned theories primarily in cognitive psychology, related to information processing. One was central processing only and the other implicated central and peripheral processing systems. Both perspectives and their implication to motor skill performance are worthy of review.

Two theories, the cognitive symbolic theory (Sackett, 1934), and the psycho-neuromuscular theory (Jacobson, 1934; Suinn, 1976), have received the greatest amount of attention in recent years. Both pertain to the information-processing paradigm and explicate the usefulness of practicing mental imagery as a means for enhancing learning and performance of general behavioral strategies and specific motor skills.

Cognitive symbolic theory

Cognitive symbolic theory is the most prominent theory found in the mental imagery literature. Originally pioneered by Sackett (1934), the theory implies the formulation of a symbolic code as a result of the practice of mental imagery. As described by Bird and Cripe (1986), an individual first formulates cognitively a symbolic code based on creating and maintaining an image. The symbolic code then modifies retrieved long-term memory, which, in turn, changes successive efferent outflow to the muscles. This implies the existence of a central processing system where output motor activity cannot be changed once it has been centrally processed. There exists no possibility for peripheral feedback once central processing is terminated and the efferent outflow to the muscles has been initiated. Although this concept is supported theoretically (Morrisett, 1956; Wrisberg & Ragsdale, 1979), it fails to account for mental imagery practice improvement of motor skills in elite athletes. (Hecker *et al*, 1988). At the elite level, the needs of the athlete are quite different from those of the novice athlete. Practicing a skill cognitively has limited benefit for the skilled athlete. His motor skill performance and mental imagery practice have been perfected to the point where little transfer is accomplished. A maximum in relation to the athlete's performance has been attained from this type of mental imagery practice.

Psycho-neuromuscular theory

The psycho-neuromuscular theory was first initiated by Jacobson (1934) and then refined by Suinn (1976). It proposes the creation of a neuro-muscular program by rehearsing a mental image. By imagining a task, the neuro-muscular pathway of action potentials produced are identical to those of an actual performance, albeit at a reduced amplitude. This theory implies that localized neuro-muscular activity of the muscle offers the presence of proprioceptive feedback in a closed loop system to the central nervous system. The symbolic code is then modified based on the proprioceptive feedback. What distinguishes psycho-neuromuscular theory from the cognitive symbolic theory is that proprioceptive feedback can still modify the symbolic code by supplying the central processing system with peripheral input used to correct future efferent outputs. Results from investigations in which athletes' EMG traces were measured following imagery practice, have shown that such muscle innervations were evoked (Hale, 1982; Harris & Robinson,1986).

The psycho-neuromuscular theory however, remains controversial, because a lack of empirical support links it to the enhancement of motor performance. Several confounds in the research, such as skill level and performance evaluation methods, may explain this lack of empirical evidence (Ahsen, 1984; Deschaumes-Molinaro, Dittmar & Vernet-Maury, 1992). The «ceiling effect», typical of elite and advanced athletes, where performance has reached a «plateau» and any further increases are likely to be minimal, is problematic (Dass, 1986). Investigations using skilled athletes are often plagued by this effect which substantially reduces the probability of reaching significant differences between experimental groups. A sufficiently large sample is crucial to establish significance in experimental studies; however, recruiting elite athletes in sufficient numbers is an important methodological and logistical problem.

A second shortcoming in research based on the psycho-neuromuscular model is the lack of suitable methods for the measurement of motor skill performance. Ahsen (1984) explains the importance of a wide variety of measures explaining the wide spectrum of physiological responses manifested in one motor skill performance. He alludes to the lack of sensitivity of motor skill performance measures in the past. Horn (1992) corroborates these assertions and suggests the use of whole batteries of motor skill performance measures in order to capture the true expressions of motor activity.

Both the cognitive symbolic and the psycho-neuromuscular theories lack empirical confirmation. Because imagery is situational, neither one of these theories offers an unequivocal explanation, allowing it to become the dominant theory. Although the cognitive symbolic theory is more popular, it does not explain mental imagery effects among elite athletes. There seems to be more potential for explaining mental imagery functions theoretically when we harmonize the two theories rather than oppose them. Because both are information processing based, they have an element of compatibility and when presented as complementing theories, can offer a more persuasive explanation of mental imagery cognitive functions at the cognitive level to even the most ardent critic

1.6 Motivational aspects of mental imagery

In this context the focus is at the general motivational level where an individual practicing mental imagery symbolically represents various behavioral situations associated with feelings and emotions. What is of interest here is how an individual is able to lower arousal levels in one instant and heighten arousal levels in another (Hecker *et al,* 1988); how an athlete uses of general mental imagery practice for an anxiolytic effect, (heightening or lowering state-anxiety; Meichenbaum, 1985); or how an athlete enhances his thoughts and beliefs as in self-confidence (Callow *et al*, 1998).

From a motivational perspective, imagining positive scenarios can counteract negative verbalization as a way to control affect and arousal. A general application of mental imagery might involve controlling state-anxiety and arousal, and evoking self-efficacy beliefs whereas a specific application of mental imagery could entail the practice of goal-oriented imagery, (for example, imagining receiving a medal on the podium) to motivate athletes. It has been found that higher level athletes use motivational mental imagery primarily in the general sense, for controlling affect and arousal (Salmon *et al,* 1994).

Several factors may explain the effect of mental imagery on performance. One explanation consists of the optimization of certain important determinants of motor skill performance such as reinforcing the athlete's self-confidence and decreasing his/her level of state-anxiety. This hypothesis is based on the notion that the quality of performance is to a great extent dependent on the mental state of the athlete at the moment of competition (Desharnais, 1971). A lack of self-confidence or an elevated level of state-anxiety are factors which may diminish motor performance levels of athletes during competition (Martens, 1975). These inadequate psychological states can provoke higher than optimal arousal levels and, by consequence, negatively affect motor performance of the athlete. Within this perspective, the practice of mental imagery could effectively reinforce an athlete's feelings of self-confidence and reduce the level of state-anxiety. Other factors such as attentional set

(Feltz et al., 1983), trait-anxiety (Kleine, 1988) and sports confidence (Vealey, 1986b) may mediate the influence of mental imagery practice upon performance.

The following is a discussion of three variables that have been advanced as predictors of motor skill performance when mental imagery is practiced. Their consideration is situationally specific and each will be discussed in relation to their motivational pertinence and explanation of mental imagery practice effects. This partially explains the mechanism involved during mental imagery practice: arousal levels, state-anxiety and self-confidence, all of which are measured as temporally specific.

1.6.1 First predictor: Arousal

Physiological stress results in an increase in physiological arousal. Physiological arousal can manifest itself as an increase in heart rate, respiration, skin conductance and as many other physiological responses. These responses prepare the body for motor performance and are often termed the 'fright, fight, flight' response and are at least conventionally thought to be essential for successful execution of motor skill.

Defining the constructs

Arousal, as a general term, can be defined as physiological and psychological manifestation within an organism that varies on a continuum from deep sleep to intense excitement (Gould & Krane, 1992). The relationship between optimal arousal and motor performance hinges on this very definition of arousal states.

As in all other scientific endeavors, the foundation to good theory building is to define concisely all pertinent or relevant constructs that act as a basis for forthcoming theories. Unfortunately, in trying to delineate the arousal-anxiety performance relationship, terms like state-anxiety and somatic and cognitive arousal have not in the past been clearly defined. As a result, interchangeable use throughout the literature, has very often confused one construct with the other (Landers, 1980; Magill, 1989). In the following discussion, we will distinguish one construct from the other by clear, concise definitions.

Duffy (1962) identified two important dimensions of anxiety: intensity and direction. Intensity corresponds to a person's energy or physiological activation. This energy level may vary from deep sleep to a very intense state of excitement. The distinguishing characteristic is that arousal remaining strictly on a physiological plane is considered to be a neutral state with no accompanying affective or emotional overtones. In contrast, anxiety consists of both a high arousal state, (the intensity factor), as well as an accompanying discomforting feeling manifested cognitively and usually identified as a negative emotion (the directional factor of either a positive or negative emotion). Anxiety, as described by Duffy, is a combination of terms: intensity of behavior and direction of affect (Spielberger, 1977). Anxiety, in effect, a countercondition to relaxation, consists of a certain level of arousal states, but both states are mutually exclusive (Wolpe, 1974). Generally speaking, low anxiety corresponds to low arousal, and high anxiety accompanied by high arousal. But it is also important to point out that the inverse may not necessarily be true: high arousal may not necessarily be accompanied with high anxiety. One can be highly aroused and not feel any anxiety (Singer, Murphey & Tennant, 1993).

Somatic and cognitive arousal

Mental activity as well as physiological activation, as viewed by Martens (1987) characterizes arousal. This composite view of arousal is consistent with the two major physiological contributors to arousal: the central nervous system (CNS) and the autonomic nervous system (ANS). Brain structures like the cerebral cortex, the hypothalamus and the reticular formation of the CNS all play important roles in arousal. Roles such as cognitive representation of arousal, generation of excitement and awakening or attention of the CNS are all respective cognitive functions of these substructures. The ANS plays an important role as well. In every individual there exists a basal rate of physiological functioning. The ANS prepares the heightened arousal levels by releasing or inhibiting hormones in interaction between the central and peripheral nervous systems. This interaction allows individuals to reach a state of activation that prepares them for motor performance. Sport psychologists have used both psyching up techniques to elevate arousal levels (Weinberg *et al,* 1980), and relaxation techniques to lower arousal levels (Jacobson, 1930). Activating individuals to optimal levels has positive consequences for the attainment of motor performance (Spence *et al,* 1966).

Gould, Weinberg and Jackson (1980) demonstrated that psyching-up strategies, one of which is mental imagery are effective in producing heightened performance of strength, power and endurance skills. Murphy and Woolfolk (1987) used behavioral stress reduction techniques to improve performance of a fine motor skill (for example, golf putt) by attaining a lower level of arousal. Psychological training programs have introduced relaxation training to make athletes more receptive to mental practice procedures (for example, visuo-motor behavioral rehearsal or VMBR), (Suinn, 1976). More importantly, a key directive in psychological training programs like VMBR and stress inoculation training (SIT), (Meichenbaum, 1985) is the integration of mental imagery which is then used to activate or relax athletes, depending on the need of the athlete at the time. Once the desired level of arousal is attained through mental imagery, then it becomes an important precursor to motor skill performance (Weinberg et al., 1980).

Arousal theories

The quality of performance is in a large part dependent on the athlete's mental state at the moment just before competition (Desharnais, 1971). This state can be influenced negatively by various psychological determinants like state-anxiety and lack of self-confidence. An inadequate psychological state can then reciprocally produce higher than optimal arousal which, in turn, can be counter productive to an enhanced motor performance.

Two relatively early theories explicate the arousal - performance relationship; drive theory (Spence *et al*, 1966) and the inverted U theory (Yerkes *et al,* 1908).

Drive theory

Drive theory predicts a positive linear relationship between arousal and performance.

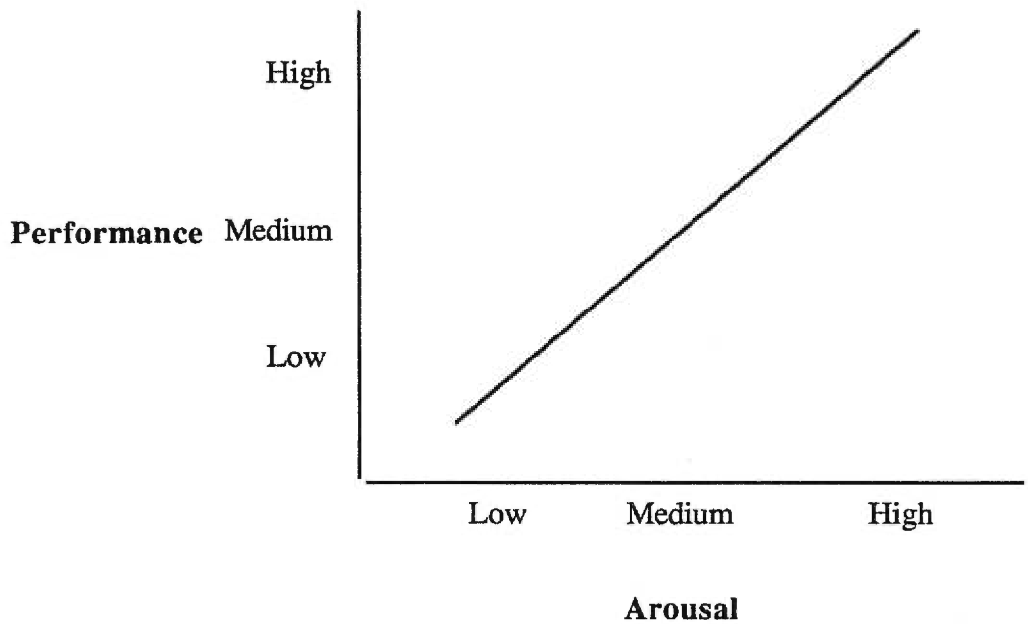


Figure 3 Drive Theory

As illustrated in Figure 3, the drive theory (Spence *et al,* 1966) maintains that during the early stages of learning a motor skill, an increased level of arousal is detrimental to motor performance. As the motor skill is mastered, increased levels of arousal increase the chances of performing well. Gross motor tasks repeatedly overlearned fit best the characteristic linearity attributed to the arousal - performance relationship (Oxendine, 1984; Spence *et al,* 1966). The «Drive Theory» is consistent as well with the «fright, flight, fight» response typically associated with the epinephrine rush occurring in threatening situations where the motor skill performance of an individual is critical to survival. Increasingly however, criticism of the theory surrounds the issues of motor skill complexity. The linear relationship between arousal and motor performance cannot explain the detrimental effects of arousal on complex athletic performances (Martens, 1971, 1974; Weinberg *et al,* 1979). A plateau would seem to be reached, where any further increase in arousal would actually be detrimental to motor skill performance. The linear relationship posited by the drive theory (Spence *et al,* 1966) is no longer supported.

Inverted U theory

Drive theory (Spence & Spence, 1966) eventually yielded to the inverted U theory (Yerkes & Dodson, 1908) illustrated in Figure 4. This theory postulates that there is an optimal level of arousal under and over which performance deteriorates. For an athlete to perform maximally, an optimal arousal level must be maintained. The athlete employs a variety of strategies to raise or lower his level of arousal to an appropriate optimum. Factors such as type of task can influence the curve as well, moving it horizontally and vertically.

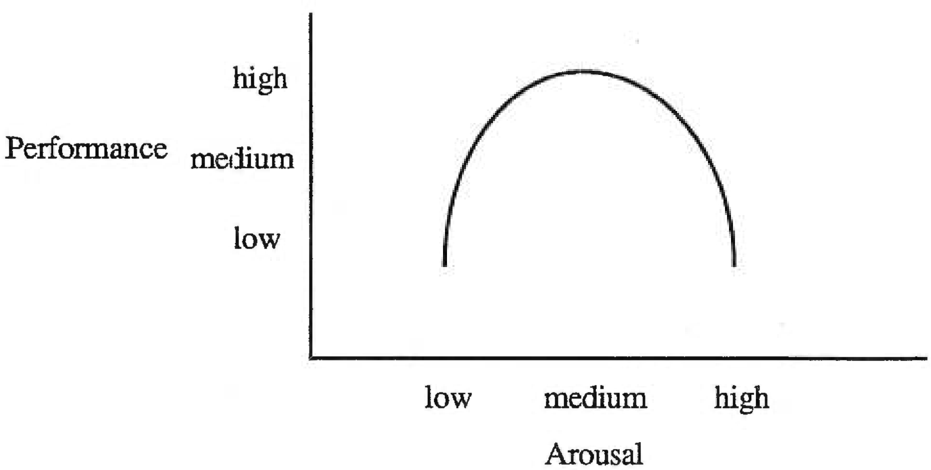


Figure 4. Inverted U theory

According to Yerkes and Dodson (1908), the more complex the motor skill performance required, the lower the optimal level of arousal obtained. Oxendine (1970) postulated a taxonomy in which different motor activities requiring variable levels of arousal are situated on a continuum spanning a high need for arousal to a low need for arousal (for example, activities characterized by endurance, speed and strength require a high level of arousal). Klavora (1977) offered empirical support for Oxendine's postulate by demonstrating a direct relationship between the level of arousal and the performance enhancement of specific motor skills.

1.6.2 Second predictor: State-Anxiety

The athlete's level of anxiety is another characteristic that influences the activation level and consequently, the quality of athletic performance. Anxiety, defined as an emotional or cognitive state of arousal, can also be partitioned into a situational (state) and a personal or individual (trait) constituent. The term trait-anxiety alludes to an acquired behavior disposition, not constrained by time, whereby the individual perceives circumstances as threatening. Trait-anxiety is considered to be part of a person's general personality. In contrast, state-anxiety, unstable over time, is considered to be a temporary condition. In this condition, an objective stimulus labeled stress leads an individual to perceive the stress subjectively as a threat. The response, what an individual feels is state-anxiety (Spielberger, 1983). Thus, trait-anxiety is regarded as personal and state-anxiety regarded as situational (for example, person, task, and environment). These distinctions of types of anxiety form the basis for Spielberger's anxiety theory (1966, 1972). However, anxiety theory is beyond the scope of the present work. For more detail refer to Singer, Murphey and Tennant (1993).

Anxiety as a general concept has long been linked to human behavior. Emotion, an integral part of anxiety, remains an important variable that athletes strive to control to attain their optimal motor performance (Mahoney, 1979; Nideffer, 1976; Oxendine, 1970). There are several ways in which an individual's level of anxiety influences motor skill performance. A direct negative relationship, where any decrease in anxiety would facilitate a performance enhancement, is among the most popular of theories (Eysenck, 1978). There is also a supposition that by indirectly controlling an individual's perceived self-efficacy (Bandura, 1986), or by controlling an individual's arousal levels (Weinberg et al., 1981), anxiety itself is controlled and as a result motor performance is increased. However, the research remains equivocal, not all studies have been able to support these hypotheses (Bennett & Stothart, 1980; Williams, 1978).

Generally speaking, anxiety occurs when an environment is perceived as threatening. One's perception is based in part on his/her predisposition to anxiety (e.g. trait anxiety) as well as one's own physiological state. How one responds to this anxiety will affect performance outcome. For example, the individual in the anxious state may call on one's own resources (self-management skills) in order to reduce the anxiety. If the individual fails to apply these skills, then motor performance may be compromised.

It has been suggested in preceding paragraphs that psychological factors like anxiety are important determinants in performing motor tasks. It has also been proposed that practicing mental imagery during competition would influence an individual's anxiety level, which consequently would affect his motor performance. Keeping in mind the impact that mental imagery practice has on controlling anxiety levels, and the lack of consensus among researchers regarding the anxiety effects on motor performance, we examine some scientific evidence pertaining to this subject.

Seabourne, Weinberg and Jackson (1982) conducted a study in karate with both male and female athletes assigned to an experimental and a placebo-control group. The experimental group practiced visuo-motor behavior rehearsal (VMBR), a technique which combines mental imagery and relaxation, in an attempt to reduce pre-competitive anxiety and in turn improve motor performance. The placebo-control group practiced the art and tradition of karate. The results of the study showed that the subjects in the VMBR group had lowered significantly their state-anxiety and significantly improved their motor skill performance levels as compared to the placebo-control group. This suggests that mental imagery practice, an integral part of the VMBR program has an effect in controlling anxiety.

In another study, (GalOr, Tenenbaum and Shimrony, 1986) Israeli orienteers (N=59) of intermediate and advanced ability explored the use of cognitive strategies in pre-competition and during competition performances. Measures of mental imagery practice and levels of anxiety were collected over several occasions throughout the study. The results demonstrated that, independent of the caliber of the performance, mental imagery was practiced similarly and moderately by all of the athletes. However, the more advanced athletes were comparatively less anxious than their intermediate level colleagues in pre-competition. The results show that the efficacious use of mental imagery by high-level athletes acts positively to controlling the pre-competitive state-anxiety levels. As well, the results suggest an effect of mental imagery practice that may be moderated by ability level of the athletes.

This relationship between anxiety and motor skill performance remains equivocal. As culminating evidence, Kleine (1988) performed a meta-analysis on fifty studies investigating the anxiety - performance relationship and found a small negative relationship ($r = -0.19$). These results suggest that only a minimal amount of performance variance is explained by anxiety. However, having explained a small percentage of the variance, heterogeneity in the results was evident, suggesting that in a subset meta-analysis, moderators exist. Kleine did find such moderators as gender, age and performance level explain much of the remaining variance.

Other confounds have been evidenced as well when investigating the state-anxiety and motor skill performance relationship. Somstroem and Bernardo (1982) compared the motor skill performance of female basketball players and found they differed depending on the level of anxiety experienced by each in the pre-competition during regulation play. The results of the study showed that the athletes who found themselves within the average levels of pre-competitive anxiety obtained the best scores. Athletes with lower anxiety had poorer motor skill performances. The athletes exhibiting relatively high levels of pre-competitive anxiety obtained poorer motor skill performances. These results seem to suggest a similar inverted «U» relationship between state-anxiety and motor skill performance.

1.6.3 Third predictor: Self-confidence

Self-confidence is viewed as playing an essential motivational role in performing well (Feltz & Riessenger, 1990; Weinberg *et al,* 1979; Weiss, Wiese & Klint, 1989) and that self-confidence is the single most important predictor of motor performance. However, the exact meaning of the term self-confidence is unclear and as a construct it was vague and ambiguous. Even today the specific or general use of the term self-confidence often lacks preciseness and context. Vealey (1986b) developed a global more parsimonious concept of self-confidence that she called «sports confidence.» Sports confidence specifically delimits a particular sport setting. It represents the degree of certainty an athlete possesses about his or her ability to be successful in a specific sport. This concept is applicable to all areas of sport and would predict behavior within these sport settings (Moritz, 1994).

Martens, Vealey and Burton, (1990) have conceptualized a measure of self-confidence by employing the competitive state anxiety inventory-2 (CSAI-2). In addition to being a temporally specific measure of self-confidence, as is state-anxiety, this measure also takes into account situational factors. The CSAI-2 is positively related to «self-efficacy», another concept of self-confidence proposed by Bandura (1977).

Self-efficacy, a type of self-referent thought, that is a construct in social cognitive theory (Bandura,1986), refers to the subjective perception that a person possesses resources necessary for the effective accomplishment of a specific motor skill performance. This concept, similar to the notion of sports confidence differs in that one's self-efficacy expectations are situationally specific. The assessment of one's belief is micro-analytical by focusing on individual motor tasks per se. Fundamentally, Vealey's (1986b) sports confidence theory is applicable to all areas of sport, while Bandura's (1986) social cognitive theory focuses upon certain aspects of a sport, as in certain tasks of a sport at a specific time (Moritz,1994). It may be open for interpretation, but Bandura's theory could be considered an extension of Vealey's theory. Bandura summarizes the self-efficacy concept: «Self-efficacy is a generative process based on cognitive, social and behavioral skills and perseverant effort» (p. 391). It should be noted that Bandura makes no mention of one's capabilities as being linked to his self-efficacy. This is because one's perceived self-efficacy is based on an individual's *judgments* about his abilities or capabilities and not on his *actual* abilities or capabilities. These judgments in turn can be influenced by other factors such as outcome expectations, and temporal and goal-oriented circumstances. All of these are linked to an individual's own cognitive appraisal of his self-efficacy.

An individual who possesses the potential to perform may at any time adequately or even extraordinarily, or again fail miserably in the execution of the motor skill he is attempting. Two individuals who possesses similar skills may at any given time exhibit very different levels of motor skill. Bandura (1986) proposes that to function properly, an individual must possess skill and as well believe he can execute the skill. This belief in one's ability to execute is referred to as an individual's «perceived self-efficacy.»

Sources of self-efficacy information

If one's perception of one's own ability explains a lot of variance in what dictates an individual's performance behavior, then on what is this perception or belief based? Bandura (1977) has advanced four principal sources of information from which individuals draw in order to make these judgments.

Performance Accomplishments

The first and most influential source of information for judging one's self-efficacy is a person's past performance, starting with the most recent performance as most important. The greater the numbers of these experiences, the more one's belief in one's capabilities are re-enforced and the greater personal self-efficacy beliefs of success or failure are influenced.

Vicarious Experience

Another source of efficacy information lies in observing others engaging in a particular motor task that the individual has never practiced oneself. This is known as a vicarious experience whereby a person symbolically models oneself upon an individual who is perceived as being similar to himself. Bandura (1986) stresses that «model - observer similarity» is essential for this evaluation to occur. He explains: «Efficacy appraisals are often based, not on comparative performance experiences, but on the similarity of models on personal characteristics that are assumed to be predictive of performance capabilities»

(p.404).

Verbal Persuasion

Another source of information that may heighten an individual's perceived self-efficacy may be garnished from verbal persuasion. Though considered to be the least effective source of information able to modify one's perceived self-efficacy, nonetheless there is some evidence to its effect, (Feltz *et al,* 1990). Given the proper context, an individual's belief in the words of a significant other, a coach for example, can become very influential in enhancing an individual's perceived self-efficacy. «Persuasive boosts in self-efficacy (statements) lead people to try hard enough to succeed; they promote development of skills and a sense of personal efficacy» (Bandura, 1986 p.400). An underlying condition influencing verbally persuasive efficacy information is that it must be believable to the subject. If the coach's statements about an athlete's competence are credible and if the verbal cues used during cognitive interventions like «self-talk» are realistic and persuasive then judgments about one's personal self-efficacy can be changed. Images may be further associated with these cues. Credible, persuasive cues associated with an image, and the rehearsed image would enhance one's self-efficacy beliefs. Palmer (1992) studied a cognitive training technique, the paper patch technique which employs the use of key words to enhance figure skaters' mental imagery and their ensuing motor skill performance. After having prenovice and novice figure skaters practice the paper patch technique for eight weeks, they were compared to a no-treatment control group. The paper patch technique group showed significant improvements in their figure skating performance as compared to controls. These results demonstrate how verbal cues and mental images can be linked. Yet, it is plausible that the verbal cues and associated images employed in the paper patch technique could have been persuasive and in themselves have served to enhance one's self-efficacy beliefs. This enhancement of personal self-efficacy could possibly explain the figure skaters ameliorated performances.

Arousal

The last source of information able to influence an individual's personal self-efficacy beliefs is a person's activation level. In sport psychology particular reference is made to an individual's level of arousal. In the fear situation, athletes interpret their arousal level as indicators of vulnerability or at the extreme, dysfunction. They become fearful that they will not be able to perform. Their distress level and as such, their arousal, is elevated beyond an optimal level. The dilemma the athlete experiences becomes a type of self-fulfilling prophecy.

Four major sources of information: past performance, the vicarious experience, verbal persuasion and arousal are all able, depending on the circumstance, to influence an individual's self-knowledge. But these sources of information do not act unilaterally and are not void of interaction among themselves and other factors that enable us to better explain the complexities of developing self-efficacy beliefs. How an athlete cognitively processes these four sources of information in varying degrees and with different combinations of each will influence his/her self-efficacy beliefs. As in previous discussions, the cognitive processes to which Bandura (1986) and Feltz (1984) allude are cognitive interventions like mental imagery practice and self-talk.

According to Feltz (1984), if an athlete is able to control his anxious state by utilizing cognitive intervention techniques, the reduction of anxiety can serve to augment an athlete's self-efficacy beliefs. Thus, cognitive interventions like VMBR, SIT or relaxation techniques employed to control anxiety would enhance an individual's self-efficacy beliefs leading to an improved motor skill performance.

Most important to our discussion of self-confidence is its relationship to mental imagery practice. Bandura's (1986) explanation of self-efficacy as it relates to motor skill performance, and his suggestion that mental imagery practice plays a role in enhancing self-efficacy beliefs is central to our research. Take mental imagery for example, because it is considered to be a vicarious experience, an individual's perceived self-efficacy may be heightened by its very practice (Feltz, 1984). Martin and Hall (1995) concur with this statement, when they explain that it is the personal nature of mental imagery that lends itself to being an effective cognitive intervention in deriving efficacy information from such vicarious experiences.

1.7 Integrative Theories

Imagery rehearsal theories, especially those relating to information-processing, have at times been of very narrow theoretical scope because of their limited application to very specific situations in sport psychology. Earlier in this section, two prominent theories in mental imagery research, Cognitive Symbolic theory (Sackett, 1934) and Psycho-neuromuscular theory (Jacobson, 1930; Suinn, 1976) were presented. One point shared by these theories is that both suffer from the narrow micro-analytic origin on which their scientific rationale is based. Some theorists in sport psychology (e.g. Lang, 1979; Mackay, 1981) have sought to explain the nature and function of mental imagery from a more holistic applied point of view. These theorists integrate the mental imagery theories, cognitive symbolic and psycho-neuromuscular theories, in an attempt to present mental imagery practice as all encompassing and macro-analytic, in other words, input and then output, or central processing first and then peripheral processing next. In this way there has been an attempt to integrate both cognitive and motivational aspects of mental imagery practice into a more comprehensive model. The need for more generalized applications has led researchers to borrow from influential theories of a much wider scope than those used in clinical psychology. This approach to theory building in mental imagery has spawned what may be called integrative theories. Lang's psychophysiological theory (1979) and Mackay's top-down hierarchy theory (1981) are two such theories whose origins are firmly embedded in the information processing paradigm but whose theoretical tentacles reach beyond the cognitive function into the motivational sphere. These theories are sufficiently broad to have integrated plausible explications for imagery effects from both the cognitive (learning) and the motivational (arousal, state-anxiety, and self-confidence) perspectives.

1.7.1 Psychophysiological theory

Lang's psychophysiological information processing theory (1979) assumes that an image is a «functionally organized, finite set of propositions» (Murphy,1990, p.165).

Consistent with psychophysiological theory, there are two types of propositions: stimulus propositions and response propositions. The stimulus propositions deal with the content of the imagined scenario, while the response propositions deal with the imager's response to that scenario. These two propositions function in tandem preparing the individual to respond. The effector activity is then determined by the image structure in the brain (Hale, 1982; Murphy, 1990). In relation to motor activity, Murphy (1990) explains: «The image is also held to contain a motor program containing instructions from the imager on how to respond to the image, and it is thus a template for overt responding" (p. 165).

Lang (1979) emphasizes the link between stimulus and response propositions. For example, the stronger the relationship between vivid mental imagery and the motor behavior, the more effective the impact of the mental imagery. The distinguishing element in Lang's theory is in its holistic approach to mental imagery practice. There is an attempt to integrate into mental imagery the visual, the auditory, the tactile, the kinesthetic and all the emotional factors associated with actual performance. Lejeune, Decker and Sanchez (1994) have likened Lang's psychophysiological theory to Suinn's visuo-motor behavioral rehearsal technique (VMBR; 1980). This technique is one of the few psychological interventions in sport that boasts solid empirical evidence (Murphy, 1990). Evidence supporting the efficacy of VMBR as a cognitive intervention strategy is solid (e.g. Seabourne, Weinberg, Jackson & Suinn, 1985; Suinn, 1984). The advantage of VMBR as an intervention technique and its consistency with Lang's psychophysiological theory, is its general ability to be applied at the motor level as well as at the mental level, either during acquisition of skills or performance enhancement. This variability of application typifies integrative theories.

1.7.2 Top-down hierarchy theory

Another integrative-type theory, Mackay's (1981) top-down hierarchy theory offers, to some extent, an amalgamation of both the cognitive symbolic theory and the psycho-neuromuscular theory. Mackay proposes a hierarchy beginning with a series of mental nodes that eventually filter down to a series of muscle nodes. He explains:

> Activating the lowest level movement nodes results in muscle movement, but activating a higher level node primes or partially activates the subordinate nodes connected to it, and this priming effect remains subthreshold until the triggering mechanisms are applied. Only the mental nodes are activated during mental practice whereas muscle and mental movement nodes are activated during physical practice» (p. 281).

Figure 5 illustrates graphically both levels of nodes, first mental and then muscle. Mackay proposes a hierarchy where a top-down activation of mental nodes results when an individual practices mental imagery to better perform a motor skill, however this activation only filters down to the muscle node level during actual physical practice.

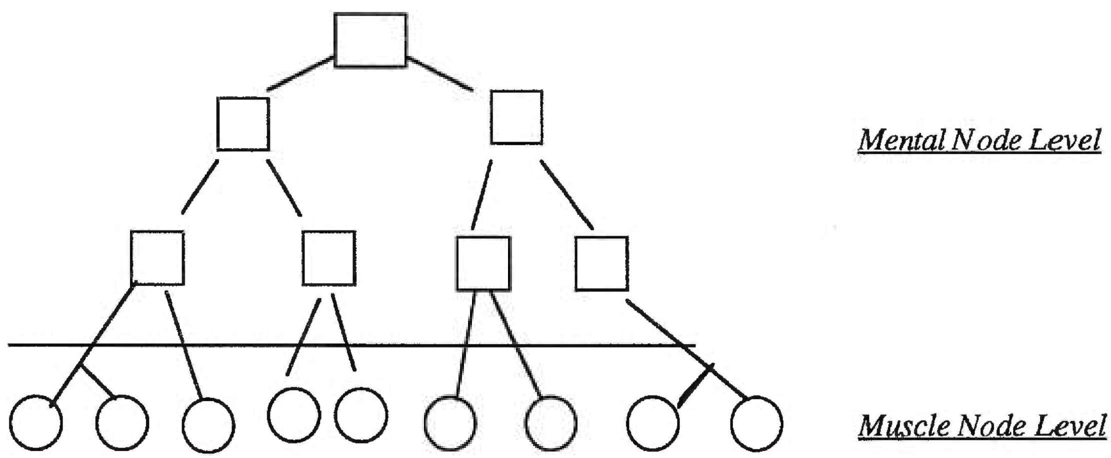


Figure 5 Top-down Hierarchy Theory.

Mackay's (1981) theory is based on previous research by Eccles (1972) who noted that frequency of past neuronal activity facilitates transmitter activity across a synapse during mental imagery but the facilitated transmission only occurs at the mental node level. Although there is support for the notion that physical practice and imagery practice share common neural programs (mental nodes) there is also evidence that other neural programs (muscle nodes) are not commonly shared by physical and imagery practices (Kohl, Ellis & Roenker, 1992). Mackay (1991) has shown transfer of performance of different tasks within the same muscle group. In a replication study, Kohl and Roenker (1983) measured performance between different muscle groups. Evidence from these studies provided by EMG feedback readings has led the authors to conclude that the transfer of performance is due to central processing of the central nervous system (CNS) at the mental node level, and not to peripheral activity at the muscle node level.

Others refute the whole idea of shared mechanisms and are quick to point out that mental imagery provokes not the same motor programs per se, but an alternative «cut down» version. In this scenario, only part of the hierarchy of mental and muscle nodes is shared. According to Annett (1988), imagery may utilize a shorter version of the global hierarchy presented by Mackay (1981). Annett's modification proposes that electric impulses penetrate to the muscle node level. This would account for the EMG readings that are similar but of lower amplitude than those EMG readings exhibited by the performance of a real motor skill. Annett's hypothesized relationship between mental and muscle nodes, evidenced by EMG studies, lend strong credence to the psycho-neuromuscular theory. Within this theory, proprioceptive feedback is made available to the CNS and modifications to imagery based symbolic codes dictates future efferent motor outputs. Using bow tying as a motor task, Annett (1988) was able to demonstrate that visualizing the motor task and describing it produced versions different from the actual performance. He cautioned against the traditional assumptions which are the basis of Mackay's (1981) top-down hierarchy theory. He also suggested that the hypothesized relationships between mental and muscle nodes were not entirely shared mechanisms.

These assertions have important implications as they relate to mental imagery practice effects at the cognitive level of Paivio's (1985) analytical framework. For reasons already discussed, information processing is operating in a closed loop system where, at least to some degree, past efferent outputs based on feedback can now be corrected by using kinesthetic mental imagery practice. The motivational aspect of Paivio's analytical framework can equally make an impact. Using kinesthetic mental imagery practice again as an example, its practice can be an important element of the progressive muscular relaxation technique (Jacobson, 1930). Used to control arousal, this effect of mental imagery practice identified as a motivational variable and predictor of better motor skill performance is in fact due to peripheral as well as central processing, the penetration of impulses to the muscle node level in Mackay's (1981) top-down hierarchy. If, in fact, behaviors, beliefs and affects can all be coded, based on Paivio's (1985) analytical framework theory from the mental nodes down to the muscle nodes, variables like arousal, state-anxiety and self-confidence, once coded for, could mediate the mental imagery - motor performance relationship. The fact that coding penetrates the muscle node level would only accentuate the influence of these motivational variables.

To summarize integrative theories, Lang's (1979) and Mackay's (1981) theories attempt to integrate complementary theories to explain mental imagery practice effects. Integrative theories, contributing to a wide spectrum of mental imagery practice applications, are conducive to Paivio's (1985) analytical framework theory which attempts to explain the variability found in motor skill performance.

1.8 Synopsis

Several theories from a variety of approaches have been elaborated in an effort to explain mental imagery's positive influence upon learning and performing motor skills. The study of mental imagery is divided into two components: nature and function (Chevalier *et al*, 1990). Finke's (1989) principles of equivalence serve to describe the dynamic nature of mental imagery by identifying temporal, spatial, and segmental parameters that characterizes mental imagery.

A description of the dual code (Paivio, 1971) and the triple code (Ahsen, 1984) theories and the empirical evidence they have generated, served to confirm that mental imagery consists of fundamental units: 1) the image (I), 2) the meaning (M), and, 3) the somatic response (S).

An examination of the function of mental imagery entails separate analysis of the cognitive and the motivational functions. Both functions were addressed in an examination of their related theories. Both the cognitive and motivational functions were examined within the context of the analytical framework theory (Paivio, 1985). The application of information processing theories of cognitive symbolic theory (Sackett, 1934) and psycho-neuromuscular theory (Jacobson, 1934; Suinn, 1976), showed a lack of empirical confirmation. It was, however, suggested that a more persuasive explanation of mental imagery functions can be achieved when the two theories are presented as complementary and generating a more integrative and applied theoretical ensemble.

From the general motivational perspective of the framework, the research findings seem to support the predictive validity of affect variables like optimal arousal levels, state-anxiety control and self-confidence enhancement to improve motor skill performance. Imagery research in turn has demonstrated the usefulness of mental imagery for controlling these constructs to achieve the required motor performance enhancement.

In an effort to synthesize an all-encompassing approach to explain mental imagery cognitive and motivational functions in relation to motor learning and performance, theories offering an alternative integrative approach were presented. The top-down hierarchy theory (Mackay, 1981) and the psychophysiological theory (Lang, 1979) both offer more holistic approaches and theoretical flexibility both at the cognitive and motivational levels of mental imagery practice effects on motor skill performance.

These theoretical constructs have served as the foundation for the corps of research and theory-building specific to mental imagery practice as it applies to sport psychology.

1.9 Theory building

The objective of scientific inquiry is to describe causal relationships based on theory. Theory allows researchers to explain data. In fact, what researchers are attempting to do, is create statistical models that best reflect or imitate theoretical models (Shadish, 1996). In the mental imagery domain, the research effort has at times demonstrated somewhat spurious effects of mental imagery practice by athletes who wish to improve their motor performance. This observed variability could possibly be explained by the fact that the statistical models employed to verify the phenomenon of mental imagery practice might not represent the theory. Although understandable in the initial stages of the research in the mental imagery domain, few statistical and theoretical models are expected to match in the early development of theory building. Ultimately, this gap is narrowed, as research is refined.

Anecdotes furnish rich descriptions of enhanced motor skill performances attributable to mental imagery practice interventions (Orlick & Partington, 1986). Anecdotal evidence however often used in describing sports behavior has methodological problems that limit its integration into any kind of data synthesis. From a historical perspective, in the initial stages of mental imagery research as was the case in other scientific domaines, conducting primary studies served to supply some elementary evidence about the phenomenon of interest. Today, the number of studies has grown quite large. Justifiably, experimental studies continue to be necessary more than ever. Current cumulative knowledge in the mental imagery domain has been descriptive in nature and solely focused on motor skill performance (e.g. Feltz *et al*, 1983; Hinshaw, 1991; Oslin, 1985). In this sense, mental imagery cumulative studies have been traditionally atheoretical by nature and largely focused on the effective use of mental imagery practice to obtain a better motor skill performance.

The focus on motor skill performance has yielded highly variable results with little explanation as to *why* mental imagery practice has such a wide range of efficacy. Statistically and theoretically, the models have not been on converging paths. The difficulty of studying such complex phenomenon as the practice of mental imagery has prompted researchers to look for other approaches. One is to consider more than one variable in order to investigate its varying facets and account for its variable effect on motor skill performance. The problem however, remains the same: being able to isolate the different variables in an attempt to identify not the efficacy, but rather a global focus on mechanisms of mental imagery practice in relation to motor skill performance.

Further advances would require the use of another type of analysis, a meta-analysis for explanation. «Because of the complexities inherent to social processes, comprehensive meta-analytic theory testing requires instead an assessment of numerous mediating and moderating factors that pertain to the relationship of interest: mental imagery practice - motor skill performance (Cohen, 1991). Within the context of our discussion of mediational modeling it is pertinent to first define and then to distinguish mediating and moderating variables. A *mediating variable* is a third variable in a relationship between independent and dependent variables (mental imagery - motor skill performance). The mediating variable acts as a generative mechanism through which the focal independent variable (mental imagery) is manifested and is able to influence the dependent variable (e.g. motor skill performance) (Baron & Kenny, 1986). The mechanism is the result of the independent variable asserting itself via the mediating variable. Within this context, there is no effect of the focal independent variable (mental imagery) if the mediating variable is controlled.

In contrast, the *moderating* variable is presented as a third variable which partitions the focal independent variable such as mental imagery (or another mediating variable in the relationship) into sub-groups that establish its effectiveness (Baron *et al*, 1986). The moderator always acts as an independent variable, not determining the existence of the relationship (mental imagery - motor performance) per se, but influencing rather the strength and variability of the relationship. In this context, the moderating variable is not correlated to the independent variable, but rather interacts with it. In the relationship: independent variable - mediating variable - dependent variable, placement of the moderating variable within the same causal system, only helps to render more dynamic the role of the independent or the mediating variable, whichever is the focus of the study.

Conceptually the benefits of mediational modeling are enormous: researchers can test hypotheses that were never and could never be tested in original studies. Caution must be taken however, because if confounds in research are to be explained, mispecification of the mediational model is a grave danger (Shadish, 1996). The mediational model must be plausible and it must be conceptually relevant. Accordingly, mediational meta-analysis requires thoughtful theory-based coding of meaningful variables that could plausibly moderate the relationships studied. If relationship strength and variability are to be qualified, it is imperative that coded variables bear a strong theoretical relation to the hypotheses tested. A mediational meta-analysis can narrow the focus of the research by verifying mediating variables and when heterogeneity in the data exists, to identify moderating variables eventually responsible for it. In other words, it will test whether a theoretical model fits a set of data adequately.

Despite their methodological shortcomings, the more global integration analyses that have already been carried out (Driskell *et al,* 1994; Feltz *et al,* 1983; Feltz *et al,* 1988; Hinshaw, 1991; Oslin, 1985) established relatively clearly the positive effects mental imagery practice has had on motor skill performance. The basic facts and conceptual building blocks for theory in the mental imagery practice literature have been put in place. The goal of research for any theorist is to build on past findings, assimilating the many pieces of research into an ensemble of fact (Hunter & Schmidt, 1990). However, the need to advance mental imagery theory demands more in-depth and more elaborate analysis. The exploration of causal mediating variables allows us to go beyond description of the phenomenon to the explanation of the mechanisms involved. In meta-analysis this is accomplished by theory building. It is the different statistical methods of analysis: correlation, blocking and different meta-analytic levels. The meta-analyst verifies the process by identifying variables mediating relationships and then extends the explanation of the variability of the effect found in the model, if it exists, by exploring moderators. The meta-analyst has the ability to provide explanations about how mental imagery works.

1.10 Meta-analysis: a tool for theory development

It is opportune to describe the evolution of cumulative methods leading to the present statistical tools employed in the present research.

1.10.1 Narrative review

Prior to the 1980s, traditional attempts at summarizing the literature and ascertaining the effects of practicing mental imagery were invariably carried out via the narrative review (Corbin, 1972; Richardson, 1967; Weinberg, 1982). Several problems were quite evident with this method of analysis. More often than not, too few studies were ever included to properly represent the identified population. More importantly, the narrative review introduced and often substantiated the researcher's biased opinion. Speculation about the real effects of practicing mental imagery were rampant, due in part to the cognitive overload of the researcher: the integration of too great a number and too many levels of variables (moderating, mediating, dependent or independent). The relationship strength between variables was also most difficult to establish.

1.10.2 Vote counting method

The vote counting method was one of the first techniques used as a cumulative analysis. Simply stated, it consisted of a tabulation of significant *versus* nonsignificant tests (Hunter & Schmidt, 1990). The group having the greater number of studies with significant results was declared to be the winner and represented the best estimate of the direction of the relationship between the variables. This method is falsified by the fact that the same correlation can be significant or nonsignificant simply based on the size of the total 'N' (number of subjets in the study). The vote counting method treats all the studies as the same without considering the different meanings of significance. For example, if we take a study where the 'N' for each experimental group is equal, and we have an observed correlation of

0.26, tests of significance between the groups do not account for sampling error attenuation. That is to say, studies with small but equal experimental groups would exhibit larger sampling errors than studies with larger but equal 'N' experimental groups. This sampling error, called an artifact diminishes or attenuates the real size of the effect of a treatment. Thus, an artifact like sampling error after correction gives a real value of 0.20. This actual corrected correlation would be significant only 40% of the time in comparison to the uncorrected correlation of .26 which is significant 100% of the time. Thus, in the majority of the cases (equal to or greater than 60%) the actual population value of 0.20 will not reach significance and the conclusions will be wrong.

It is inadequacies like these in the cumulative research methods of the day that led researchers like Thomas & French (1986) to state that previous narrative reviews had been so systematically inept and objectively incongruent that an integrative approach based on scientific principles had become imperative.

1.10.3 Glassian method

Meta-analysis is defined by Glass (1976) as «an approach to research reviewing based upon the quantitative synthesis of results of related research studies» (Feltz, Landers & Becker, 1988 p. 8). Cooper & Hedges (1994) are more explicit in presenting meta-analysis as a type of research that attempts to integrate empirical research for the purpose of generalization. However, it must be noted that these generalizations have limits and modifiers as determined by the inclusion criteria and the moderating variables specified in the meta-analysis.

Integrative analysis, a term synonymous with and used interchangeably with the term meta-analysis, has been criticized for not being logical and rational in its approach. Slavin (1984) describes meta-analysis as «thoughtless application of statistical summaries.» This criticism has some validity insofar as some earlier studies had violated procedures essential to the process. This was due in some cases to poor data collection procedures (for example, Oslin, 1985) and in other cases to the paucity of appropriate meta-analytic methods at the time (for example, Feltz & Landers, 1983).

Recent advances in correction for bias by means of weighted means, tests of homogeneity and computation of effect size, in addition to the more diligent coding of moderating variables, have contributed greatly to countering for the poor quality control of studies (Salazar, Petruzello, Landers, Etnier & Kubitz, 1993). In an update of Feltz and Landers, 1983 study, Slavin's (1984) critique of meta-analysis is contested based on these innovations in statistical analysis: «... when thoughtfully conducted, a meta-analysis can provide a more rigorous and objective alternative to the traditional narrative review" (Feltz *et al,* 1988, p.9). With the advent of a new battery of procedural and statistical techniques, meta-analysis as a valid and reliable statistical tool provides a quantitative index of rigor and objectivity as sought in today's research.

Inspired by the quantitative method, Thomas & French (1986) describe the procedure for conducting a proper meta-analysis. The product of this scientific manipulation is a statistical index called <<effect size>> (ES), a measure of the treatment effect across studies. Not being able to establish relationship strength in a clear and logical fashion was the "Achilles Heel" of the narrative review. With the effect sizes between variables established in a meta-analysis, the subjectivity of past estimates has been systematically alleviated and supplanted with rigor and objectivity. In other words, by considering the size of the effect rather than relying on the significance tests, meta-analysis avoids the low power of the vote counting method by not depending on the sample size. It exploits rather the combination of effect sizes across studies. For this reason it is considered the instrument of choice for the integrative analysis undertaken by the present study.

Most of the following discussion is concerned with meta-analysis as advocated by Glass (1976) and by Hedges and Olkin, (1985). Both of these methods of meta-analysis deal with sampling error as an artifact source of variation across studies; however the latter method additionally accounts for variation across studies by testing models of artifacts such as sex, age, and imagery ability.

Though the Glassian (1976) method of meta-analysis was being developed at approximately the same time as another, the Hunter and Schmidt (1977) method of meta-analysis, it would appear that neither of its authors knew of each other's research efforts. Like Glass (1976), Hunter and Schmidt (1977) propose the inclusion of all pertinent studies in their method of meta-analysis; study quality per se, is not an issue. The Glassian (1976) method of meta-analysis in particular is based heavily on the effect size (ES).

$$ES = \frac{M_e - M_c}{S_p}$$

M_e = experimental mean
M_c = control mean
S_p = pooled standard deviation

The ES can be translated into an effect magnitude (EM) which represents a common metric of the original data found in the many different studies. This quantitative summary is expressed in an average difference of all studies, or ES, for the variables being studied. Once an ES has been calculated for a study, it is then averaged among all the study ESs pertaining to the meta-analysis in question. This averaged ES is then the common metric used to estimate the treatment effect being measured. It is justifiable for Glass (1976) to cumulate data under this common metric (ES) and to attempt to explain or give some order to the randomness of certain phenomenon or influences found, for example, in the realm of mental imagery literature, such as Feltz and Landers' (1983) study.

The Cohen 'd' statistic is depicted as the ES statistic and its function is to represent the quantitative cumulation of all ESs across studies. In the Glass (1976) example, Cohen has tried to describe the treatment effect, using the 'd' statistic in order to paint a broader, more general picture of the variable effects under investigation. The Glassian meta-analysis has traditionally been employed more for descriptive type cumulative analyses.

1.10.4 Hedges & Olkin method for explanation

Taking ES at face value when uncorrected for artifacts was the Achille's heel of the Glassian method. Artifacts attenuate each ES: sampling error and measurement error are the most prominent. By correcting for possible artifacts, more accurate and less variant estimates of ES would ensue. The Hedges and Olkin (1985) method advocates such a procedure and distinctly differs from the Glassian (1976) approach on another important point: it includes a homogeneity test based on significance testing. Accounting for heterogeneity in the results in this way is the cornerstone to the identification of significant moderators. For example, should a meta-analysis between mental imagery practice and motor skill performance with an overall effect size show that it is heterogeneous, we could conclude that the ES is moderated by some other parameter. It is possible and even probable that some of the heterogeneity could be explained by the protocol used in assigning subjects to experimental groups. A sub-group meta-analysis that was significant would identify the group with random assignment as being more homogenous than their counterparts who had not undergone random assignment. We could then conclude that assignment status is a significant moderator in the mental imagery practice - motor skill performance relationship.

From our discussion of the two most prominent approaches to meta-analysis, two very different purposes for meta-analysis emerge. Initially the purpose of meta-analysis using the Glassian method was descriptive in nature, painting a broader, more general picture of a particular research literature. This type of descriptive meta-analysis is evident in the early mental imagery practice meta-analytic literature. Although the Hedges and Olkin approach can be considered an extension of Glass, it attempts to answer narrower questions by accounting for variability. Multiple variables, independent, dependent, mediating and moderating can be integrated into a multivariate, regression type of meta-analysis.

Shadish (1996) states that the use of meta-analysis is changing. More sophisticated and subtle ways of using meta-analysis allows us more in-depth analysis. By accounting for ES variance, researchers can investigate heterogeneous effects in distinct dependent measures. Desegregating study ESs and regrouping studies into appropriate categories does this. Regression analyses may then be employed to account for the variances within these subgroup analyses (Shadish & Haddock, 1994).

1.11 Objectives and two study questions

Based on existing theory (Bandura, 1977; Paivio, 1985; Yerkes *et al,* 1908) and corresponding empirical evidence (Ainscole & Hardy, 1987; Feltz, 1984; Feltz *et al,* 1990; Martin & Gill, 1991; Seabourne *et al,* 1982), it is plausible to suppose a direct link between intermediary mediating variables such as arousal, self-confidence and state-anxiety and both mental imagery practice and motor skill performance. In view of the complexity of the mental imagery phenomenon, establishing these relationships between the dependent, independent and mediating variables would provide strong empirical support to explain how motivational effects of mental imagery practice enhance motor skill performance. Thus, the first objective of the study is to build a model, as illustrated in Figure 6, the Proposed Model, showing the role played by the mediating variables arousal, state-anxiety and self-confidence in enhancing the mental imagery - motor skill performance relationship. A second objective is to identify within our model the moderating variables that account for the variable effects in these same relationships. Once these two objectives are attained, an explanation at the motivational level of the mechanism of mental imagery practice enhancement of an individual's motor skill performance will have been advanced.

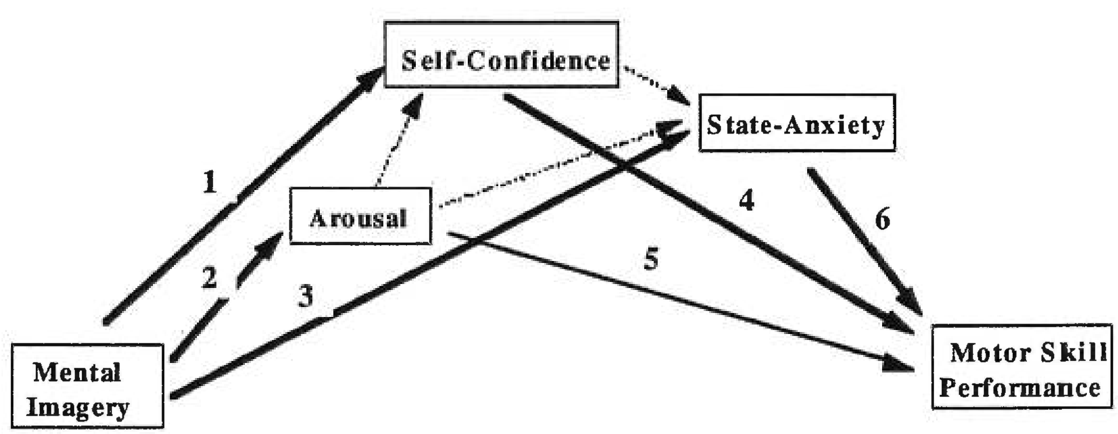


Figure 6 Proposed Model

First Question:

The first question of the study deals with relationship mediators in relation to this model and of Paivio's (1985) analytical framework theory. It asks if the mental imagery practice mechanism at play when individuals intend it to enhance their motor skill performance is mediated at the general motivational level by his optimal level of arousal, by his control of state-anxiety, and by his enhancement of self-confidence. The verification of each of the mediating variables will be achieved by a series of multivariate meta-analyses. Analysis of the results should demonstrate a significant contribution (for example, an effect magnitude 'r') for each of the nine separate relationships.

Second Question:

Based on Paivio's (1985) analytical framework theory, the second question of the study deals with any variability found in the above study relationships. It asks: if and when mental imagery practice is mediated by variables such as arousal, state-anxiety and self-confidence, when individuals intend to enhance their motor skill performance, are these mediating variables modified by moderating variables. The degree of contribution of each of the moderating variables between the relationship variables will be assessed by a series of multivariate sub-group meta-analyses. Analysis of the results should identify moderators that each explains a significant amount of variance (also termed heterogeneity 'QR' statistic) in each of the nine study relationships if variability does exist.

CHAPTER 2: Methods

2.0 An Overview

In the present study, Paivio's (1985) « Analytical Framework Theory» served as a model to guide the study syntheses and meta-analyses. The framework is expanded for purposes of the present research to include further sub-divisions, which exemplify relationships between independent, dependent, and mediating variables. The focus of our research was the empirical studies fitting an *a priori* set of inclusion criteria based on these relationships. Grouping of study relationships within the framework into smaller or larger entities was based on theory and on data availability from the literature. The methodology employed to conduct these meta-analyses is presented below.

2.1 Data collection and inclusion criteria

Target studies. All studies including relationships among two or more of the motivational components of Paivio's Analytical Framework Theory were targeted by the data collection strategy. The primary studies needed to include a practice of mental imagery, intent to perform a motor skill, and a measure of at least one of the mediating variables. These mediating variables were hypothesized to be in relation with either mental imagery practice or a motor skill performance, or alternatively in relation with each other (such as arousal, state-anxiety and self-confidence). Cognitive strategies were excluded from the data set (e.g., self-talk, relaxation techniques, meditation, modelling, cognitive restructuring, or psychological training programs like stress management training-SMT, stress inoculation training-SIT and visuo-motor behavior rehearsal -VMBR), if they were judged not to have incorporated a significant portion of their practice as mental imagery. As well, all empirical studies identified as measuring cognitive or academic performance only were not included in the present research.

The search for primary studies was not limited by publication date. However, it became apparent that the bulk of primary studies on mental imagery practice and motor skill performance integrating at least one mediating variable were published in the past two decades, post 1980. The cut-off for collecting primary studies was March 1999.

Type of physical activity was not distinguished when including a motor skill performance, nor was type of physical activity used to delineate the target collection of primary studies based in a specific sport domain. For purposes of the present research, all aspects of everyday life physical activity qualified as a motor skill performance although the great majority of the data set originated in the sport and physical activity domain.

Martin, Moritz and Hall (1999) have termed performance (i.e.competition) as representing an event where the athlete's skill is being evaluated and learning (i.e. training) as representing other practice situations. The present research has established performance (i.e. as identified in the selection of primary studies section on page 64 based on key words) as an inclusion criteria and not learning.

Search procedures. Document searches were conducted on seven data banks. These included Educational Resources Information Center (ERIC), Science Citation Index (compact disc version), Sport Discus, CD Thèses, Medline, PSYCLIT and Dissertation Abstract (DISS). In addition, relevant sport psychology reviews such as the *Journal of Sport and Exercise Psychology, the Sports Psychologist, the Journal of Perceptual and Motor Skills, the Journal of Mental Imagery* and other scientific reviews in the field of sport psychology were exhaustively reviewed on an ongoing basis through out the research period. Another important source of document searches was the scanning of pertinent reference lists.

Table I, p.64 summarizes the results of the search strategies employed for selection refinement that eventually resulted in a final data set on which the synthesis analyses were based.

Table I.

Distribution of EM by study relationship across primary study selection refinement phases

Col. 1	2	3	4 (5)
	Selection of Primary Studies		
Study Relationship	Phase 1	Phase 2	Phase 3
IM_SC	38	12	24 (62)
IM_AR	242	110	24 (60)
IM_AN	231	77	23 (55)
AR_AN	312	151	3 (8)
AR_SC	24	6	1 (1)
SC_AN	274	42	1 (1)
SC_PER	142	32	5 (15)
AR_PER	161	14	5 (26)
AN_PER	736	153	5 (12)
TOTAL:	**2160**	**597**	**(*47)91(240)**

In phase 1 (Table I, col 2), an initial block of relevant documents was retrieved from the databases using very general key words. These key words included IMAGERY, AROUSAL, ANXIETY and PERFORMANCE. This initial search was conducted to ensure that no relevant studies were overlooked. As an example, there were primary studies that did not distinguish their performance term as academic performance or motor performance. This initial search for primary studies yielded 2,160 primary studies.

In phase 2, each of the 2,160 primary study abstracts were examined and based on more specific key words, for example, MENTAL IMAGERY, STATE-ANXIETY, AROUSAL and MOTOR PERFORMANCE, the selection was further refined. This second selection is represented in Table I, col 3 and yielded 597 primary studies.

In phase 3 an attempt was made to retrieve the 597 primary studies identified in phase 2. Of the number of primary studies retrieved, each was assessed to ascertain that the inclusion criteria were met and the necessary empirical data were included in the publication. Phase 3 presented in Table 1, p. 64, col.4 (5) illustrates the number of primary studies meeting the inclusion criteria and the total number of measures (EM) supplied by these primary studies. Because of the significant overlap, that is primary studies supplying more than one EM, the numbers not in parentheses is larger. Overlap is also evident between study relationships where the total number of primary studies collect for the research is 91, but in reality a smaller number primary studies actually supplied all of the EM's in the total research of 9 study relationships or meta-analyses.There were primary studies that, for example, supplied an EM for AR_PER, another for AN_PER, and yet another for SC_PER. The number in parentheses in col 5 corresponds to the number of EM or study correlations for each study relationship. After taking the overlap into consideration, the total number of primary studies considered for synthesis analysis was 47, col. 4, accounting for an accumulated total of 240 EM (col 5) distributed across all study relationships of the present research.

2.2 Coding

Nomological coding involves identifying the presence and frequency of a battery of study characteristics that best describe the data. Adjustments were made to the coding of the study characteristics throughout the procedure. It may be that research questions are changed in the course of a meta-analysis. This means making an adjustment to coding of different study characteristics as the meta-analytic process unfolds (Stock, 1994). Initially, 10 primary studies of the 47 that had already met the inclusion criteria were randomly selected and were nomologically coded (Abrami, Cohen & d'Apollonia, 1988). Data was collected by scanning primary studies, extracting the relevant information and compiling this information on a coding grill (coding sheets, appendix 1, p.153) used later as our data bank for the ends of synthesis analysis. The coding of dependent measures, the necessary statistical information and finally of moderator variable characteristics was done in a systematic fashion following a coding protocol (appendix 2, p.157). The protocol though flexible enough to allow for modifications along the duration of the research, is a guide to consistent and pertinent gathering and classifying of information across all the study relationships investigated.

The initial phases of coding first included groupings based on the type of dependent measures described in the coding protocol. Identifying a data set fitting the study relationships was the first priority in coding. Each primary study coded was identified by the researcher who was coding as being representative of a dependent measure (EM) corresponding to one of the study relationships in the present research.

The second coding priority consisted of obtaining data points such as the number of subjects (n), standard deviation (sd), group means, the 't', F, X^2 and 'r' statistic.

The third coding priority was deciding what relevant study moderator characteristics to code and that was based on several considerations: 1) theory, literature review and domain-specific knowledge; 2) past synthesis research reviews; and 3) conjecture, hunches, hypotheses and speculations. Based on these considerations and on the availability of the data in the collected literature, specific study moderator variable characteristics are then consistently coded across all the study relationships. Coding possible moderators variables as study characteristics *a priori* reflects the intent of the present study to explain the variability (heterogeneity) in the main effect of each study relationship if it exists. The moderator variable study characteristics coded for in the present research are illustrated in Table II, and described in appendix 3, p.164.

Table II

Types of Moderating Variable Study Characteristics Coded in the Synthesis

- Article Characteristics
  - Study Type
  - Publishing Status
- Study Subject Characteristics
  - Age
  - Gender
- Study Quality Characteristics
  - Assignment
  - Manipulation Checks
- Independent Variable Characteristics
  - Mental Imagery Practice Type
  - Mental Imagery Practice Style
  - Mental Imagery Practice Time
  - Relaxation Session
- Dependent Variable Characteristics
  - Ability Level of the Participants
  - Type of Task
  - Type of Test

Reliability of coding. Only one coder was involved in the coding of study correlations and study characteristics. Reliability of coding known as «coder drift» could thus have occurred. In an effort to redress coder drift, a form of test-retest procedure developed by Orwin (1994) was used to verify coding reliability. The procedure is based on recoding a random twenty five percent (25%) of the total primary study samples. The agreement rate is calculated by adding the number of EM or the number of study characteristics recoded then, divided by the total number of study correlations or total number characteristics coded originally giving upwards of r = 0.90, as acceptable. Twenty-five percent of both the EM and study characteristics were recoded in the present research. The agreement rate was r = .94, indicating coder drift to be within acceptable limits.

2.3 Analyses

Analyses in the present research follow a progression starting with the calculation from raw data (zero-order correlations) of an EM. Accounting for dependencies (for example, employing variance/covariance matrices to estimate dependencies) in the EM would be a second step in the analyses. The last step implicates a regression analysis (GLS regression analysis) for the analysis of multiple effects that could explain the variation found within the study relationship EM.

Analysis begins with the conversions of experimental findings into data points, called effect magnitudes (EM). The effect size (d) is defined by Hedges and Olkin (1985) as the difference between the means of the experimental group and the control group divided by the pooled-within group standard deviation (Sp). In the present research the approach was to integrate all 'd' statistics into an effect magnitude (EM) or a study relationship correlation. It should be noted that this integration is possible for all of the primary statistics. The primary study statistics 'd', F, X^2, 't' and 'r' can all be transformed into EM (Hunter & Schmidt, 1990). Taking the study relationship IM_SC, the majority (80%) of the experimental findings was group means, 't' and F statistics. These were converted to a 'd' statistic. The other experimental findings were zero order correlations 'r'. Both the 'd' and the 'r' are converted to EM. For this study relationship IM_SC, (p. 86), the EM = 0.24.

Missing data. When primary statistics and zero order correlations were not reported in the publications, extensive attempts were made to contact the authors of these works. A maximum of three attempts was made. When the data was not forthcoming, dependent measures were dropped or procedures were undertaken to estimate the necessary statistics depending on the type of missing data. Three procedures in estimating missing data were employed in this research study:

1) Pre-post group means: for primary studies that failed to report the correlation between pre-post group means, a procedure developed by Looney, Feltz and VanVleet (1994), was used for integrating a correction factor. The correlation between groups was calculated in the ES and then transformed into an EM.

2) Dependent variable reliability measures: among the correctable artifacts, for example, errors of measurement, test reliability at the dependent variable level was the most reported. Good examples are reliabilities reported for psychometric tests like the CSAI-2, the STAI and the STPI. Correcting for this artifact would aid in disattenuating the mean study correlation from this type of error. The correction for reliability of dependent variable measures was conducted following the computation of individual primary study EM. For the large majority of primary studies these reliability estimates were reported. When studies did not report reliability estimates for a particular measure, these were taken from other primary studies having the same measures within the present meta-analysis. If that failed, reliability estimates from the test specifications themselves were searched, and if that failed, as a last resort, an average was taken from the existing reliability estimates of primary studies reported in the meta-analysis (Hunter & Schmidt, 1990).

3) intercorrelations between measures: when two or more dependent measures originate from a same study sample, it is crucial to know their intercorrelation in order to calculate the covariance among the dependent measures. For example, the same group of subjects practising external mental imagery for one state-anxiety measure and then internal type mental imagery for a second measure of the state-anxiety would mean that these two measures are correlated. The measures originate from the same subjects and the two types of mental imagery styles could share variances. An intercorrelation

intercorrelation between these two measures of state-anxiety is needed to calculate the covariance, that is, the variance share by both groups. These intercorrelations were not reported for eight study correlations. We used Becker's (1992) procedure to estimate the covariance of unreported intercorrelations by replacing them with a corresponding mean estimate drawn from the study correlations.

Interdependence in outcomes. Correlations of primary studies not originating from the same samples were assumed to be independent. However, when multiple correlations originated from the same sample, then these sample correlations were treated in turn as if they were correlated. Variances for all the primary study correlations were calculated and imputed into a matrix on the diagonal. Illustrated in appendix 3, p.170, the diagonal is represented by the high lighted straight line. For the sample correlations that showed non-independence, corresponding intercorrelations were used to determine their covariance and imputed into the matrix on the off diagonal. Illustrated in appendix 3, p.170, the off diagonal is represented by the squared high lighted area. The following formulas were used in the calculations of the variances and covariances:

$Var(r_{12}) = (1-p_2r_2)^2/n$ .... (diagonal in the matrix)

$Cov(r_1, r_2) = [0.5\ (2r_{int} - r_1\ r_2) \times (1 - r_1^2 - r_2^2 - r_{int}^2) + r_{int}^3/n$ .. (off-diagonal in the matrix)

- Var = variance
- Covar= covariance
- r_{12} = sample correlation between 1 and 2.
- r_{int} = intercorrelation between 1 and 2
- n = sample size

Regression analysis. A weighted, average correlation (EM) across all study correlations included for the study relationship was first conducted. Continuing with our example on page 68, the study relationship mental imagery practice - self-confidence (IM_SC), the average study correlation (EM) obtained for this relationship was 'r' = 0.24 (Table IX, p.86). A test of homogeneity (Q_E) measures the presence of a significant difference in the data set to what might be otherwise expected because of sampling error. In the example IM_SC, a Q_E = 2,586.6 (Table IX, p.86) was obtained. This value exceeded the critical value and indicates that it is significant. This is interpreted to mean that there exists an important amount of variability that remains unexplained, indicating that the data set is *heterogeneous*. These results would suggest that other study characteristics or predictors could be added in order to construct other regression models accounting for this variability.

Accounting for the variation. GLS regression is a valuable method used to identify predictors which may be contributing to the variation in any one of the study relationships. Once complete, the variance-covariance matrix (Appendix 3, p.170) based on the study correlations, is composed of an independent data set which is used, in turn, to construct a predictor matrix (Appendix 4, p.173) upon which regression models are formulated. These models then verify our theoretical assertions.

Continuing with our example IM_SC, a possible predictor of self-confidence was the type of task which can be subcategorised as cognitive, physical or other. Specifically, in those individuals who practice mental imagery to raise their personal self-confidence, whether the task is predominantly cognitive in content, physical or other, these levels of the moderator would predict ones self-confidence. Thus there are then three possibilities in our predictor matrix on type of task. In appendix 4, p.173, line 32 illustrates a study correlation for a cognitive type task and is coded as 10, the column v14, line 32 is imputed with 1 and column v15, line 32 is imputed with a dummy coded 0. Physical task is represented by 01and other as 00 when a study correlation represents their alternative. The GLS regression model would then be estimated on the basis of the means of these three alternatives identified. Beginning with the study characteristic (or predictor) «type of task» added to the regression model, (Table IX, p.86) the regression fit (Q_R = 743.2, col 6) changes significantly. Along with the Q_R, a percentage of the variance explained (last column) by the moderator type of task is reported (29%). It is the additional percentage of variance explained by the moderator that is reported. Turning back to the example taken from Table IX, p.86, much of the variability Q_E = 1,843 remains unexplained. Thus, we continue to add predictors (such as relaxation, manipulation checks, type of self-confidence, amount of mental imagery practice time and ability level of the subjects). Predictors are added in order of importance (depending on how much of the variability is explained) until all of the heterogeneity is totally explained, which rarely occurs or until the regression models no longer change significantly.

It must be mentioned that there is a danger of an inflated Type 1 error when introducing multiple predictors to the regression model. As iterated by Hunter and Schmidt (1990), the greater the number of variables introduced the greater the possibility of error in the results due to capitalization on chance. In the present research, we tried ultimately across all study relationships to explain as much of the variability as possible with the least number of predictors (or moderators) based on theory in the mental imagery practice - motor skill performance domain, as advocated by Hunter and Schmidt (1990).

A further analysis was then undertaken to identify the influence of each level of the moderator. Following the IM_SC example, the first predictor added to the regression analysis was the type of task performed when an individual who practices mental imagery performs better by enhancing his self-confidence. Type of task was separated into cognitive type tasks and physical type tasks. The effect of each level of the predictors added to the regression model yielded a beta weight (β) and corresponding confidence interval (CI). These statistics were then employed to decipher the relative contribution of each level of the predictor to the regression model. In the example given the β for physical type tasks was 0.92 and for cognitive type tasks the β was 0.21. Their confidence intervals (CI) did not overlap and neither included the value of 0. These statistics would indicate that both levels are significant in that neither level had CI that included 0. As well, neither levels' CI overlapped, which means that they remain distinguishable one from the other. Because the β for physical type tasks was much larger then that of the cognitive type task level, the findings suggest that it is the physical type tasks that are responsible for explaining most of the variability accounted for in the regression model by the type of task in the IM_SC study relationship.

Computer software. The coding of study characteristics and necessary empirical data as well as initial study correlation computations of primary studies was completed using Microsoft Excel. These data points were then transferred for further multivariate statistical analysis (study relationship EM and multiple regression analysis) completed with SPSS 6.1 (SPSS 6.1 for Windows update, 1994).

Chapter 3: Results

3.0 Description of the primary studies

Sources. Of the 47 primary studies satisfying the inclusion criteria, all were conducted between the years 1981 and July 1999. A record of article characteristics: publication status and the type of empirical primary study design by study relationship (see Proposed Model, Figure 6, p.58) is summarized in Table III. Almost three-quarters (71%) of the primary studies collected for the research were published articles, the other primary studies (29%) were unpublished dissertations. Most of the empirical data consisted of experimental primary studies (75%) with the remainder of the data drawn from correlational primary studies (25%).

Table III.

Distribution of article moderator characteristics within and across proposed model relationships: Publication status and empirical design of primary study sub-totals, totals and cumulative %.

Col. 1	2	3	4	5
Study	Publication Status		Empirical Design	
Relationships	Published	Unpublished	Experimental	Correlational
#1 IM_SC	18	6	19	5
#2 IM_AR	17	7	22	2
#3 IM_AN	16	7	20	3
#4 SC_PER	4	1	0	5
#5 AR_PER	3	2	2	3
#6 AN_PER	3	2	1	4
TOTAL	61	25	64	22
%	71	29	75	25

Glossary of abbreviations in appendix 6.

Samples. The number of subjects (n_{total}) for the entire research study, including all the study relationships, gave a total of 8,063 (Table IV, p. 76, col.2). However, it should be noted that any one primary study sample could have been employed for more than one measure

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However, it should be noted that any one primary study sample could have been employed for more than one measure within a study relationship or across several study relationships. Table IV, also summarizes the subtotals of the number of subjects by study relationship in the proposed model (p.58) and shows the distribution of primary study subject characteristics: age and gender of the participating subjects within and across study relationships. The majority of the subjects were >20 years and older (57%) (col 3 & 4), and in relation to gender, males were the most represented (44%), with females poorly represented (16%) (col 5, 6 & 7).

Table IV.

The Distribution of subject moderator characteristics within and across proposed model relationships: by the number of subjects (n), by age, and by gender.

Col. 1	2	3	4	5	6	7
Study Relationship	n Total	Age ≤20	Age >20	Gender Male	Gender Female	Gender Male+Female
IM_SC	2,371	31	31	15	16	31
IM_AR	2,000	27	33	25	3	22
IM_AN	1,921	20	35	21	19	17
SC_PER	839	7	8	5	0	10
AR_PER	736	9	17	25	0	1
AN_PER	196	4	5	9	0	0
TOTAL	8,063	98	129	100	36	91
%		43	57	44	16	40

Table V The Distribution of Study Quality, Independent and Dependent Moderator Characteristics within and across Proposed Model Relationships

	Study Quality Moderator Characteristics				Independent Variable Moderator Characteristics										Dependent Variable Moderator Characteristics			
Study Relashion-ship	Assignment of Subjects		Manipulation Checks		Mental Imagery Practice Type		Mental Imagery Practice Style			Mental Imagery Practice Time			Relaxation Used During Imagery		Motor Skill Ability Level Of the Subjects		Type of Motor Skill Task	
	Random	Non-Random	Yes	No	Multiple	Simple	both	external	internal	14+	>2 14	≤2	Yes	No	non-elite	elite	Physical	Cognitive
IM_SC	33	39	32	12	21	34	26	14	15	34	5	7	26	16	32	30	14	48
IM_AR	34	25	10	33	13	40	25	14	7	15	13	14	28	14	37	23	14	35
IM_AN	32	23	16	25	12	22	22	13	0	23	11	8	21	15	24	31	20	27
SC_PER	4	11	4	6	4	10	4	7	0	8	6	0	10	4	14	1	14	1
AR_PER	22	4	23	2	0	23	22	0	3	20	1	0	22	2	25	1	12	14
AN_PER	6	6	5	6	0	8	3	0	8	1	0	8	6	3	11	1	11	1
TOTAL	131	108	90	84	50	137	102	48	23	101	36	37	113	54	143	87	85	126
%	55	45	52	48	27	73	59	28	13	60	20	20	67	33	62	38	40	60

Table V, p.77 summarizes the subtotals and percentage of EM by study relationship of the proposed model (p.58) and shows the distribution of the moderator variable characteristics concerning study quality: 1) assignment of subjects to experimental groups; and 2) manipulation checks of the independent variables. Across the study relationships 55% of the study correlations were extracted from primary studies that randomly assigned subjects to experimental groups in the primary study. Manipulation checks of the independent variable were found to have occurred in 54% of the primary studies.

An *independent moderator variable characteristic* category describing mental imagery practice was also coded across all the study relationships. Included in the category of independent variable characteristics were the following descriptors: 1) mental imagery practice type (mental imagery practice alone as in simple form or practised within a psychological training program as a multiple form of practice); 2) mental imagery practice style (style has been redefined as visual and kinesthetic); 3) mental imagery practice time trichomized into three categories: ≤2 min, >2 min to <14 min, ≥ 14 min); and 4) relaxation sessions integrated in mental imagery practice. In most primary studies (75%), mental imagery was practised alone rather than within a psychological training program (25%). Of the primary studies that did report mental imagery practice style, the majority (69%) employed a combination of both styles of practice, 28% of the primary studies used visual mental imagery practice and only 13% used the kinesthetic style. Also, the majority (60%) of primary studies reported practices of mental imagery lasting 14 minutes or longer as opposed to practices lasting between two and 14 minutes (20%) and practices lasting ≤2 min (20%). And lastly, two thirds (67%) of the primary studies incorporated a relaxation session with their mental imagery practice.

The third category of study moderator variable characteristics, *dependent variable characteristics* included: 1) ability level of the subjects; and, 2) type of task. The first, ability level of the subjects, dichotomised into elite and non-elite classifications, and revealed that the majority (62%) of the primary studies involved non-elite ability level participants. As well, the majority (60%) of the primary studies employed cognitive type tasks as measures of motor skill performance.

3.1 Data Analysis

Presented as a summary in the form of a matrix, the distribution of the number of study correlations (EM) across each study relationship in the proposed model originally intended for investigation is illustrated in Table VI, p 80. The matrix shows dramatically which study relationships have been well researched and which have not. It is evident that the study relationships involving mental imagery practice and self-confidence, arousal and state-anxiety respectively have been well studied. Conversely, self-confidence, arousal and state-anxiety in relation with motor skill performance have been under-studied. The inter-relation between the mediating variables self-confidence, arousal and state-anxiety (those relationships in parentheses in the matrix, Table VI, p. 80) were so poorly studied that a valid synthesis analysis could not be conducted.

Table VI.

Distribution of the number of study correlations per study relationship for the Proposed Model

Original model variables	IM	SC	AR	AN	PER
IM		62	60	55	n/a
SC			(1)	(1)	15
AR				(8)	26
AN					12

Thus, of the nine study relationships *originally* intended for investigation (Figure 6, p.58) within the *Proposed Model* (those 9 study relationships illustrated in the matrix, Table VI), only six had a sufficient number of study correlations to warrant synthesis analysis.

As the research progressed, it became apparent and necessary based on theory and data availability, to reclassify study correlations according to more specific dependent measures. As a result, study relationships were either enlarged or collapsed, as shown in Figure 7, p.82. For example, authors of the primary studies included for synthesis specified the intended effect of mental imagery practice upon state-anxiety and arousal. Where the term state-anxiety and arousal was all inclusive (referring to both lowered and raised state-anxiety and arousal) these effects were in the opposite direction, that is one negative (lowered) and the other positive (raised). These opposing levels of both state-anxiety and arousal reflects somewhat the inverted 'U' curve, proposed by Yerkes and Dodson (1908) where there exists optimal levels of arousal for motor skill performance; over or under these levels motor skill performance deteriorates. Mental imagery practice when employed to lower or raise arousal or state-anxiety could in a similar fashion be representing one or the other side of an inverted

'U' relationship. The same could be said for raised and lowered arousal in relation to motor skill performance. Based on this rationale, categories of both state-anxiety and arousal were separated to distinguish lowered state-anxiety (-AN) from raised state-anxiety (+AN), lowered arousal (-AR) from raised arousal (+AR).

As well, in primary studies which measured self-confidence and its relation to motor skill performance, those specifically identifying that self-efficacy had been measured, were recategorized as such (SE) while all other measures of self-confidence were kept under the category of situational self-confidence (SCs). As explained by Stock (1994), adjustments made to coding can and should be made during the course of a meta-analytic process, based on data availability, theory and even hunches. It became clear as coding went on, that most self-confidence primary studies measured SE as opposed to SC in relation to motor skill performance. In addition, more recent motor skill performance literature (Feltz, 1984; Feltz, 1988; Feltz & Mugno, 1983; Feltz & Albrecht, 1986) has been suggesting SE as an important predictor of motor skill performance. Based on this information, the two constructs SE/SCs were separated on the motor skill performance side of the modified model. It should be noted that mental imagery practice variable in relation to segrated variables situational self-confidence and self-efficacy (SE/SCs) on the imagery side of the modified model and lowered state-anxiety (-AN) in relation to motor skill performance on the performance side of the model were not analysed. The first because no significant difference between the two concepts was found and the second due to lack of data. This reclassification changed the *proposed model.* (illustrated in Figure 6, p.58) to give the *modified model* (illustrated in Figure 7, p.82). Paivio's (1985) Analytical Framework Theory and the new *modified model* then served as a template for all empirical information integrated in the now ten study relationships or meta-analyses.

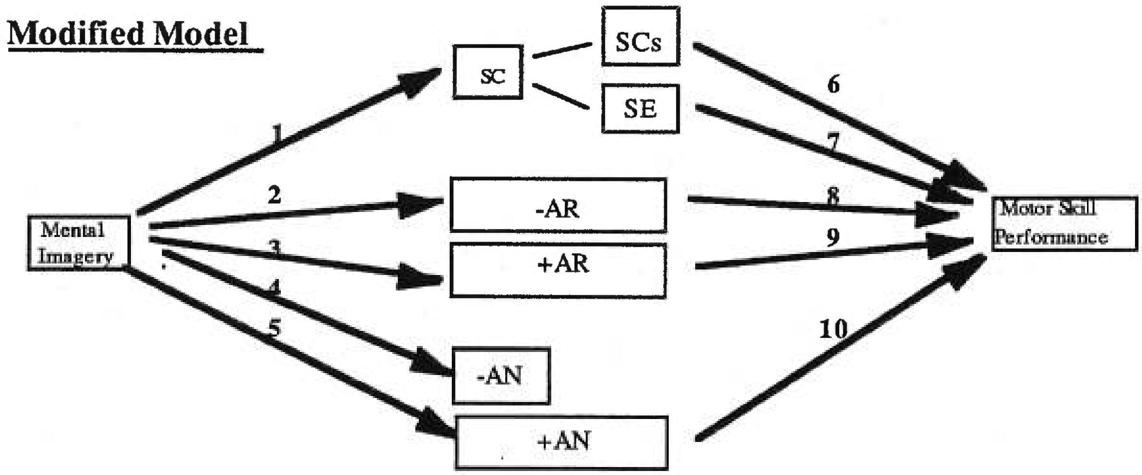

Figure 7. Schematic representation of the Modified Model. Study relationships results are presented as enumerated 1-10.

Analysis of the ten study relationships of the modified model. Analysis of the correlation values (EM) along with their homogeneity test (Q_E) and confidence intervals (CI) across the ten study relationships of the *modified model* followed procedures outlined by Hedges and Olkin (1985). Results of these analyses are enumerated below in Table VII, p. 83.

Table VII.

Distribution of the number of primary study correlations, study relationship EM, homogeneity tests (Q_E) and confidence intervals (CI), across the ten study relationships of the Modified Model.

Study Relationships	Number of primary study correlations	Study relationship EM	Homogeneity test Q_E	Confidence Intervals CI
#1 IM_SC	62	0.24	2587 *	.20,.28
#2 IM_-AR	38	0.14	300 *	.08,.19
#3 IM_+AR	22	0.74	718 *	.70,.78
#4 IM_-AN	48	0.07	888 *	.02,.12
#5 IM_+AN	7	0.51	339 *	.40,.68
#6 SC_PER	5	0.12	_	-.04,.28
#7 SE_PER	10	0.57	71 *	.52,.62
#8 -AR_PER	13	0.28	212 *	.17,.38
#9 +AR_ PER	13	-0.13	538 *	-.23,-.03
#10 +AN_PER	9	-0.20	106 *	-.34,-.05

* Denotes values significant at .01

The *modified model* represents ten multivariate meta-analyses, one for each study relationship. Each meta-analysis will be described, first by a stem and leaf diagram, followed by a battery of regression statistics and a summary table of *post hoc* moderator sub-group analyses, data permitting. A stem and leaf plot describing the distribution of primary study correlations for each study relationship is presented, followed by the statistics: mean correlation (EM), confidence interval (CI) and a homogeneity test statistic (Q_E). If needed, that is a significant homogeneity statistic, then predictors will be added progressively to a series of multiple regression models to account for the heterogeneity found in the relationship study main effects (EM). A summary table for each study relationship regression analysis is presented. Figure 7, p.82 of the modified model, numbered 1 -10, illustrates the respective order of presentation of each study relationship meta-analysis.

3.1.1. Study relationship: *Mental Imagery Practice - Situational Self-confidence*

Table VIII[a]

Stem-and-Leaf Diagram of 62 Primary Study Correlations for the Study Relationship Mental Imagery Practice - Self-Confidence (IM_SC)

IM_SC	1	5	8	9	9	9	14	17	17	30	36
	0.9	9	17	17	28	29	30	36			
	0.8	28	35	35							
	0.7	40									
	0.6	13	46								
	0.5	13	20	35	35	44					
	0.4	18	39	42	44	44					
	0.3	25	25	29	44						
	0.2	15	35	42							
	0.1	42	42	42	44	44	44				
	0	8	12	12	16	25	35	35	42		
	1										
	-0.1	13									
	-0.2	19									
	-0.3	46									
	-0.4	13									
	-0.5										
	-0.6	18									
	-0.7	16									
	-0.8	15									
	-0.9										
	-1.0	43									

In the mental imagery practice - situational self-confidence study relationship (Figure 7, p.82 study relationship #1), mental imagery practice effects in relation to an individual's situational self-confidence was measured. Table VIII displays the stem and leaf plot for the primary study distribution of this study relationship. The vertical

[a] The vertical axis on the extreme left of the diagram represents the range of EMs found within the study relationship IM_SC. The columns of numerals opposing the range of EMs represent the distribution of primary studies correlations within the study relationship IM_SC.

axis on the extreme left of the diagram represents the range of EMs found within the study relationship IM_SC. The columns of numerals opposing the range of EMs represent the distribution of primary studies correlations within the study relationship IM_SC. The weighted average correlation (EM) for this study relationship was r = 0.24. The confidence intervals illustrate an effect (0.20 and 0.28) larger than 0 with an EM considered low to medium. However, the stem and leaf diagram shows a wide range (-1.0 to 1.0) of primary study correlations confirming the significant homogeneity test value (Q_E = 2,586). This result suggests that other moderating variables play a role in explaining the variability found across the 62 primary study correlations. After having performed this first regression positing a distinct effect of mental imagery practice on an individual's self-confidence, three multiple regression models were tested in an attempt to explain the heterogeneity in the data set. Table IX, p. 86 summarizes the introduction into the regression analysis of three of these most significant predictors by order of descending importance.

Table IX[b]

Results from Regression Model Tests for the Generalized Least Squares Analysis of the Study Relationship Mental Imagery Practice - Self-Confidence IM_SC

IM_SC Regression models	Regression Model Test, QR	df_2	Model Specification Test, QE	df_1	Change due to Added Predictor	Δdf	cum. % exp.
IM_SC	1,734	1	2,586	61			
Task Type	2,477	3	1,843	59	743*	2	29
Relaxation Sessions	2,822	4	1,497	58	345*	1	41(12)
Manipulation Checks	3,000	5	1,319	57	179*	1	48(7)

The predictors introduced into subsequent regression models were: type of task, relaxation integrated into the mental imagery practice, and manipulation checks of the mental imagery practice. These three predictors accounted for 48% of the total variance.

The first predictor, type of task, accounted for 29% of the variance, yielding a $\beta = 0.92$ for physical type motor tasks quite large in relative size, as opposed to a smaller $\beta = 0.21$ for cognitive type task. Neither levels' CI included 0 or overlaped. As a result, both levels were significant and distinguishable one from the other. Physical type tasks would account for the large portion of the variability explained by type of task. It seems that those individuals practising mental imagery and enhancing their self-

[b] df_1 are the degrees of freedom for the Model Specification statistic QE; df_2 are for the degrees of freedom for the Regression Model statistic QR; and Δdf are the associated degrees of freedom between the indicated model and the previous model. % exp. is the percent of the variance explained, and * is level of significance at 0.01. ( ) additional % of the variance explained.

confidence would do so best when performing a physical-type task as opposed to a cognitive-type task.

The second predictor, use of relaxation prior to practising mental imagery, accounted for an additional 12% of the total variance, explaining an added total variance of 41%. Those individuals who employed relaxation yielded a $\beta = -0.71$ as opposed to those individuals who never integrated relaxation into their mental imagery practice, ($\beta = -0.62$) to enhance their situational self-confidence. The CI of both levels includes 0 and as a result demonstrates no effect. Relaxation as a moderator is significant, however the two levels as coded do not explain the heterogeneity.

A third predictor added to the multiple regression was manipulation checks of the mental imagery practice. It accounted for an additional 7% of the variance when introduced, bringing the total accumulated variance accounted for to 48%. Neither levels' CI included 0 or overlaped. As a result, both levels were significant and distinguishable one from the other. Those individuals who were verified for having practised mental imagery, $\beta = 0.23$ had enhanced their situational self-confidence to a greater degree. Those individuals who had not been verified for actually having practised mental imagery had a negative relationship, $\beta = -0.84$ with situational self-confidence.

The remaining predictors in the multiple hierarchical regression models: amount of practice time, segregation of the primary studies into measuring SC or SE, and the ability level of the subjects, accounted for a relatively small amount of additional variance (1%, 3%, and 1% respectively). As a result, inclusion of these three predictors for further regression analysis was not justified. This decision was based on Hunter and Schmidt's (1990) premise that it is better to account for more variance with fewer predictors than to include a larger number of predictors for little additional variance explained. The capitalization on chance factor (inflated type 1 error) is a concern in this instance.

3.1.2. Study relationship: *Mental Imagery Practice - Lowered Arousal*

Table X. Stem-and-Leaf Diagram of the 38 Primary Study Correlations for the Study Relationship Mental Imagery Practice - Lowered Arousal (IM_-AR)

IM_-AR	1	3							
	0.9	8							
	0.8	26							
	0.7	26	16	34	40				
	0.6	1							
	0.5								
	0.4	38	38						
	0.3	8	16	19	26	31	39	42	
	0.2	42	42						
	0.1	13	13	14	26	26	27	27	
	0	11	12	25	26	26	26	42	42
	-0.1	13	13	42					
	-0.2	42							

In the mental imagery practice - lowered arousal study relationship (Figure 7, p.82, study relationship #2), mental imagery practice effects on lowering an individual's arousal level are measured. Table X displays the stem and leaf plot for the primary study correlations of this study relationship. The weighted average correlation (EM) for this study relationship is r = 0.14. The confidence intervals illustrate an effect (0.08, 0.19) larger than 0 with an EM considered low in relative size. The stem and leaf diagram shows a wide range (-0.2 to 1.0) with a positive skew of low values for the primary study correlations confirming the significant homogeneity test value (Q_E = 300). This result would indicate that other moderating variables play a role in explaining the variability found across the 38 primary study correlations. After having performed this first regression positing a distinct effect of mental imagery practice on lowering an individual's arousal levels, two multiple regression models were tested in an attempt to explain the heterogeneity in the data set. Table XI summarizes the introduction into the regression of each new predictor by order of descending importance.

Table XI

Regression Model Tests for the Generalized Least Squares Analysis for the Study Relationship Mental Imagery Practice - Lowered Arousal (IM_-AR)

IM_-AR Study relationship	Regression Model Test, Q_R	df_2	Model Specification Test, Q_E	df_1	Change Due to Added Predictor	Δdf	cum. % exp.
IM_-AR	249	1	300	37			
IM style	350	2	199	36	101	1	34
Practime	384	5	165	34	34	3	45(11)

The predictors introduced into subsequent regression models were: imagery style and the amount of time mental imagery was practised. These two predictors accounted for 45% of the total variance.

In the first regression model, imagery style accounts for 34% of the total variance producing a β of -0.05 for individuals practising both visual and kinesthetic mental imagery; a β of 0.33 for those individuals practising visual mental imagery only; and, a β of 0.99 for those individuals practising kinesthetic mental imagery only. Individuals who wish to lower their arousal levels would find it most beneficial to practice an kinesthetic mental imagery practice style as opposed to an visual mental imagery practice style that has only a moderate effect. A practice of a combination of both styles had no effect at all.

In the second regression model, the predictor amount of mental imagery practice time was added and it accounted for an additional 11% of the total variance, bringing the total variance explained to 44%. The first level of practice time, practising mental imagery for more than 14 min yielded a β of 0.36. The second level, practising mental imagery greater than 2 min but less than 14 min produced a β of -0.08 that included zero in its CI and as a result was not significant. Finally the third level, practising mental imagery for 2 min and less yielded a β of 0.67. The CI of the first and third levels overlap, and therefore do not allow either one of these levels to distinguish themselves one from the other. From the data we can suppose that mental imagery practice does make a difference in accounting for 11% of additional heterogeneity; however because the β of the three levels of mental imagery practice time are inconclusive, they do not account for any explanation of this added variance.

3.1.3. Study relationship: *Mental Imagery Practice - Raised Arousal*

Table XII.

Stem-and-Leaf Diagram of 22 Primary Study Correlations for the Study Relationship Mental Imagery Practice - Raised Arousal (IM_+AR)

IM_+AR	1	7	8	10	18	23	23	23
	0.9	23	31					
	0.8	10	41					
	0.7	8						
	0.6	41						
	0.5	46	46					
	0.4	13						
	0.3	13						
	0.2							
	0.1							
	0	27	27					
	-0.1							
	-0.2							
	-0.3	13						
	-0.4	13						
	-0.5							
	-0.6							
	-0.7							
	-0.8							
	-0.9							
	-1	13						

In the study relationship mental imagery practice - raised arousal (Figure 7, p.82 study relationship #3), mental imagery practice effects on raising an individual's arousal level is measured. Table XII displays the stem and leaf plot for the primary study correlations of this study relationship. The weighted average correlation (EM) for this study relationship is r = 0.74. The confidence intervals (0.70, 0.78) illustrate an effect larger than 0 with an EM considered very high in relative size. However the stem and leaf diagram shows a wide range of values (-1.0 to 1.0) with the majority positively skewed although three have large negative correlations confirming the significant homogeneity test value (Q_E = 718). This result would indicate that other moderating variables play a role in explaining the variability found across the 22 primary study correlations. After having performed this first regression positing a distinct effect of mental imagery practice on raising an individual's arousal levels, two multiple regression models were tested in an attempt to explain the heterogeneity in the data set. Table XIII summarizes the introduction into the regression of each new predictor by order of descending importance.

Table XIII

Regression Model Tests for the Generalized Least Squares Analysis for the Study Relationship Mental Imagery Practice - Raised Arousal (IM_+AR)

IM_+AR Description of the study relationship	Regression Model Test, QR	df_2	Model Specification Test, QE	df_1	Change Due to Added Predictors	Δdf	cum. % exp.
IM_+AR	535	1	718	21			
Task Type	794	3	459	19	259*	2	36
Ability Level	813	4	439	18	20*	1	39(3)

The predictors introduced to subsequent regression models were type of task and ability level of the subjects. These two predictors accounted for 39% of the total variance.

In the first regression model, type of task accounted for 36% of the total variance. This regression analysis yielded a β of 1.03 for individuals, who when they performed motor skills that had predominantly a cognitive content, practised mental imagery to raise the arousal levels. A β of 0.82 was obtained for individuals, who performed motor skills that lacked a predominantly a cognitive content, practised mental imagery to raise their arousal levels. Both β are high and the CI do overlap. It is possible that no difference lies between these two types of tasks as coded in this instance. However type of task accounts for a lot of variance (e.g. 36%) and is a significant predictor.

In the second regression model, the predictor ability level of the subject was added and it accounted for an additional 3% of the total variance, bringing the total variance explained to 39%. The elite ability level of the subjects showed a large effect in raising their arousal levels by practising mental imagery as shown by their $\beta = 1.12$. The non-elite level serve as a control ($\beta = 0$) This analysis shows that ability level of the subjects has an effect when they attempt to raise their arousal levels by practising mental imagery. It seems highly suggestive that elite ability level subjects account for this added variance explained.

3.1.4. Study relationship: *Mental Imagery Practice - Lowered State-Anxiiety*

Table XIV.

Stem-and-Leaf Diagram of the 48 Primary Study Correlations for the Study Relationship Mental Imagery Practice - Lowered State-Anxiety (IM_-AN)

IM_-AN	1	1	1	11	21	32			
	0.9	18	40						
	0.8								
	0.7	18	26						
	0.6	17	17	17	15	15	19	22	45
	0.5	26	26	34					
	0.4	4	25						
	0.3	16	39	42	45				
	0.2	22	22	22	31	42	42	42	
	0.1	11	26						
	0	8	12	18	25				
	-0.1	42							
	-0.2	42							
	-0.3	42							
	-0.4	13							
	-0.5	8							
	-0.6	13	13						
	-0.7	13							
	-0.8	18							
	-0.9								
	-1.0								

In the study relationship mental imagery practice - lowered state-anxiety, (see Study Relationship #4, Figure 7, p.82) mental imagery practice effects on lowering an individual's state-anxiety level is measured. Table XIV displays the stem and leaf plot for the primary study correlations of this study relationship. The weighted average correlation (EM) for this study relationship is $r = 0.07$. The confidence intervals illustrate an effect (0.02, 0.12) larger than 0 with an EM considered low in relative size. The stem and leaf diagram shows a wide range of values (-0.8 to 1.0) the majority is positively skewed, but still confirming the significant homogeneity test value (Q_E = 888). This result would indicate that other moderating variables play a role in explaining the variability found across the 48 primary study correlations. After having performed this first regression positing a small effect of mental imagery practice on lowering an individual's state-anxiety level in the motor skill performance domain, four multiple regression models were tested in an attempt to explain the heterogeneity in the data set. Table XV summarizes the introduction of each new predictor into the regression by order of descending importance.

Table XV.

Regression Model Tests for the Generalized Least Squares Analysis for the Study Relationship Mental Imagery Practice - Lowered State-Anxiety (IM_-AN)

IM_-AN Study Relationship	Regression Model Test, Q_R	 df_2	Model Specification Test, Q_E	 df_1	Change Due to Added Predictors	 Δdf	cum. % exp.
IM_- AN	45	1	888	47			
Type of Im	372	3	469	45	419*	2	44
Age	420	4	358	44	111*	1	58(14)
PracTime	586	6	302	42	57*	2	65(7)
Test Type	662	7	225	41	76*	1	74(9)

The predictors introduced into subsequent regression models were: type of mental imagery practice, age of the subjects, amount of mental imagery practice and type of test utilized to measure state-anxiety. These four predictors accounted for 74% of the total variance.

In the first regression model, the predictor type of mental imagery practice accounts for 44% of the total variance producing a β of 0.48 for individuals practising a multiple type mental imagery to lower their state-anxiety and a β of 0.56 for those individuals practising mental imagery alone to lower their state-anxiety. The CI of these two levels of mental imagery type of practice were overlapping indicating that both levels explain the variance; however neither can be distinguished as being more effective one over the other.

In the second regression model, adding subjects' age accounted for an additional 14% of the variance, bringing the total variance explained to 58%. This category of age, ≥20 years yielded a β of 0.54, with a CI that did not include 0 and did not overlap with the CI of subjects < 20 years. Therefore subjects ≥20 years could be distinguished from subjects < 20 years when practising mental imagery to lower an individual's state-anxiety. This latter group, < 20, had β = -0.1. Older subjects seem to control their state-anxiety by using mental imagery practice better than younger subjects.

In the third regression model, the addition of amount of mental imagery practice time accounted for an additional 7% of the variance, bringing the total variance explained to 65%. The analysis of these predictor levels yielded a β of 0.51 for ≥14 min of practice, a β of 0.19 for a practice > 2 min - < 14 min and a β of -0.33 for ≤2 min of practice. From this regression analysis it is apparent that the category, amount of mental imagery practice larger than > 2 min - < 14 min shows no effect because its CI include 0. This finding suggests that the amount of mental imagery practice time to lower an individuals state-anxiety when he wishes to enhance his motor performance would have an effect, but only the categories ≤ 2 and ≥14 contribute to explaining the variance.

The fourth and last regression model for this study relationship added type of test employed to measure lowered state-anxiety. Type of test accounted for an additional 9% of the variance. The first level of this moderator represented a test of lowered state-anxiety, the competitive state-anxiety inventory -2 (CSAI-2) whose β = -0.01. The second level included all other measures of lowered state-anxiety tests and it yielded a β= 0. The β were in both cases too small to be interpreted.

3.1.5. Study relationship: *Mental Imagery Practice - Raised State-Anxiety*

Table XVI.

Stem-and-Leaf Diagram of 7 Primary Study Correlations for the Study Relationship Mental Imagery Practice - Raised State-Anxiety (IM_+AN)

IM_+AN	1	23 23
	0.9	13 13
	0.8	
	0.7	
	0.6	
	0.5	
	0.4	
	0.3	13
	0.2	13
	0.1	
	0	
	-0.1	
	-0.2	
	-0.3	
	-0.4	31
	-0.5	

In the study relationship mental imagery practice - raised state-anxiety (study relationship #5, Figure 7, p.82), mental imagery practice effects on raising an individual's state-anxiety level is measured. Table XVI displays the stem and leaf plot for the primary study correlations of this study relationship. The weighted average correlation (EM) for this study relationship is r = 0.51. The confidence intervals illustrate an effect (0.40, 0.68) larger than 0 with an EM considered high in relative size. The stem and leaf diagram shows a wide range of values (-0.4 to 1.0) the majority is positively skewed, confirming the significant homogeneity test value ($Q_E = 339$). This result would indicate that other moderating variables play a role in explaining the variability found across the 7 primary study correlations. After having performed this first regression positing a large effect of mental imagery practice on raising an individual's state-anxiety level in the motor skill performance domain, no further regression analysis was possible. This was due to the low number of study correlations, a condition not allowing for any further investigation.

3.1.6. Study relationship: *Situational Self-Confidence - Motor Skill Performance*

Table XVII.

Stem-and-Leaf Diagram of 5 Primary Study Correlations for the Study Relationship Self-Confidence - Motor Skill Performance (SC_PER)

SC_PER	0.2	25		
	0.1	25	25	25
	0	42		

In the study relationship self-confidence - motor skill performance (Study Relationship #6, Figure 7, p.82), the effect of an individual's enhanced situational self-confidence after having practised mental imagery is measured against his/her motor skill performance. Table XVII displays the stem and leaf plot for the primary study correlations of this study relationship. The weighted average correlation (EM) for this study relationship is r = 0.12 and not significant. The confidence intervals illustrate no effect (-0.04, 0.28) as they do include 0. The stem and leaf diagram shows a small number of study correlations (n=5) with a narrow distribution near zero. Situational self-confidence enhanced by a mental imagery practice does not seem to be related to an increase in motor skill performance.

3.1.7. Study relationship: *Self-Efficacy - Motor Skill Performance*

Table XVIII.

Stem-and-Leaf Diagram of 10 Primary Study Correlations for the Study Relationship Self-Efficacy - Motor Skill Performance (SE_PER)

SE_PER	0.3	2	9		
	0.4				
	0.5	9	37	37	37
	0.6	9	37		
	0.7	37	37		

In the study relationship self-efficacy - motor skill performance (Study Relationship #7, Figure 7, p.82), the effect of an individual's enhanced self-efficacy from having practised mental imagery is measured against his/her motor skill performance. Table XVIII displays the stem and leaf plot for the primary study correlations of this study relationship. The weighted average correlation (EM) for this study relationship is r = 0.57. The confidence intervals illustrate an effect (0.52, 0.62) larger than 0 with an EM considered high in relative size. The stem and leaf diagram shows a medium range of values (0.3 to 0.7). The homogeneity test value (Q_E = 87) is significant. This result would indicate that other moderating variables play a role in explaining the variability found across the 10 primary study correlations. After having performed this first regression positing a large effect of self-efficacy enhanced by mental imagery practice on motor skill performance, no further regression analysis was possible due to the small number of study correlations. The lack of data severely limits the further search for possible moderators that could account for the residual heterogeneity.

3.1.8. Study relationship: *Lowered Arousal - Motor Skill Performance*

Table XIX.

Stem-and-Leaf Diagram of 13 Primary Study Correlations for the Study Relationship Lowered Arousal - Motor Skill Performance (-AR_PER)

-AR_PER	0.9	13		
	0.8	13	31	
	0.7			
	0.6	13	13	13
	0.5	31		
	0.4			
	0.3	13	13	13
	0.2			
	0.1	6		
	0			
	-0.1			
	-0.2			
	-0.3			
	-0.4			
	-0.5			
	-0.6			
	-0.7	13		
	-0.8			
	-0.9	13		
	-1.0			

In the study relationship lowered arousal - motor skill performance, (Study Relationship #8, Figure 7, p.82), the effect of an individual's lowered arousal through mental imagery practice is measured against his motor skill performance. Table XIX displays the stem and leaf plot for the primary study correlations of this study relationship. The weighted average correlation (EM) for this study relationship is r = 0.28. The confidence intervals illustrate an effect (0.17, 0.38) larger than 0 with an EM considered medium in relative size. The stem and leaf diagram shows a wide range of values skewed at the positive end (-0.9 to 0.9) with the possibility of two outliers at the extreme negative end. The homogeneity test value (Q_E = 212) is significant. This result would indicate that other moderating variables play a role in explaining the variability found across the 13 primary study correlations. After having performed this first regression positing a medium effect of lowered arousal on motor skill performance, only a limited regression analysis in search of moderators was possible due to the small number study correlations.

Table XX.

Regression Model Tests for the Generalized Least Squares Analysis for the Study Relationship Lowered Arousal - Motor Skill Performance (-AR_PER)

-AR_PER Study Relationship	Regression Model Test, Q_R	df_2	Model Specification Test, Q_E	df_1	Change Due to Added Predictors	Δdf	cum. % exp.
AR-_PER	24	1	212	12			
Type of Task	65	2	171	11	41	1	19

The predictor introduced in the subsequent regression model was the type of task performed by the subjects. In the only regression model possible, type of task accounted for 19% of the total variance. The β of -0.13 for individuals performing a physical-type motor skill indicates no significant difference because the CI includes 0. A β of 0.62 for those individuals performing a cognitive-type motor skill is significant. Cognitive type motor skill would be the level contributing to the variance explained by the type of task moderator.

3.1.9. **Study relationship**: *Raised Arousal - Motor Skill Performance*

Table XXI.

Stem-and-Leaf Diagram of 13 Primary Study Correlations for the Study Relationship Raised Arousal - Motor Skill Performance (+AR_PER)

+AR_PER	0.9	13	13
	0.8	13	
	0.7		
	0.6	33	
	0.5		
	0.4	13	13
	0.3		
	0.2	6	
	0.1	14	
	0		
	-0.1		
	-0.2		
	-0.3		
	-0.4		
	-0.5		
	-0.6		
	-0.7	13	
	-0.8	13	
	-0.9	13	
	-1.0	13	13

In the study relationship, raised arousal - motor skill performance (Study Relationship #9, Figure 7, p.82), the effect of an individual raising his/her arousal levels through mental imagery practice to increase motor skill performance is measured. Table XXI displays the stem and leaf plot for the primary study correlations of this study relationship. The weighted average correlation (EM) for this study relationship is r = -0.13. The confidence intervals illustrate an effect (-0.23, -0.03) smaller than 0 with an EM considered small in relative size. The stem and leaf diagram shows a wide range of values distributed at the two extremes (-1.0 to 0.9). The homogeneity test value (Q_E

= 538) is significant. This result would indicate that other moderating variables play a role in explaining the variability found across the 13 primary study correlations. After having performed this first regression positing a relatively low negative EM for the study relationship raised arousal - motor skill performance, the small number of study correlations would permit only limited further regression analysis.

Table XXII. Regression Model Tests for the Generalized Least Squares Analysis for the Study Relationship Raised Arousal - Motor Skill Performance (+AR_PER)

+AR_PER Study Relationship	Regression Model Test, QR	df2	Model Specification Test, QE	df1	Change Due to Added Predictor	cum. % Δdf	exp
+AR_PER	79	1	538	12			
Type of Task	132	2	485	11	53	1	10

The predictor introduced in the subsequent regression model was type of task performed by the subjects. In the only regression model possible, the predictor type of task accounted for 10% of the total variance. The β of 0.25 for individuals performing a more physical-type motor skill and the β of -0.51 for those individuals performing a more cognitive-type motor skill are both significantly different but the former is positive and the latter negative. Both cognitive- and physical-type tasks contribute to explaining type of task as a moderator.

3.1.10. Study relationship: *Raised State-Anxiety - Motor Skill Performance*

Table XXIII. Stem-and-Leaf Diagram of 9 Primary Study Correlations for the Study Relationship Raised State-Anxiety - Motor Skill Performance (+AN_PER)

+AN_PER	0	6		
	-0.1			
	-0.2	6	6	31
	-0.3	6		
	-0.4	11		
	-0.5	31		
	-0.6	33		
	-0.7			
	-0.8			
	-0.9			
	-1.0	33		

In the study relationship raised state-anxiety - motor skill performance (Study Relationship #10, Figure 7, p.82), the effect of an individual raising his state-anxiety levels by having practised mental imagery to increase motor skill performance is measured. Table XXIII displays the stem and leaf plot for the primary study correlations of this study relationship. The weighted average correlation (EM) for this study relationship is r = -0.2. The confidence intervals illustrate an effect (-0.34, -0.05) smaller than 0 with an EM considered small to medium in relative size. The stem and leaf diagram shows a medium range of negative values (-1.0 to 0.0). The homogeneity test value (Q_E = 106) is significant. This result would indicate that other moderating variables play a role in explaining the heterogeneity found across the nine primary study correlations. After having performed this first regression positing a relatively low to medium EM of the study relationship raised state-anxiety - motor skill performance, the small number study correlations did not allow any further regression analysis.

Chapter 4: Discussion

4.0 Synopsis

This chapter consists of five sections: a synopsis of the findings; a comparative discussion of the analyses, its strengths and limitations; conclusions drawn from the findings; and finally, directions for future research.

The present research is based on Paivio's (1985) Analytical Framework Theory. In this theory, Paivio elaborates the motivational function of mental imagery practice effects on motor skill performance. Building on this theory, the present work sought to include the following variables: self-confidence/self-efficacy (SC/SE), raised (+) and lowered (-) state-anxiety(AN) and raised and lowered arousal, to better describe the possible intermediary processes involved in the mental imagery practice - motor skill performance mechanism. Through extension of Paivio's theory, moderating variables were introduced to clarify and increase certainty about assertions in the present research. Subsequently, the modified model was developed and verified.

The synopsis begins by repositing the first study question. It asks if the mental imagery practice mechanism at play, when individuals intend to enhance their motor skill performance is mediated at the general motivational level by their optimal level of arousal, by their control of state-anxiety, and by their enhancement of self-confidence.

The arduous coding of theoretically relevant predictors as mediating and moderating variables has yielded some traditional givens. However, other results were contrary to expectations. All of the findings deemed relevant to our research questions will be discussed in the order presented in the chapter on results.

Within the series of meta-analyses conducted (see modified model p.82) in our research, ten mediating relationships were investigated. An initial overview of the individual study relationship analyses has evidenced some striking observations. Beginning with the distribution of primary studies across the ten study relationships, a scan of Table VII, p.83, illustrates in an obvious manner the disproportionate number of primary studies skewed to the mental imagery side of the figure. Clearly, mental imagery practice investigations on the intermediary variables have been more extensive. With the sole exception of IM_+AN, all of the remaining study relationships on the mental imagery side, that is IM_SC (k=62), IM_-AR (k=38), IM_+AR (k=22) and IM_-AN (k=48), have a greater number of primary study measures. The disparity in primary studies on the motor skill performance side of the modified model is evident. Because of the paucity of primary studies, accounting for the heterogeneity present in the main effects of the relationships -AR_PER (k=13), +AR_PER (k=13) was limited and not at all possible for the remaining study relationships SC_PER (k=5), SE_PER (k=10), +AN_PER (k=9). This limitation is a serious concern in the present research.

The lack of research into mediating processes in the mental imagery domain is not surprising given the attention paid to outcome based type empirical studies prevalent in the literature. The lack of primary studies probing for explanations of mediating variable effects, relegates our synthesis analyses to a «bare bones» type of investigation reducing the power of the meta-analysis, reducing its ability to explain heterogeneity and compromising its ability to infer theoretical assertions about mental imagery practice effects.

Some interesting findings have however been observed. In particular, mental imagery practice seems to be consistent when used to influence state-anxiety and arousal. As discussed in Chapter one, state-anxiety and arousal are conceptual cousins; their constructs are parallel in many ways. So it does not come as a surprise when they are similarly enhanced or controlled by mental imagery practice. The study relationships IM_-AN and IM_-AR both yielded small but significant EMs ('r'= 0.07 and 'r'= 0.14, respectively). Mental imagery practice seems to have a limited controlling effect upon both state-anxiety and arousal although its effect is significantly heterogeneous. Also, both study relationships, raised state-anxiety and raised arousal, seem to have strong relationships with mental imagery practice (IM_+AN r=0.51 and IM_+AR r=0.74). Psyching-up strategies employing mental imagery practice, using fear and anger mental imagery practice as examples, seem to be strongly associated to raising an individual's state-anxiety and arousal levels. On the motor skill performance side of the modified model, both raised state-anxiety and raised arousal have significant but small negative relationships with motor skill performance (+AN_PER 'r'=-0.18, +AR_PER 'r'=-0.13). Conversely, as was anticipated, lowered levels of arousal were positively related to motor skill performance (-AR_PER 'r' =0.28).

These findings on state-anxiety and arousal illustrate that the intended use of the mental imagery practice to raise or to lower either one of these mediating variables is crucial in their evaluation as mediators. Interestingly, findings on both arousal and state-anxiety seem to suggest that mental imagery effects are strongly associated with heightening these mediating variables, even though their lowered levels are more strongly associated with better motor skill performance. The findings suggest that mental imagery practice have a differential effect when raising as opposed to lowering both state-anxiety and arousal. However, once mental imagery's effects on these two variables was realized, their raised levels result in a negative relationship with motor skill performance (e.g. AR+_PER r=-0.13 and AN+_PER r=-0.20).

A third mediator in the modified model, self-confidence (as a general term on the imagery side) was found to be moderately associated to mental imagery practice ('r'= 0.24). This motivational construct included measures of self-efficacy, self-confidence component of the CSAI-2, athletic motivational inventory (AMI), and others. It would seem that mental imagery practice does not differentiate its effect based on the type of self-confidence measure used. In other words, if you practice mental imagery, these findings suggest that you will enhance your self-confidence at least moderately.

On the motor skill performance side of the modified model, self-confidence as a construct was dichotomized into a self-efficacy (SE) and situational self-confidence construct (SCs) (including all other measures of situational self-confidence). Therefore the study relationships analyzed were SCs_PER ('r'=0.12), found not to be significant and SE_PER ('r'= 0.59) found to be large, significant and heterogeneous. The findings seem to suggest that when individuals practice mental imagery to better perform a motor skill, these individuals do show an enhanced level of self-confidence, though moderate. However those individuals who practice mental imagery to better perform a motor skill seem to show an enhanced self-efficacy. The findings show that self-efficacy and motor skill performance are strongly related. These findings are consistent with Paivio's (1985) assertions of mental imagery practice's motivational role in enhancing an individual's motor skill performance. Self-efficacy, as a very significant mediator within the modified model, lends support to Paivio's contentions. Not only are motor patterns coded through the cognitive role of mental imagery practice, but also behaviors and affect are symbolically coded through its motivational role. Paivio (1985) suggests that motivationally, scenarios, actions and their consequences are represented in self-efficacy beliefs.

In summary, the results of the study relationship main effects of the modified model seem to show that intermediary variables act between mental imagery practice and motor skill performance. However, prudence in interpreting the results is necessary in light of the fact that heterogeneity in the data points to moderating study variable influences.

4.1 Moderator Analysis:

As mentioned in the Chapter 3, Table VII, p.83, concerning the distribution of study correlations (EM) among the study relationships of the modified model, the small number of primary studies in six of the ten study relationships outlined, represent a serious impediment to any in-depth analysis and ability to interpret results.

The second research question asks: if and when the mental imagery practice mechanism is mediated by the variables arousal, state-anxiety and self-confidence, when individuals intend it to enhance their motor skill performance, is it modified by moderating variables? The degree of contribution of each of the moderating variables in and among the study relationships were assessed by a series of multivariate sub-group meta-analyses. Where data permitted, sub-group analyses were conducted and yielded some interesting and relevant findings.

4.1.1 IM_SC

In the first of the study relationships IM_SC, three variable moderators explained a significant amount of variance in the reported study correlation (r=0.24). It is difficult to extend the meta-analysis to a *post hoc* exploration where moderators are used to form a series of models of increasing complexity that would explain the heterogeneity in the main effects. The difficulty in posing these models is that the data would have to be homogeneous, a situation that does not exist in any of the study relationships in the present research. The most we can hope to achieve is an explanation of the variance obtained via the GLS regression analysis. This means a multivariate regression analysis performed for each study relationship, with, of course sufficient data pending. The GLS permits the identification of significant moderators and their relative contribution to the heterogeneity. In addition, it allows for the identification of the 'β' or beta weights for each level of the moderator (coefficients that tell us which level of a moderator is most influential). In the IM_SC study relationship, type of task was the first significant moderator explaining 29% of the variance, with physical type tasks explaining most of that variance. This is an interesting result given that cognitive type tasks have been identified in the literature (Feltz *et al*, 1983) as those most influenced by mental imagery practice. It should be noted that no other meta-analyses have synthesized data at the intermediary level where the IM_SC relationship could be probed to identify which type of task would be most related to mental imagery practice. In the present synthesis research, the intent was to verify ameliorated performance of motor skills by exploiting motivational variables. It seems that physical type tasks are most related to mental imagery practice when an individual endeavours to improve his motor skill performance with an enhanced self-efficacy.

As a second moderator, a relaxation session integrated within a mental imagery practice explained an additional 12% of the variance. Previous empirical data attest to the success of psychological training programs that have incorporated relaxation within their mental imagery practices. Examples are VMBR (Suinn, 1976), SIT (Meichenbaum, 1977) and SMT (Smith, 1980). The incorporation of relaxation has become common place in mental imagery practice. However, our findings are equivocal, neither β for either level, with or without relaxation incorporated into a mental imagery practice, could support or contradict previous empirical research.

The last significant moderator identified to have modified the IM_SC study relationship was the verification of whether mental imagery was actually practised. Under the study characteristic named manipulation checks (MANI), it was included in the present research as a study quality characteristic. However, it has little theoretical significance, though a significant moderator nonetheless. The 'β' representing those primary studies that employed manipulations checks to verify if subjects were actually practising mental imagery explained the variability (7%). These findings suggest then that researchers conducting primary studies in mental imagery practice-motor skill performance designed to enhance an individual's self-confidence, should verify if the individuals are practising mental imagery. It becomes clear that a methodological issue involving study quality in the same way as manipulation checks of the independent variable would have important repercussions on the validity of assertions made about whether an individual is actually practising what we say he is practising.

4.1.2 IM_-AR

In the study relationship IM_-AR, two variable moderators explained a significant amount of the variance in the reported study correlation (r=0.13). As for the previous study relationship, the data were also heterogeneous. Two moderators, mental imagery practice style and amount of mental imagery practice were able to account for 45% of the variance. The mental imagery practice style moderator was divided into three levels: visual, kinesthetic and both. The β suggests strongly that it is the kinesthetic style of mental imagery practice that individuals utilise to most efficiently lower their arousal levels. Present findings show that a kinesthetic or proprioceptive mental imagery practice accounts for 34% of the variability. These findings seem to be in keeping with practices of mental imagery found in relaxation type programs such as the Jacobson's (1930) progressive muscle relaxation technique where elements of this practice include a kinesthetic type of mental imagery practice application. The intended effect of internal mental imagery practice is to lower or control an individual's arousal level. Although the study correlation for this study relationship is modest (r=0.14), the β for kinesthetic practice of mental imagery is differentially high, which distinguishes it easily from the other levels of mental imagery practice style and contributes the larger portion of the variability explained by the style of mental imagery practice moderator. Visual imagery does explain a portion of the variance, however a smaller portion. It is interesting that kinesthetic mental imagery is generally associated with greater levels of arousal, and visual mental imagery associated with lower arousal levels (Davidson & Schwartz, 1977; Davidson, 1978). Unfortunately, few primary studies have addressed research literature are inconsistent and sometimes contradictory, as shown in the present research findings.

The second moderator explaining a significant amount (11%) of variability is the amount of mental imagery practice. The β of different levels of this moderator are either insignificant or indistinguishable. It is not possible to decipher what amount of mental imagery practice is responsible for the moderator effect. The results seem to indicate that practice lasting ≤2 mins. and practice lasting ≥14 mins. are effective but not different one from the other. Consequently, the findings suggest that the amount of mental imagery practice is an important moderator in the IM_-AR relationship. However the levels as they are identified in the present research may be mispecifications of the actual practice time levels due to the trichotimization of such a continuous variable. This mispecification could explain the result of variability un-accounted by this moderating variable.

4.1.3 IM_+AR

In the third study relationships, IM_+AR, two variable moderators were shown to explain a significant amount of the variance in the reported heterogeneous study correlation (r=0.74). The two moderators accounted for 39% of the total variance of which the first, type of task accounted for 36%. Because both moderator level confidence intervals overlapped significantly, neither level representing cognitive or physical type of task could be differentiated. Empirical support exists for an association between higher levels of arousal, initiated by mental imagery practice, favouring physical type tasks (Murphy *et al*, 1988; Gould *et al,* 1980; Caudill *et al*, 1983). Oxendine (1970) proposed that gross motor activities are associated with higher arousal. Conversely, Gould et al. (1980) did not find that arousal state induced by mental imagery practice was associated with an enhanced physical type motor skill performance. Wilkes and Summers (1984) in a similar study, came to the same conclusion. In relation to cognitive type task, Oxendine (1970) proposed that fine motor tasks would deteriorate in an environment with a high arousal state. Murphy *et al,* (1987) found that arousal groups that use psyching-up techniques least influenced a positive performance of fine motor skills (cognitive type tasks). In the present research, although type of task was a significant moderator in the IM_+AR study relationship, type of task was equivocal, in that, regardless of the type of task level identified as cognitive or physical, the relationship IM_+AR exists.

The second significant moderator, ability level of the individuals performing the motor skill, explained an additional 3% of the variance. The β clearly identified the elite category of this moderating variable responsible for contributing to the variance explained. This finding suggests that the elite athlete seems to profit most from a mental imagery practice in order to raise his level of arousal. Other researchers (Mahoney *et al,* 1978; Martens *et al,* 1976) have found the use of mental imagery practice prevalent among elite athletes, especially employed as a motivational strategy in setting optimal arousal levels in order to better perform a motor skill. Findings in the present research seem to corroborate this intended use by elite athletes.

4.1.4 IM_-AN

In the fourth of the study relationships, IM_-AN, four variable moderators explained a significant amount of the variance in the reported heterogeneous study correlation (r=0.07). The four moderators accounted for 74 % of the variance. The first of these four moderators, type of mental imagery practice, explained 44 % of the initial variance. The two levels of this moderator, multiple type (VMBR, SIT, SMT) *versus* simple type practice (meaning mental imagery practice alone) were indistinguishable, their beta weight CI overlapping to a large degree. However, because both had elevated β, both multiple and simple type of mental imagery practice contributed to explaining the moderator effect. These findings are not surprising as some researchers who employed VMBR (for example, Bennett and Stothart, 1978) and SIT (for example, Mace and Carroll, 1989), have shown significantly effective lowering of state-anxiety in their respective empirical primary studies. Mental imagery practised alone has also shown similar results when employed in reducing state-anxiety (Vadocz *et al*, 1987; GalOr *et al*, 1986).

The second moderator, age of the individual, was also significant and explained an additional 14 % of the variance. Only two levels distinguished age: < 20 years old level, the control; and second, ≥ 20 years old, the experimental group. The β for the ≥ 20 age group contributed to the explained variance. These findings suggest that the maturation of individuals would play a role in explaining how mental imagery practice reduces state-anxiety when individuals intend it to improve their motor skill performance. Many empirical studies in the area of mental imagery practice-motor skill performance have involved adults (Chevalier and Renaud, 1990; Hale, 1982; Orlick *et al*, 1988), the elderly (Linden, 1987), and children (Orlick *et.al*, 1992). Yet, of all of the studies that have investigated the mental imagery practice-motor skill performance paradigm and considered age as a moderating variable, few have included measures of mediating variables. The very importance of identifying maturation as a moderator and its influence on the mediational and motivational aspects of mental imagery practice-motor skill performance paradigm would certainly warrant its inclusion in future empirical investigations.

The third moderator, the amount of mental imagery practice time, was significant and explained an additional 7 % of the variance in this study relationship. These findings were equivocal about the level of practice time which most accounted for the additional variance. Amount of mental imagery practice time has consistently shown its importance as a moderator across several other study relationships. However, the trichotomisation of the levels of mental imagery practice time show mispecification in relation to the variable moderator. Plainly said, something is happening with the amount of practice time but not as is specified in the present research. The error in mispecification is illustrated in the inadvertent loss of information in trichotomising of the continuous moderating variable of mental imagery practice time. In the present study, cut points of the trichotomisation were: ≤2 min, >2 min to <14 min, ≥ 14 min. Findings about this moderator show that the practice time level, >2 min to <14 min, is not significant in both study relationships IM_-AR and IM_-AN. For the ≤ 2-min level in IM_-AR the β weights are positive and in IM_-AN, negative. Thus, practice time seems to be contributing to lower arousal but not to lower state-anxiety. However, mental imagery practice seems to be beneficial in both study relationships where ≥ 14 min of practice lowers both arousal and state-anxiety. Again, little research exists pertaining to the contribution of mental imagery practice time to lowering either arousal or state-anxiety to better perform a motor skill. Feltz and Landers, in their meta-analysis (1983) did directly measure mental imagery practice time as a continuous moderating variable in relation to motor skill performance. Among other conclusions, practice time lasting <1 min or >15 min were the most effective. These results are similar to the findings of the present study where mental imagery practice (≤ 2 min and ≥14 min) lowered arousal and (≥14 min only) lowered state-anxiety when the intent was to enhance motor skill performance. Mispecification of the practice time variable due to their overlapping CI, however did not allow us to identify which category contributed most to the variance explained by the practice time moderator variable. This error could have been avoided had a continuous variable regression analysis been conducted as in the Feltz and Landers 1983 study.

The fourth and last moderator in the IM_-AN, type of test employed to measure lowered state-anxiety was significant and explained an additional 9 % of the variance. Two levels of this moderator were identified: tests employing the CSAI-2 measure of state-anxiety, and all other state-anxiety tests. Both levels, CSAI-2 level, and the second level which included all other measures of state-anxiety, were indistinguishable because of their overlaping CI and both had small β. The levels do not help in explaining the variance explained by type of test moderator. This moderator does account for 9% of the variance. Speculating, one could suggest that these findings may be pointing to the validity of the test employed to measure lowered state-anxiety.

4.1.5 -AR_PER / +AR_PER

There were two other study relationships where the data only allowed one level each of a sub-group moderator analysis: -AR_PER and +AR_PER. In both cases, the type of task was the significant moderator identified. In the former study relationship, this moderator explained 19% of the variance and in the latter it explained 10 % of the variance. In the study relationship -AR_PER, cognitive type task (β=0.62) seemed to be the greater contributor to the variance explained whereas in the study relationship +AR_PER, physical type tasks (β=0.25) were responsible for the contribution to the variance explained. Both are at the opposite ends of the type of task spectrum. These findings are consistent with the literature on arousal levels and type of tasks. In particular, in Oxendine's (1970) taxonomy inspired by the inverted 'U' theory, he differentiated types of tasks (complex/cognitive *vs.* simple/physical) and positioned them on a continuum extending from low to high levels of arousal. Findings in the present study would seem to support lowered arousal for cognitive (complex) type tasks as illustrated in the -AR_PER study relationship results and raised arousal levels for physical (simple) type tasks as illustrated in the +AR_PER study relationship results. Klavora (1977) found the same kind of relationships between arousal levels and type of task as hypothesised by Oxendine (1970). The findings in the present research seem to be consistent in showing the same kind of trends as explained by Oxendine's taxonomy. However, we must be extremely cautious in an interpretation based on such a small number of primary studies, as is the case for these study relationships (e.g., 13 primary study correlations in each). Suffice it to say that type of task in the study relationship -AR_PER and +AR_PER are moderators explaining a significant amount of the heterogeneity and that different levels of type of task may be showing some results consistent with the literature on type of task and arousal levels.

Random effects model: The present research employed a fixed-effects model approach for analysis. This approach to analysis assumes that we have all the true effects of a mental imagery practice on the mediating variables and their effects in turn, on motor skill performance. However, if there still remains unexplained variance, as was the case across all the study relationships in the present research, it is possible not to have all of the true treatment effects of mental imagery practice across all of the primary studies. Not meeting this pre-condition could be an additional explanation for the heterogeneity that remains unaccounted for in the data. In reality, there may be only a distribution of treatment effects of a mental imagery practice representing specific study units, each unique. Only an average index of these effects would represent the overall efficacy of practising mental imagery on these variables. This type of analysis of treatment effects is called a random effects model. It takes into account the variation of mental imagery practice effects across primary studies explaining further variability in the data set. It is more conservative in its estimate of EM and would allow more certainty in making assertions. Unfortunately, not conducting a random effects type analysis was a limitation to more thorough interpretations of the present research findings.

CHAPTER 5: Conclusions

5.0 General Conclusions

Past meta-analyses of the mental imagery practice - motor skill performance paradigm were descriptive in nature and directly linked the enhancement of motor skill performance to mental imagery practice. The classic Feltz and Landers (1983) study followed the Glassian type of synthesis analysis, and painted a broad picture of mental imagery practice effects. These researchers found an effect that was variable but important enough to establish clearly that when compared to a no practice control, mental imagery practice was an effective cognitive tool in enhancing an individual's motor skill performance. An attempt was made by integrating intermediate variables in the process, that is mediating variables that link mental imagery practice to motor skill performance and the ensuing moderating variables that interact in the process to modify it.

The self-confidence variable was harmonized as a more global construct to include all situationally specific self-confidence measures. It was represented as such on the mental imagery side of the modified model. On the motor skill performance side of the modified model, self-confidence was divided into SE, a temporally specific construct, and SCs, including all other measures of situational self-confidence. With reason, present findings have suggested that mental imagery practice does not seem to distinguish between different entities of SC so long as they are situationally specific. On the other hand, SE, this temporally and situationally specific construct on the motor skill performance side of the modified model seems to be strongly related to motor skill performance. For this mediating variable, self-confidence, the mechanism seems to require an application of mental imagery practice that is circumstantial and very localised on one construct SE, within the more global concept of self-confidence. Emerging more specifically are the findings that identify the association of self-confidence with mental imagery practice, and the particularly strong association of SE with motor skill performance. These results suggest that a better motor skill performance might be linked to an elevated self-efficacy and that mental imagery practice might be acting on motor skill performance through its possible effect on self-efficacy. Thus practising mental imagery with self-efficacy in perspective might help enhance motor skill performance. However, given the heterogeneity in the relationship, it is moderated by certain other variables, which makes it presently impossible to clarify further.

Other conclusions can be drawn from different elements of the arousal/state-anxiety findings. Keeping in mind that these two constructs are conceptually intertwined, it is sometimes difficult to dissect them into dissimilar entities. The findings in the present research serve to exemplify this conceptual reality. After examining the modified model, the parallels emerging from the analyses on these two variables are striking in both intensity and direction. How mental imagery practice would have smaller associations with lower arousal and lowered state-anxiety and stronger assertions with raised arousal and raised state-anxiety are very interesting and suggestive. Though moderators play an important role in all of the study relationships, by qualifying them, mental imagery practice seems to play a very important role as a motivational tool (psyching-up an individual). Conversely, a lesser motivational role in controlling or lowering one's arousal or state-anxiety when preparing to perform a motor skill is attributed to mental imagery practice. Implications here, in the applied sense, illustrate the very specificities of optimal mental imagery practice.

These similarities between arousal and state-anxiety with their association of motor skill performance continue on the performance side of the modified model. As discussed in an earlier section, and keeping in mind the lack of data availability for synthesis analysis, the parallels emerging from the results, are congruent at least in direction. Both raised arousal and raised state-anxiety are small and negatively associated with motor skill performance. Lowered arousal proved to be more strongly and positively associated with motor skill performance. These similarities would suggest that arousal and state-anxiety are not so dissimilar.

From a synopsis of arousal/state-anxiety findings, emerge four important points. First, mental imagery practice can be used to lower arousal and state-anxiety but the association is weaker. Secondly, it seems mental imagery can raise both arousal and state-anxiety with a stronger association. Thirdly, lowered arousal is moderately related to motor skill performance and, finally, both raised arousal and state-anxiety have weak but negative associations with motor skill performance. Therefore it would seem that the link between mental imagery practice and motor skill performance might pass via arousal and state-anxiety. The plausibility of such an intermediary relationship was proposed in the present research study questions. The findings are highly suggestive that the substantive links in the mediational process sought have been verified. As graphically illustrated in a summary of the findings of the modified model, the mediating variables arousal/state-anxiety appear as intermediaries in the generative process linking the independent variable mental imagery practice to the dependent variable motor skill performance.

Arousal / state-anxiety / self-confidence as intermediaries seem to allow the expression of the mental imagery influence on motor skill performance. Findings emerging from the moderator analyses have also served to explain some of the variability by identifying moderating variables external to the independent, the mediating and dependent processes. The interactions of moderators like type of task and practice time as examples have explained and accounted for some of the strength and variability within the study relationship main effects.

The modified model supported by the present research findings seems to have substantiated the mediational effects of mental imagery practice on motor skill performance. Though correlational and with a great amount of prudence because of the lack of data and confounds in the collected data due to possible construct mispecification, assertions made are theory relevant and empirically consistent. The findings in the present research, as a motivational mediating process involving arousal, state-anxiety and self-confidence, support Paivio's analytical framework and his belief in the intermediary motivational process involved in the paradigm of mental imagery practice - motor skill performance.

5.1 Recommendations for Future Research

A line of research investigation implicating experimental design protocols is a logical progression along the road to a causal explanation of the mechanism of mental imagery practice-motor skill performance. Findings of the present research along with substantive literature have built a theoretical foundation and a possible course of action. It is time for causal design and solid substantiation.

The atheoretical nature of motor skill performance-based variable research would do little to explain variability and develop mechanistic explanations of mental imagery practice effects. In the author's opinion, the next progression is to experimentally design primary studies manipulating practice of mental imagery and all its facets (for example: style, type, ability) with the purpose of ameliorating motor skill performance by measuring the mediational processes responsible for the enhancement. Recently an applied model of mental imagery use proposed by Martin, Moritz and Hall (1999), suggests the role of mediating motivational variables such as confidence, competitve anxiety and arousal. The model conceptualizes the sport situation, imagery type of practice and imagery ability as precursors to enhancing outcomes. These outcomes include motor performance, modifications of cognitions (i.e. confidence) and regulating arousal and anxiety. Martin *et al,* (1999) based their formulation of the imagery use model on Paivio's (1985) Analytical framework, however in contrast to the modified model in the present research, their emphasis is predominantly on mental imagery type and ability. They identify mental imagery type as motivational and cognitive as does the present research, but in addition they specify sub-groups within motivational general mental imagery. These are identified as motivational general - mastery influencing cognitions that enhance confidence and motivational general - coping influencing cognitions that optimizing anxiety and arousal levels. Imagery ability is also an important proponent of the mental imagery use model. Experimental design could involve for example measures of multiple levels of mediating variables, like highly aroused or highly anxious subjects. Conducting mental imagery experiments where the intent is to enhance motor skill performance, but measuring the mental imagery ability of the athletes and the effect of their mental imagery type of practice (i.e. MG-M and MG-A mental imagery) on intermediary motivational variable would be most appropriate and relevant. How did the highly aroused subject react to these specific mental imagery practices? Was their mental imagery ability level an important predictor to their motor skill performance? Under such experimental conditions, the addition of other moderators could as well be exploited, ability level of the athlete, cognitive content of the motor task, age and gender.

Experimental design is all-important, however so too, is valid specification of intermediary variable constructs, a serious limitation to reaching, with certainty, any findings, especially true in the present research. Future experimental research delimiting precisely the conceptual motivational variable constructs as raised and lowered arousal, raised and lowered state-anxiety is an issue that must be resolved. Causal mechanistic explanations of mental imagery practice-motor skill performance depend on the proper specification of these intermediary variables.

5.2 Application to Sport

Keeping in mind the correlational nature of the analysis in the present research, the highly suggestive and heterogeneous results in the findings, some cautious suggestions to the application based on the research results would seem pertinent. Inherently all athletes employ some form of mental imagery, whether cognitive or motivational, in their everyday lives if not competitve lives (Paivio, 1986). The present research seems to suggest that an efficacious practice of motivational general mental imagery would benefit the athlete in enhancing his motor skill peformance.

This mediational process at the motivational level would seem to explain the results in showing enhancement of motor skill performance. This could in part be explained by elevating or lowering the psychological variables of state-anxiety, arousal and self-confidence. The results suggest that coaches should encourage athletes to practice mentally, scenarios that make them confident. In particular specific situations that raise an athlete's self-efficacy would be most productive. The conditions which could favor such an enhancement of self-confidence variables are still unclear.

In relation to arousal and state-anxiety, both these constructs show confounding results. However the results also seem to suggest striking parallels between both state-anxiety and arousal. For the athlete, he/she must be careful not to over-arouse with motivational mental imagery practice. The findings from the present research seem to indicate that the treatment of motivational mental imagery practice in relation to raising an athlete's state-anxiety or arousal is quite effective. Trying to practice relaxation mental imagery, may be more difficult and less efficient but more productive in relation to motor skill performance. The conditions (i.e. heterogeneity in the results) in which the influence of motivational mental imagery practice produces these desired effects on state-anxiety and arousal are difficult to ascertain and need further investigtion.

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Appendix 1: Coding Sheets

A coding sheets and protocol (next appendix) are needed to promote the consistent and systematic classification of the features or characteristics of the variables selected for study. This is accomplished by using accurate coding sheets and a well designed code protocol. In this, effective coding is based on conventions chosen and implemented both on the sheets and explained in the code protocol. It is also imperative that the information retrieved be arranged in such a fashion as to facilitate data entry. For the purposes of the proposed synthesis analysis, code sheets for study characteristics coding have been elaborated.

															STATISTIQUES			
#	TITLE	YEAR	AUTHOR	Institution	PUBLICATION	AGE	SEX	ASSIGNMENT	EXPERIMENTAL GROUPS	n	r	t	F	p	X1	sd1	X2	sd2
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X3	sd3	X4	sd4	IM AN+	IM AN -	IM AR+	IM AR-	IM SE	IABL SE AN	SE AR	AN AR	SE PER	AN PER	AR PER	SELF-EFFICACY	ANXIETY	AROUSAL	IMAGERY/ # OF PRACTICE	IMAGERY/EXT VS INT

Appendix 2: Coding Protocol

Rules and Regulations for Coding

1) The present manual includes coding procedures for study variable characteristics and appropriate instructions given to minimize errors in the coding procedure.

2) Where the data permits, coding of variable study characteristics must be done consistently across all study relationships.

3) As new studies are brought in , the nomological coding must be updated. Categories can be modified, expanded or collapsed, as the coding of variable study characteristics procedes. Primary studies who have already been coded prior to the change must be recoded.

4) Record as much information as possible, especially when EM have to be estimated. It is very important to record sample size and means even when EM are being estimated from other statistics , because we need to know the size of the sample and the direction of the change.

5) All primary studies must meet all the following prerequisite conditions:

> 1) Primary studies must have a practice of mental imagery. Cognitive strategies like SIT, VMBR and SMT satisfy this criteria if a majority of their practice is mental imagery.
>
> 2) In the primary studies there must be an intent to perform a motor skill.
>
> 3) Primary studies must include at least one measure of a mediating variable.
>
> 4) Primary studies must have reported the statistics necessary to calculate the effect magnitude (EM). The means, the standard deviations and/or the "F", "t" X^2, or "r" statistic along with the "n" must haven been be reported.

Types of Variable Study Characteristics Coded in the Synthesis

Descriptive Study Characteristics

Study ID #

Title

Author

Year

Study Subject Characteristics

Age

A) < 20

B) ≥ 20

Gender

A) female

B) male

C)both

Article Study Characteristics

Study Design

A) experimental

B) correlational

Publishing Status

A) published (e.g. peer reviewed scientic article)

B) unpublished (e.g. masters or doctoral thesis)

Study Quality Characteristics

Assignement of Subjets (e.g. how were the subjects assigned in the primary studies)

A) random assignement of subjects

B) nonrandom assignement of subjects

Manipulation Checks (e.g. was the practice of mental imagery verified)

A) yes

B) no

Independent Variable Study Characteristics

Mental Imagery Practice Type

A) simple (e.g. mental imagery only)

B) multiple (e.g.mental imagery integrated within a psychological training program)

Mental Imagery Practice Style

A) internal imagery (e.g. kinesthetic or 1st person imagery)

B) external imagery (e.g. visual or 3rd person imagery)

Mental Imagery Practice Time (e.g. number of sessions x the length of each session)

A) < 2 mins.

B) > 2 mins. ↔ < 14 mins.

C) ≥ 14 mins.

Relaxation Sessions (e.g. was relaxation incorporated in the mental imagery practice)

A) yes

B) no

Mediating Variable Study Characteristics

Self-Confidence Measures(e.g. segregation of self-efficacy and situational self-confidence)

A) self-efficacy measures

B) situational self-confidence measures

Arousal Measures (e.g. direction of the measures)

A) raised (+) arousal

B) lowered (-) arousal

State-Anxiety Measures (e.g. direction of the measures)

A) raised (+) anxiety

B) lowered (-) anxiety

Dependent Variable Study Characteristics

Ability Level of the Subjects

A) elite (e.g. includes advanced and elite subjets)

B) non-elite (e.g. includes intermediate and novice subjects)

Type of Task (see content criteria at the end of the manual)

A) cognitive skill

B) physical skill

Type of Test Employed to Measure Dependent Variables

(varies according to dependent measures e.g. CSAI-2 for state-anxiety, heart rate for arousal)

Primary Study Statistics Coded

n	r	t	F	X^2	pre-post group Means	sd	dependent variable reliabilities

Physical and Cognitive Dimensions Used in Evaluating Cognitive Content of a Task

Domain and Dimension	Activity
Physical	
Muscular strength	exert force, apply speed and power, lift, pull
Endurance	sustain physical activity resulting in increased heart rate
Coordination	flex, twist or bend limbs of the body, maintain balance co-ordinate movements of the arms, legs, or body in action

Cognitive	
Perceptual input	search for and acquire information, observe, read, monitor, scan, indentify, locate
Mental operations	compare and contrast information, organise, analyse, categorize, generate hypotheses, apply principles
Output and response	make decisions, solve problems, make judgments, evaluate

Driskell, Copper and Moran (1994)

Appendix 3: Moderator Variable Study Characteristics

Description of Moderator Variable Study Characteristics

Article Characteristics

Study Type

Study type as a study characteristic coded pertained to design of the primary studies: correlational or experimental. Using the appropriate language in reporting and discussing the findings is influenced by the study designs.

Publication Status

This study characteristic refers to the published versus unpublished status of the studies used in the meta-analysis. In the past, it has been generally assumed that study quality as well as the level of reported significance of treatment effects are reflected in the publishing status of the primary studies. Accordingly, the Feltz and Landers (1983) study did code for publication status and found a significant bias effect that favored an elevated level of performance when practising mental imagery in those studies that were published. It is important then in the proposed study, to include the publication status as a study characteristic so as to maintain our awareness of its' influence.

Study Subject Characteristics

Age

Is age a significant moderating variable? The very influence of the maturation factor for both psychomotor and cognitive development are very important when reporting results. College age students as subjects have been invariably over-represented in primary studies (Corbin, 1967; Epstein,1980; Ryan & Simons, 1981; Wrisberg & Ragsdale, 1979). Although more rare, some studies have also been reported for elementary school age children; results showed that children who used mental imagery practice experienced significantly greater improvement in motor performance than children in comparison groups,(Fishburn, 1990; Orlick *et al*, 1992; Partington, 1990). The elderly have also been studied, Linden (1987). The inclusion of age in the meta-analysis may yield a clearer picture of age as a moderating variable.

Gender

The use of only male or only female subjects is a common characteristic of many mental imagery studies. Few primary studies have included both sexes and of those that have, little light has been shed on the issue of possible differential effects between the sexes when practising mental imagery. Likewise, two prior meta-analyses in mental imagery, (Feltz & Landers,1983; Oslin, 1985) also failed to find any differential effects between the sexes.. With the advent of better methodological procedures at the primary study level, (e.g., larger n's, tests for homogeneity and study quality), the influence of gender differences in moderating the relative efficacy of mental imagery practice may yet prove to be nonnegligible.

Study Quality Characteristics

Assignement

Random assignment of subjects across all conditions is essential to primary study quality. It has the potential of acting as a counter balance to errors, for example sampling error. Thus, it is important that, in any meta-analysis, type of assignment be identify (random vs. nonrandom).

Manipulation Checks

Manipulation checks as a study characteristic pertains to within primary studies if the practice of mental imagery was actually verified. It becomes clear that a methodological issue involving study quality as does manipulation checks of the independent variable would have important repercussions upon the validity of assertions made as to whether an individual is actually practicing what is said that he is practicing.

Independent Variable Study Characteristics

Mental Imagery PracticeType

Mental imagery practice type study characteristic was identified as mental imagery practice alone or integrated into a psychological training program (multiple), Visuo-Motor Behavioral Rehearsal (VMBR) or Stress Inoculation Training (SIT) being examples. Effectiveness of these type of cognitive behavioral interventions have been supported in the literature (Bennett *et al,* 1978; Mace *et al,* 1989). It would seem relevant to distiguish and code mental imagery practice based on this differentiation.

Mental Imagery PracticeStyle

Mental imagery practice style study characteristic is distinguished in the literature as being practiced either externally or internally (Epstein, 1980). It has been hypothesized that internal (internal) mental imagery is more effective in enhancing motor skill performance (Mahoney *et.al,* 1977). Including mental imagery practice style as a moderator could possibly explain some variability in its effect if in fact internal type mental imagery practice has greater effects on motor skill performance.

Mental Imagery Practice Time

Important determinants as the number and the duration of practice sessions have been documented in prior meta-analyses (Feltz *et al*, 1983; Hinshaw, 1991; Oslin, 1985),. There is evidence in the literature underlining the inadequacies in the development of proper practice programs of mental imagery (Woolfolk, Parrish & Murphy, 1985). Is more practice better, or is there a decline after a certain practice time level. Arbitrarily mental imagery practice time was categorized into three levels, ≤ 2 mins., >2 mins. to <14 mins., ≥ 14 mins. and coded as such.

Relaxation Session

Relaxation techniques designed to reduce arousal are increasingly being incorporated into athletic training regimens (Mahoney *et.al,* 1977). Primary studies realised in recent years have to a much greater degree incorporated the practice of various relaxation methods as an important precursor to practising mental imagery. Because of a greater frequency in the use, relaxation as a study characteristic was included in the present study and coded as those primary studies who integrated it in the practice of mental imagery and those who did not.

Dependent Variable Characteristics

Ability level of the Participants

Ability level is another study characteristic thought to have important consequences when evaluating the early and later stages of learning and motor performance through the use of practising mental imagery. When the practice of mental imagery is motivational in nature, advanced elite high skilled athletes are thought by some researchers to benefit most from its employment as a performance tool (Mahoney *et al,* 1978; Martens *et al,* 1986). Ability level of an athlete could certainly have some repercussions in relation to explain mental imagery effects especially at the motivational level.

Type of Task

The issue of rating the type of task based on the cognitive continuum still elicits much interest as a study characteristic. By differentiating type of task based on cognitive content one could then predict if mental imagery should be practised, and if so what type of mental imagery would be most appropriate. Driskell *et al*,(1994) made a compromise between the two strategies in their meta-analysis when they harmonized their data collection methods with those of Feltz *et al,* (1983) and collapsed three categories (i.e. motor, cognitive and strength) to two categories (i.e. physical and cognitive). The categorised type of task based on more stringent and precise criterion. Their findings showed that the greater the cognitive content of the task increased the more effective was the practice of mental imagery. Type of task was coded by first attributing a cognitive percentage value to each motor task based on the cognitive content continuum.

Type of Test

The type of test study characteristic was decided upon, because of the importance given to psychometric tests, physiological and motor performance measures in every domaine investigated in the present research. Kliene, (1988) found in his meta-analysis of anxiety and performance that no difference emerged from state and trait measures, surprising result given the specificity of state and trait anxiety tests. Relevant in the present research was the investigation of whether different measures of the same mediating and dependent variables across all study relationships explained variability as moderators. Different levels of the moderator type of test were chosen arbitrarily depending on the study relationship investigated.

Appendix 3: Variance/Covariance Matrix

The variance-covariance matrix consists of a table showing variances (i.e. on the diagonal) of each of the primary study measures included for synthesis. If these dependent variable measures are non-independent, their covariances are calculated and these are imputed into the same table but on the off-diagonal. This information about the dependent variable measures can then be integrated to estimate a truer study relationship EM.

30	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
31	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
32	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
33	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
34	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
35	15	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
36	.00	15	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
37	.00	.00	35	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
38	.00	.00	.00	183	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
39	.00	.00	.00	.00	25	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
40	.00	.00	.00	.00	.00	51	123	248	***	498	225	371	.00	.00	.00
41	.00	.00	.00	.00	.00	123	51	181	270	337	255	371	.00	.00	.00
42	.00	.00	.00	.00	.00	248	181	51	87	128	144	93	.00	.00	.00
43	.00	.00	.00	.00	.00	***	270	87	51	168	185	95	.00	.00	.00
44	.00	.00	.00	.00	.00	498	337	128	168	51	114	96	.00	.00	.00
45	.00	.00	.00	.00	.00	225	255	144	185	114	51	149	.00	.00	.00
46	.00	.00	.00	.00	.00	371	148	93	95	96	149	51	.00	.00	.00
47	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	23	.00	.00
48	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	23	.00
49	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	54.0
50	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	202
51	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	1926
52	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	334
53	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	450
54	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	831
55	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	814
56	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
57	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
58	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00

Appendix 4: Predictor Matrix

The predictor matrix consists of a table showing the different levels of a moderator (or predictor) variable characteristic involved in the synthesis. A particular level is identified by being assigned a value (i.e. #1) in that column of the moderator variable characteristic when its alternative is represented, and 0 when it is not. The computer program selects all the #1's in that column and calculates the β coefficient for that alternative of the moderator variable characteristics. It goes on to the next column to calcuate the β coefficient for the next alternative level of the moderator variable characteristic and so on. This information representing the different levels of the moderator variable characteristics can then be integrated into a regression model to estimate its relative contribution to the variance explained by the moderator.

	study#	r	n	svz	z	v1	v2	v3
0	29	.25	30	.04	.26	.00	.00	1.00
1	29	.94	30	.04	1.74	.00	.00	1.00
2	30	.87	23	.05	1.33	1.00	.00	.00
3	30	.96	20	.06	1.95	1.00	.00	.00
4	35	.01	18	.07	.01	.00	1.00	.00
5	35	.53	18	.07	.59	.00	1.00	.00
6	35	.01	18	.07	.01	.00	1.00	.00
7	35	.82	18	.07	1.16	.00	1.00	.00
8	35	.18	18	.07	.18	.00	1.00	.00
9	35	.47	18	.07	.51	.00	1.00	.00
0	35	.77	18	.07	1.02	.00	1.00	.00
1	36	.91	18	.07	1.53	.00	1.00	.00
2	36	.98	38	.03	2.30	.00	.00	1.00
3	39	.35	186	.01	.37	1.00	.00	.00
4	40	.66	28	.04	.79	.00	1.00	.00
5	42	.02	54	.02	.02	.00	.00	.00
6	42	-.04	54	.02	-.04	.00	.00	.00
7	42	.09	54	.02	.09	.00	.00	.00
8	42	.10	54	.02	.10	.00	.00	.00
9	42	.09	54	.02	.09	.00	.00	.00
0	42	.35	54	.02	.37	.00	.00	.00
1	42	.15	54	.02	.15	.00	.00	.00
2	43	.99	26	.04	2.65	1.00	.00	.00
3	43	-.99	26	.04	-2.65	1.00	.00	.00
4	44	.39	57	.02	.41	.00	.00	.00
5	44	.38	57	.02	.40	.00	.00	.00
6	44	.08	57	.02	.08	.00	.00	.00
7	44	.10	57	.02	.10	.00	.00	.00
8	44	.46	57	.02	.50	.00	.00	.00

	v4	v5	v6	v7	v8	v9	v10
30	.00	1.00	.00	.00	1.00	.00	1.00
31	.00	1.00	.00	.00	1.00	.00	1.00
32	1.00	.00	.00	1.00	.00	1.00	.00
33	1.00	.00	.00	1.00	.00	1.00	.00
34	1.00	.00	.00	.00	1.00	1.00	.00
35	1.00	.00	.00	.00	1.00	1.00	.00
36	1.00	.00	.00	.00	1.00	1.00	.00
37	1.00	.00	.00	.00	1.00	1.00	.00
38	1.00	.00	.00	.00	1.00	1.00	.00
39	1.00	.00	.00	.00	1.00	1.00	.00
40	1.00	.00	.00	.00	1.00	1.00	.00
41	1.00	.00	.00	.00	1.00	1.00	.00
42	.00	.00	.00	.00	1.00	.00	1.00
43	.00	1.00	.00	.00	.00	.00	1.00
44	.00	1.00	.00	.00	1.00	.00	1.00
45	.00	.00	.00	.00	.00	.00	.00
46	.00	.00	.00	.00	.00	.00	.00
47	.00	.00	.00	.00	.00	.00	.00
48	.00	.00	.00	.00	.00	.00	.00
49	.00	.00	.00	.00	.00	.00	.00
50	.00	.00	.00	.00	.00	.00	.00
51	.00	.00	.00	.00	.00	.00	.00
52	1.00	.00	.00	.00	.00	.00	1.00
53	1.00	.00	.00	.00	.00	.00	1.00
54	.00	1.00	.00	.00	.00	.00	1.00
55	.00	.00	1.00	.00	.00	.00	1.00
56	.00	.00	.00	.00	.00	.00	1.00
57	.00	.00	.00	.00	.00	.00	1.00
58	.00	.00	.00	.00	.00	.00	1.00

	v11	v12	v13	v14	v15	v16	v17
0	1.00	.00	.00	.00	1.00	.00	1.00
1	1.00	.00	.00	.00	1.00	.00	1.00
2	1.00	.00	.00	1.00	.00	.00	1.00
3	1.00	.00	.00	1.00	.00	.00	1.00
4	1.00	.00	.00	.00	1.00	1.00	1.00
5	1.00	.00	.00	.00	1.00	1.00	1.00
6	1.00	.00	.00	.00	1.00	1.00	1.00
7	1.00	.00	.00	.00	1.00	1.00	1.00
8	1.00	.00	.00	.00	1.00	1.00	1.00
9	1.00	.00	.00	.00	1.00	1.00	1.00
40	1.00	.00	.00	.00	1.00	1.00	.00
41	1.00	.00	.00	.00	1.00	1.00	.00
42	1.00	.00	.00	1.00	.00	1.00	1.00
43	.00	.00	.00	1.00	.00	.00	.00
44	1.00	.00	.00	1.00	.00	1.00	.00
45	.00	.00	.00	.00	.00	1.00	.00
46	.00	.00	.00	.00	.00	1.00	.00
47	.00	.00	.00	.00	.00	1.00	.00
48	.00	.00	.00	.00	.00	1.00	.00
49	.00	.00	.00	.00	.00	1.00	.00
50	.00	.00	.00	.00	.00	1.00	.00
51	.00	.00	.00	.00	.00	1.00	.00
52	1.00	.00	.00	.00	1.00	.00	1.00
53	1.00	.00	.00	.00	1.00	.00	1.00
54	.00	.00	.00	.00	.00	1.00	.00
55	.00	.00	.00	.00	.00	1.00	.00
56	.00	.00	.00	.00	.00	1.00	.00
57	.00	.00	.00	.00	.00	1.00	.00
58	.00	.00	.00	.00	.00	1.00	.00

Appendix 6: Glossary of Terms

AN. *State-Anxiety*. Mediating Study Variable.

-AN. *Lowered State-Anxiety*. Mediating Study Variable.

+AN. *Raised State-Anxiety*. Mediating Study Variable.

AN_PER. *State-Anxiety - Motor Skill Performance*. Study Relationship.

-AN_PER. *Lowered State-Anxiety - Motor Skill Performance*. Study Relationship.

+AN_PER. *Raised State-Anxiety - Motor Skill Performance*. Study Relationship.

ANS. *Autonomic Nervous System*.

AR. *Arousal*. Mediating Study Variable.

-AR. *Lowered Arousal*. Mediating Study Variable.

+AR. *Raised Arousal*. Mediating Study Variable.

AR_PER. *Arousal- Motor Skill Performance*. Study Relationship.

-AR_PER. *Lowered Arousal- Motor Skill Performance*. Study Relationship.

+AR_PER. *Raised Arousal- Motor Skill Performance*. Study Relationship.

AR_SC. *Arousal- Self-Confidence*. Study Relationship.

β . *Beta Weight*. Statistic.

CI . *Confidence Interval.* Statistic.

CNS. *Central Nervous System.*

Covar. *Covariance.* Statistic.

CSAI-2. *Competitive State-Anxiety Inventory* - 2. Psychometric Test.

'd '. *Cohen's ES.* Statistic.

EM. *Effect Magnitude.* Statistic.

EMG . *Electromyogram.*

ES. *Effect size.* Statistic.

GLS. *Generalized Least SquaresRegression Analysis.* Statistic.

'G'. *Glass's ES.* Statistic.

He. *Homobeneity test.* Statistic

IM_SC. *Mental Imagery Practice-Self-Confidence.* Study Relationship.

IM_AN. *Mental Imagery Practice-State-anxiety.* Study Relationship.

IM_-AN. *Mental Imagery Practice - Lowered State-Anxiety.* Study Relationship.

IM_+AN *Mental Imagery Practice- Raised State-Anxiety.* Study Relationship.

IM_AR. *Mental Imagery Practice - Arousal.* Study Relationship.

IM_-AR. *Mental Imagery Practice - Lowered Arousal.* Study Relationship.

IM_+AR. *Mental Imagery Practice-Raised State-Anxiety.* Study Relationship.

ISM. *Ahsen's Triple Code of Mental Imagery.*

k . *Number of Primary Studies.* Statistic.

MANI. *Manipulation Check.* Variable Study Characteristic.

n . *Number of Subjects.* Statistic.

PRACTIME. *Amount of Mental Imagery Practice Time.* Variable Study Characteristic.

Qe. *Homogeneity Test of Goodness of Fit of the Model.* Statistic.

Qo. *Test of significance- Hypothesis.* Statistic.

Qr. *Homogeneity Test of Significance of the Moderators.* Statistic.

RELAX. *Relaxation Integrated into a Mental Imagery Practice.* Variable Study Characteristic.

Sc. *Control Standard Deviation.* Statistic.

Sp. *Pooled Standard Deviation.* Statistic.

SC. *Self-confidence.* Mediating Study Variable.

SC_AN. *Self-Confidence-State-Anxiety*. Study Relationship.

SC_PER. *Self-Confidence-Motor Skill Performance*. Study Relationship.

SCs_PER. *Situational Self-Confidence-Motor Skill Performance*. Study Relationship.

SE. *Self-Efficacy*. Mediating Study Variable.

SE_PER. *Self-Efficacy-Motor Skill Performance*. Study Relationship.

SIT. *Stress Inoculation Technique*. Psychological Training Program.

SMT. *Stress Management Training*. Psychological Training Program.

STAI . *State Trait Anxiety Inventory*. Psychological Test.

STPI . *Stait Trait Personality Inventory*. Psychological Test.

Var. *Variance*. Statistic.

VMBR. *Visuo-Motor Behavior Rehearsal*. Psychological Training Program.

Z . *Fisher's Transformation Score*. Statistic.

Appendixe 7: Data Tables

Data tables consist of a series of code sheets showing the coded data items entered. The coded relevant information based on the coding protocol was compiled using Microsoft Excel. Information from the data tables was then used in the synthesis analysis.

IM_SC

Study#	Author	Year	Publication	Age	Gender	Assign	Design	M style	mani	IM type	total mins.	relax	activity	ability	Test	"n"	corrected"r"
5	Mack	1992	Thesis	12.5	F	Random	con	Int.	Yes	Simple		No	Figure Skate	Adv.	SE - Mental St/conf.	20	1.00
8	Wilkes	1984	Article	20.5	M	Random	con	Ext.	No	Simple	2	No	Strength	Novice	SE-Confidence	24	0.00
8		1984	Article	20.5	M	Random	con	Ext.	No	Simple	2	No	Strength	Novice	Bandura-SE	24	1.00
9	Feltz	1990	Article	20.5	M & F	Random	con	_	Yes	Simple	20	No	Phant chair	Novice	Bandura -SE	79	0.95
9		1990	Article	20.5	M & F	Random	con	_	Yes	Simple	20	No	Phant chair	Novice	Bandura -SE	79	0.89
9		1990	Article	20.5	M & F	Random	con	_	Yes	Simple	20	No	Phant chair	Novice	Bandura -SE	79	1.00
12	McAleney	1990	Thesis	21	M & F	Non	con	Ext.	No	Multi	300	Yes	Tennis	Elite	SE- CSAI	11	-0.04
12		1990	Thesis	21	M & F	Non	con	Ext.	No	Simple	180	No	Tennis	Elite	SE- CSAI	9	0.00
13	Weinberg	1987	Article	21	M	Random	con	Both	Yes	Simple	420	Yes/No	all activities	Novice	SE- CSAI	30	0.61
13		1987	Article	21	M	Random	con	Both	Yes	Simple	420	Yes/No	all activities	Novice	SE- CSAI	30	-0.11
13		1987	Article	21	M	Random	con	Both	Yes	Simple	840	Yes/No	all activities	Novice	SE- CSAI	30	0.50
13		1987	Article	21	M	Random	con	Both	Yes	Simple	840	Yes/No	all activities	Novice	SE- CSAI	30	-0.43
14	Carter	1997	Article	20	M & F	Random	con	Both	Yes	Simple	3	No	Free Throw	Inter.	SE- CSAI (CON)	50	0.95
15	Johnston	1991	Article	21.2	F	Random	con	Both	No	Multi	175	Yes	Golf Putt	Novice	SE- Bandura	30	-0.91
15		1991	Article	21.2	F	Random	con	Both	No	Multi	175	Yes	Golf Putt	Novice	SE-Bandura	30	0.17
16	Crocker	1988	Article	17	M	Non	con	Both	Yes	Multi	480	Yes	Volleyball	Adv.	SE- CSAI (CON)	14	-0.04
16		1988	Article	17	F	Non	con	Both	Yes	Mult	480	Yes	Volleyball	Adv.	SE- CSAI (CON)	13	-0.67
17	Gould	1980	Article	21	M	Non	con	Int.	Yes	Simple	1.6	No	Leg Strength	Novice	SE- CON. MEAS.	30	0.93
17		1980	Article	21	F	Non	con	Int.	Yes	Simple	1.6	No	Leg Strength	Novice	SE- CON. MEAS.	30	1.00
17		1980	Article	21	M	Non	con	Ext.	Yes	Simple	1.6	No	Leg Strength	Novice	SE- CON. MEAS.	30	0.90
17		1980	Article	21	F	Non	con	Ext.	Yes	Simple	1.6	No	Leg Strength	Novice	SE- CON. MEAS.	30	1.00
18		1980	Article	21	M	Random	con	Ext.	Yes	Simple	1.6	No	Leg Strength	Novice	SE- CON. MEAS.	20	0.44
18		1980	Article	21	F	Random	con	Ext.	Yes	Simple	1.6	No	Leg Strength	Novice	SE- CON. MEAS.	20	-0.68
19	Zervas	1987	Article	28.5	M &F	Non	con	Both	Yes	Multi	480	Yes	Archery	Elite	SE- CSAI (CON)	18	-0.18

20	Murphy	1987	Article	20	M & F	Random	Corr.	-	Yes	Multi	25	Yes	Golf Putt	Novice	SE- Bandura	19	0.46
25	Marinakis	1988	Thesis	15.4	M	Non	con	Both	-	Multi	180	Yes	Free Throw	Inter.	SE-CSAI (con)	68	0.03
25		1988	Thesis	15.4	M	Non	Corr.	Both	-	Multi	180	Yes	Free Throw	Inter.	SE- CSAI (con)	29	0.31
28	Ratelle	1995	Thesis	21.4	M & F	Random	con	Both	No	Multi	60	Yes	Wt. Lifting	Novice	SE- Bandura	23	0.93
28		1995	Thesis	21.4	M & F	Random	con	Both	No	Multi	60	Yes	Wt. Lifting	Novice	SE- Bandura	20	0.82
29	Ellis	1993	Article	15	M	Random	con	Ext.	Yes	Simple	230	No	Video Games	Novice	SE-Bandura	30	0.25
29		1993	Article	15	M	Random	con	Ext.	Yes	Simple	230	No	Video Games	Novice	SE-Bandura	30	0.94
30	Ratelle	1995	Thesis	21.4	M & F	Random	con	Both	No	Multi	60	Yes	Wt. Lifting	Novice	SE- Bandura	23	0.87
30		1995	Thesis	21.4	M & F	Random	con	Both	No	Multi	60	Yes	Wt. Lifting	Novice	SE- Bandura	20	0.96
35	Garza	1998	Article	14	F	Random	con	Both	Yes	Multi	140	No	Figure Skate	Elite	SE- Bandura	18	0.00
35		1998	Article	14	F	Random	con	Both	Yes	Multi	140	No	Figure Skate	Elite	SE- Bandura	18	0.53
35		1998	Article	14	F	Random	con	Both	Yes	Multi	140	No	Figure Skate	Elite	SE- Bandura	18	0.01
35		1998	Article	14	F	Random	con	Both	Yes	Multi	140	No	Figure Skate	Elite	SE- Bandura	18	0.82
35		1998	Article	14	F	Random	con	Both	Yes	Multi	140	No	Figure Skate	Elite	SE- Bandura	18	0.18
35		1998	Article	14	F	Random	con	Both	Yes	Multi	140	No	Figure Skate	Elite	SE- Bandura	18	0.47
35		1998	Article	14	F	Random	con	Both	Yes	Multi	140	No	Figure Skate	Elite	SE- CSAI-2 (CON)	18	0.77
36		1998	Article	14	F	Random	con	Both	Yes	Multi	140	No	Figure Skate	Elite	SE- CSAI-2 (CON)	18	0.91
36	Callery	1997	Article	20	M	Random	con	-	Yes	Simple	50	Yes	Goal Kicking	Elite	SE - Bandura	38	0.98
39	Ryska	1998	Article	41	M & F	Non	Corr.	Ext.	n/a	Simple	n/a	Yes	Tennis	Inter.	CSAI-2 (SC)	186	0.35
40	Cogan	1995	Article	19	F	Non	con	Ext.	Yes	Simple	60	Yes	Gymnastics	elite	CSAI-2 (SC)	28	0.66
42	Vadocz	1997	Article	15	M & F	Non	Corr.	_	n/a	_	n/a	n/a	Roller Skating	Elite	CSAI-2 (CON)-IM KIN	54	0.02
42		1997	Article	15	M & F	Non	Corr.	_	n/a	_	n/a	n/a	Roller Skating	Elite	CSAI-2 (CON)-IM VIS	54	-0.04
42		1997	Article	15	M & F	Non	Corr.	_	n/a	_	n/a	n/a	Roller Skating	Elite	CSAI-2 (CON)-CS	54	0.09
42		1997	Article	15	M & F	Non	Corr.	_	n/a	_	n/a	n/a	Roller Skating	Elite	CSAI-2 (CON)-CG	54	0.10
42		1997	Article	15	M & F	Non	Corr.	_	n/a	_	n/a	n/a	Roller Skating	Elite	CSAI-2 (CON)-MS	54	0.09
42		1997	Article	15	M & F	Non	Corr.	_	n/a	_	n/a	n/a	Roller	Elite	CSAI-2 (CON)-	54	0.35

42		1997	Article	15	M & F	Non	Corr.	_	n/a	_	n/a	n/a	Skating Roller Skating	Elite	MGM CSAI-2 (CON)-MG-A	54	0.15
43	Martin	1995	Article	27	M & F	Random	con	Both	_	Simple	210	No	Golf	Novice	Bandura-SE	26	-1.00
43		1995	Article	27	M & F	Random	con	Both	_	Simple	210	No	Golf	Novice	Bandura-SE	26	-1.00
44	Moritz	1994	Thesis	15.4	M&F	Non	Corr.	Ext.	n/a	Simple	n/a	n/a	Skating	Elite	SSCI-CON	57	0.39
44		1994	Thesis	15.4	M&F	Non	Corr.	Int.	n/a	Simple	n/a	n/a	Skating	Elite	SSCI-CON	57	0.38
44		1994	Thesis	15.4	M&F	Non	Corr.	_	n/a	Simple	n/a	n/a	Skating	Elite	SSCI-CON	57	0.08
44		1994	Thesis	15.4	M&F	Non	Corr.	_	n/a	Simple	n/a	n/a	Skating	Elite	SSCI-CON	57	0.10
44		1994	Thesis	15.4	M&F	Non	Corr.	_	n/a	Simple	n/a	n/a	Skating	Elite	SSCI-CON	57	0.46
44		1994	Thesis	15.4	M&F	Non	Corr.	_	n/a	Simple	n/a	n/a	Skating	Elite	SSCI-CON	57	0.33
44		1994	Thesis	15.4	M&F	Non	Corr.	_	n/a	Simple	n/a	n/a	Skating	Elite	SSCI-CON	57	0.14
46	Caudill	1983	Article	21	M&F	Non	con	Int.	No	Simple	3.5	_	Bench Press	Novice	Anxiety/Confi	60	0.62
46		1983	Article	21	M&F	Non	con	Ext.	No	Simple	3.5	_	Bench Press	Novice	Anxiety/Confi	60	-0.32

IM_-AR

Study#	Author	Year	Publication	Age	Gender	Assign	Design	M style	mani	IM type	total mins.	relax	activity	ability	Test	"n"	corrected"r"
1	Mace	1989	Article	20.5	F	Random	con	Both	No	Multiple	263	No	Gymnastics	Novice	HR	18	-0.63
3	Zervas	1995	Article	20.5	M	Random	con	Int.	Yes	Multiple	240	Yes	Archery	Novice	AR-tense/relax scale	22	1.00
8	Wilkes	1984	Article	20.5	M	Random	con	Ext.	No	Simple	2	No	Strength	Novice	AR- Thayer	24	0.25
8		1984	Article	20.5	M	Random	con	Ext.	No	Simple	2	No	Strength	Novice	AR-Thayer	24	-0.93
11	Weinberg	1981	Article	21	M	Non	con	Both	Yes	Multi	420	Yes	Karate	Inter	AR-HR	16	0.04
12	McAleney	1990	Thesis	21	M & F	Non	con	Ext.	No	Simple	180	No	Tennis	Elite	AR-CSAI	9	-0.04
13	Weinberg	1987	Article	21	M	Random	con	Both	Yes	Simple	420	Yes/No	all activities	Novice	AR- CSAI	30	0.11
13		1987	Article	21	M	Random	con	Both	Yes	Simple	840	Yes/No	all activities	Novice	AR- CSAI	30	0.11
13		1987	Article	21	M	Random	con	Both	Yes	Simple	420	Yes/No	all activities	Novice	AR- CSAI	30	-0.05
13		1987	Article	21	M	Random	con	Both	Yes	Simple	840	Yes/No	all activities	Novice	AR- CSAI	30	-0.10
14	Carter	1997	Article	20	M & F	Random	con	Both	Yes	Simple	3	No	Free Throw	Inter.	AR- CSAI (SOM)	50	0.11
16	Crocker	1988	Article	17	M	Non	con	Both	Yes	Multi	480	Yes	Volleyball	Adv.	AR-CSAI (SOM)	14	-0.31
16		1988	Article	17	F	Non	con	Both	Yes	Multi	480	Yes	Volleyball	Adv.	AR-CSAI (SOM)	13	-0.65
19	Zervas	1987	Article	28.5	M &F	Non	con	Both	Yes	Multi	480	Yes	Archery	Elite	Ar- CSAI (SOM)	18	-0.31
25	Marinakis	1988	Thesis	15.4	M	Non	con	Both	-	Multi	180	Yes	Free Throw	Inter.	AR- CSAI (som)	68	0.02
26	Armstrong	1985	Thesis	9.5	M & F	Random	con	Ext.	Yes	Simple	10	Yes	Pegboard	Novice	AR- EMG	18	-0.31
26		1985	Thesis	9.5	M & F	Random	con	Int.	Yes	Simple	10	Yes	Pegboard	Novice	AR- EMG	18	-0.73
26		1985	Thesis	9.5	M & F	Random	con	Ext.	Yes	Simple	10	Yes	Pegboard	Novice	AR-Skin Conductance	18	0.01
26		1985	Thesis	9.5	M & F	Random	con	Int.	Yes	Simple	10	Yes	Pegboard	Novice	AR-Skin Conductance	18	0.02
26		1985	Thesis	9.5	M & F	Random	con	Ext.	Yes	Simple	10	Yes	Pegboard	Novice	AR- HR	18	-0.11
26		1985	Thesis	9.5	M & F	Random	con	Int.	Yes	Simple	10	Yes	Pegboard	Novice	AR- HR	18	-0.78
26		1985	Thesis	9.5	M & F	Random	con	Ext.	Yes	Simple	10	Yes	Pegboard	Novice	AR- Resp. Rate	18	0.00
26		1985	Thesis	9.5	M & F	Random	con	Int.	Yes	Simple	10	Yes	Pegboard	Novice	AR- Resp. Rate	18	-0.11
27	McCaffrey	1988	Thesis	16.4	M	Random	con	Both	Yes	Multi	150	Yes	Wrestling	Inter.	AR- Blood Pressure	36	0.08
27		1988	Thesis	16.4	M	Random	con	Both	Yes	Multi	150	Yes	Wrestling	Inter.	AR- Blood Pressure	36	0.05
31	Machlus	1986	Thesis	17	M	Random	con	Both	Yes	Multi	120	Yes	Sprints	Inter.	AR- Pulse	53	0.27
34	Thompson	1981	Thesis	9	M & F	Random	con	Int.	No	Simple	280	Yes	Pegboard	Novice	AR- HR	32	0.68
38	Hale	1998	Article	21.5	M	Non	con	Both	Yes	Simple	2	Yes	Goal Kick	Adv.	HR	24	-0.38
38		1998	Article	21.5	M	Non	con	Both	Yes	Simple	2	Yes	Goal Kick	Adv.	HR	24	-0.41
39	Ryska	1998	Article	41	M & F	Non	Corr.	Ext.	n/a	Simple	n/a	Yes	Tennis	Inter.	CSAI-2 (SOM)	186	-0.30
40	Cogan	1995	Article	19	F	Non	con	Ext.	Yes	Simple	60	Yes	Gymnastics	elite	CSAI-2 (SOM)	28	-0.67
42	Vadocz	1997	Article	15	M & F	Non	Corr.	_	n/a	_	n/a	n/a	Roller Skating	Elite	CSAI-2 (SOM)- IM VIS	54	-0.08
42		1997	Article	15	M & F	Non	Corr.	_	n/a	_	n/a	n/a	Roller	Elite	CSAI-2 (SOM)-	54	-0.03

											Skating		MS		
42	1997	Article	15	M & F	Non	Corr.	_	n/a	_	n/a	n/a	Roller Skating	Elite	CSAI-2 (SOM)-MG-M	54	-0.21
42	1997	Article	15	M & F	Non	Corr.	_	n/a	_	n/a	n/a	Roller Skating	Elite	CSAI-2 (SOM)-IM KIN	54	0.29
42	1997	Article	15	M & F	Non	Corr.	_	n/a	_	n/a	n/a	Roller Skating	Elite	CSAI-2 (SOM)-CS	54	0.02
42	1997	Article	15	M & F	Non	Corr.	_	n/a	_	n/a	n/a	Roller Skating	Elite	CSAI-2 (SOM)-CG	54	0.18
42	1997	Article	15	M & F	Non	Corr.	_	n/a	_	n/a	n/a	Roller Skating	Elite	CSAI-2 (SOM)-MG-A	54	0.17

IM_+AR

Study#	Author	Year	Publication	Age	Gender	Assign	Design	M style	mani	M type	total mins.	relax	activity	ability	Test	"n"	corrected"r"
7	Kennitzer	1991	Article	20.5	F	Non	con	Both	No	Simple	600	Yes	Swimming	Adv.	AR-SIQ	16	0.97
8	Wilkes	1984	Article	20.5	M	Random	con	Ext.	No	Simple	2	No	Strength	Novice	AR- Thayer	24	0.73
8		1984	Article	20.5	M	Random	con	Ext.	No	Simple	2	No	Strength	Novice	AR- thayer	24	1.00
10	Anshel	1988	Article	20.5	M & F	Non	con	_	Yes	Simple	10	No	Baseball	Adv.	AR-HR	20	0.82
10		1988	Article	20.5	M & F	Non	con	_	Yes	Simple	10	No	Baseball	Adv.	AR-HR	20	0.95
13	Weinberg	1987	Article	21	M	Random	con	Both	Yes	Simple	420	Yes/No	all activities	Novice	AR- CSAI	30	0.44
13		1987	Article	21	M	Random	con	Both	Yes	Simple	840	Yes/No	all activities	Novice	AR- CSAI	30	0.25
13		1987	Article	21	M	Random	con	Both	Yes	Simple	420	Yes/No	all activities	Novice	AR- CSAI	30	-0.37
13		1987	Article	21	M	Random	con	Both	Yes	Simple	840	Yes/No	all activities	Novice	AR- CSAI	30	-0.31
18	Gould	1980	Article	21	M	Random	con	Ext.	Yes	Simple	1.6	No	Leg Strength	Novice	AR-Thayer	20	-0.97
18		1980	Article	21	F	Random	con	Ext.	Yes	Simple	1.6	No	Leg Strength	Novice	AR- Thayer	20	1.00
23	Anshel	1993	Article	23.8	M & F	Random	con	_	Yes	Simple	2	Yes	Tennis Serv.	Adv.	AR- HR	28	1.00
23		1993	Article	23.8	M & F	Random	con	_	Yes	Simple	2	Yes	Tennis Serv.	Adv.	AR- HR	28	0.98
23		1993	Article	23.8	M & F	Random	con	_	Yes	Simple	2	Yes	Tennis Serv.	Adv.	AR- CAS	28	0.92
23		1993	Article	23.8	M & F	Random	con	_	Yes	Simple	2	Yes	Tennis Serv.	Adv.	AR- (CAS)	28	1.00
27	McCaffrey	1988	Thesis	16.4	M	Random	con	Both	Yes	Multi	150	No	Grip Streng.	Inter	AR- BP	36	0.00
27		1988	Thesis	16.4	M	Random	con	Both	Yes	Multi	150	Yes	Grip Streng.	Inter.	AR- BP	36	0.01
31		1986	Thesis	17	M	Random	con	Both	Yes	Multi	120	Yes	Sprints	Inter.	AR- Pulse	58	0.93
41	Gallego	1996	Article	21	M & F	Non	con	Both	Yes	Simple	1.5	No	Swimming	Adv.	HR	12	0.59
41		1996	Article	23	M & F	Non	con	Both	Yes	Simple	1.5	No	Judo	Adv.	HR	16	0.76
46	Caudill	1983	Article	21	M&F	Non	con	Int.	No	Simple	3.5	_	Bench Press	Novice	Anxiety/Confi	60	0.47
46		1983	Article	21	M&F	Non	con	Ext.	No	Simple	3.5	_	Bench Press	Novice	Anxiety/Confi	60	0.46

IM_-AN

Study#	Author	Year	Publication	Age	Gender	Assign	Design	M style	mani	IM type	total mins.	relax	activity	ability	Test	"n"	corrected"r"
1	Mace	1989	Article	20.5	F	Random	Con	Both	No	Multiple	263	Yes	Gymnastics	Novice	Perceived Stress Index	18	-1.00
1		1989	Article	20.5	F	Random	Con	Both	No	Multiple	263	No	Gymnastics	Novice	observer est. stress	18	-1.00
4	Mayeran	1992	Thesis	16.5	M	Random	Con		No	Simple	_	Yes	Volleyball	Inter.	AN-SCAT	17	-0.40
8	Wilkes	1984	Article	20.5	M	Random	Con	Ext.	No	Simple	2	No	Strength	Novice	AR-Thayer	24	0.00
8		1984	Article	20.5	M	Random	Con	Ext.	No	Simple	2	No	Strength	Novice	AN- Speiberg/Gorsuch	24	0.48
11	Weinberg	1981	Article	21	M	Non	Con	Both	Yes	Simple	420	Yes	Karate	both	Marten's Short Form	16	-0.10
11		1981	Article	21	M	Non	Con	Both	Yes	Multi	420	Yes	Karate	both	Marten's Short Form	16	-1.00
12	McAleney	1990	Thesis	21	M&F	Non	Con	Ext.	No	Simple	180	No	Tennis	Elite	AN- CSAI	9	0.03
13	Weinberg	1987	Article	21	M	Random	Con	Both	Yes	Simple	420	Yes/No	all activities	Novice	AN- CSAI	30	0.38
13		1987	Article	21	M	Random	Con	Both	Yes	Simple	840	Yes/No	all activities	Novice	AN- CSAI	30	0.62
13		1987	Article	21	M	Random	Con	Both	Yes	Simple	420	Yes/No	all activities	Novice	AN- CSAI	30	0.61
13		1987	Article	21	M	Random	Con	Both	Yes	Simple	840	Yes/No	all activities	Novice	AN- CSAI	30	0.66
15	Johnston	1991	Article	21.2	F	Random	Con	Both	No	Multi	175	Yes	Golf Putt	Novice	An-Stress	30	-0.64
15		1991	Article	21.2	F	Random	Con	Both	No	Multi	175	Yes	Golf Putt	Novice	An- Stress	30	-0.58
16	Crocker	1988	Article	17	F	Non	Con	Both	Yes	Multi	480	Yes	Volleyball	Adv.	AN-CSAI (COG)	13	-0.30
17	Gould	1980	Article	21	M	Non	Con	Int.	Yes	Simple	1.6	No	Leg Strength	Novice	AN- STAI	30	-0.60
17		1980	Article	21	M	Non	Con	Ext.	Yes	Simple	1.6	No	Leg Strength	Novice	AN- STAI	30	-0.62
17		1980	Article	21	F	Non	Con	Ext.	Yes	Simple	1.6	No	Leg Strength	Novice	AN- STAI	30	-0.62
18		1980	Article	21	M	Random	Con	Ext.	Yes	Simple	1.6	No	Leg Strength	Novice	AN- STAI	20	0.00
18		1980	Article	21	F	Random	Con	Ext.	Yes	Simple	1.6	No	Leg Strength	Novice	AN- STAI	20	0.75
18		1980	Article	21	M	Random	Con	Ext.	Yes	Simple	1.6	No	Leg Strength	Novice	AN-Thayer	20	-0.88
18		1980	Article	21	F	Random	Con	Ext.	Yes	Simple	1.6	No	Leg Strength	Novice	AN-Thayer	20	-0.72
19	Zervas	1987	Article	28.5	M &F	Non	Con	Both	Yes	Multi	480	Yes	Archery	Elite	AN- CSAI (COG)	18	-0.62
21	Speck	1990	Article	22	M & F	Random	Con	Both	Yes	Simple	180	Yes	Injections	Novice	An- STAI	26	-1.00
22	Dean	1987	Thesis	21	F	Non	Con	-	-	-	-	-	Running	Adv.	An-STAI	100	0.23
22		1987	Thesis	21	F	Non	Con	-	-	-	-	-	Running	Adv.	An-STAI	20	0.15
22		1987	Thesis	21	F	Non	Con	-	-	-	-	-	Running	Adv.	An-STAI	97	0.22

22		1987	Thesis	21	F	Non	Con	-	-	-	-	-	Running	Adv.	An-STAI	100	0.55
25	Marinakis	1988	Thesis	15.4	M	-	Con	Both	-	Multi	180	Yes	Free Throw	Inter.	AN- CSAI (cog)	68	0.03
25		1988	Thesis	15.4	M	Non	Corr.	Both	-	Multi	180	Yes	Free Throw	Inter.	CSAI (AN)	29	-0.37
26	Armstrong	1985	Thesis	9.5	M & F	Random	Con	Ext.	Yes	Simple	10	Yes	Pegboard	Novice	AN- Fear Thermometer	18	-0.06
26		1985	Thesis	9.5	M & F	Random	Con	Int.	Yes	Simple	10	Yes	Pegboard	Novice	AN- Fear Thermometer	18	-0.71
26		1985	Thesis	9.5	M & F	Random	Con	Ext.	Yes	Simple	10	Yes	Pegboard	Novice	AN- STAI (*)	18	-0.52
26		1985	Thesis	9.5	M & F	Random	Con	Int.	Yes	Simple	10	Yes	Pegboard	Novice	AN- STAI (*)	18	-0.51
31	Machlus	1986	Thesis	17	M	Random	Con	Both	Yes	Multi	120	Yes	Long Distance	Inter.	AN- SCAT	58	-0.19
32	Lohr	1998	Article	20	M & F	Non	Con	Both	Yes	Multi	900	Yes	All Types	Adv.	AN- SCAT	36	-1.00
34	Thompson	1981	Thesis	9	M & F	Random	Con	Int.	No	Simple	280	Yes	Pegboard	Novice	AN- STAIC	32	-0.51
39	Ryska	1998	Article	41	M & F	Non	Corr.	Ext.	n/a	Simple	n/a	Yes	Tennis	Inter.	CSAI-2 (COG)	186	-0.32
40	Cogan	1995	Article	19	F	Non	Con	Ext.	Yes	Simple	60	Yes	Gymnastics	elite	CSAI-2 (COG)	28	-0.94
42	Vadocz	1997	Article	15	M & F	Non	Corr.		n/a		n/a	n/a	Roller Skating	Elite	CSAI-2 (COG)-IM KIN	54	-0.31
42		1997	Article	15	M & F	Non	Corr.		n/a		n/a	n/a	Roller Skating	Elite	CSAI-2 (COG)- IM VIS	54	-0.05
42		1997	Article	15	M & F	Non	Corr.		n/a		n/a	n/a	Roller Skating	Elite	CSAI-2 (COG)-CS	54	0.15
42		1997	Article	15	M & F	Non	Corr.		n/a		n/a	n/a	Roller Skating	Elite	CSAI-2 (COG)-CG	54	0.21
42		1997	Article	15	M & F	Non	Corr.		n/a		n/a	n/a	Roller Skating	Elite	CSAI-2 (COG)-MS	54	0.16
42		1997	Article	15	M & F	Non	Corr.		n/a		n/a	n/a	Roller Skating	Elite	CSAI-2 (COG)-MG-M	54	-0.16
42		1997	Article	15	M & F	Non	Corr.		n/a		n/a	n/a	Roller skating	Elite	CSAI-2 (COG)-MG-A	54	0.26
45	Yanuskiewicz	1987	Thèse	21	F	Random	Con	_	yes	Simple	1	No	seringe	Novice	SUDS-An	5	0.56
45		1987	Thèse	23	F	Random	Con	_	yes	Simple	1	No	seringe	Novice	SUDS-An	5	0.25

IM_+AN

Study#	Author	Year	Publication	Age	Gender	Assign	Design	M style	mani	IM type	total mins.	relax	activity	ability	Test	"n"	corrected"r"
13	Weinberg	1987	Article	21	M	Random	Con	Both	Yes	Simple	420	Yes/No	all activities	Novice	AN- CSAI	30	0.89
13		1987	Article	21	M	Random	Con	Both	Yes	Simple	840	Yes/No	all activities	Novice	AN- CSAI	30	0.87
13		1987	Article	21	M	Random	Con	Both	Yes	Simple	420	Yes/No	all activities	Novice	AN- CSAI	30	0.21
13		1987	Article	21	M	Random	Con	Both	Yes	Simple	840	Yes/No	all activities	Novice	AN- CSAI	30	0.33
31	Machlus	1986	Thesis	17	M	Random	Con	Both	Yes	Multi	120	Yes	Long Distance	Inter	AN- SCAT	62	-0.37
23	Anshel	1993	Article	23.8	M & F	Random	Con		Yes	Simple	2	Yes	Tennis Serv.	Adv.	AN- (CAS)	28	-1.00
23		1993	Article	23.8	M & F	Random	Con		Yes	Simple	2	Yes	Tennis Serv.	Adv.	AN-(CAS)	28	-1.00

SCs_PER

Study#	Author	Year	Publication	Age	Gender	Assign	design	IM style	IM type	total mins.	relax	activity	ability	Test	"n"	corrected"r"
25	Marinakis	1988	Thesis	15.4	M	Non	Corr.	Both	Multi	180	Yes	Free Throw	Inter.	Con-Perf	22	0.08
25		1988	Thesis	15.4	M	Non	Corr.	Both	Multi	180	Yes	Free Throw	Inter.	Con-Perf	22	0.08
25		1988	Thesis	15.4	M	Non	Corr.	Both	Multi	180	Yes	Free Throw	Inter.	Con-Perf	29	0.13
25		1988	Thesis	15.4	M	Non	Corr.	Both	Multi	180	Yes	Free Throw	Inter.	Con-Perf	29	0.22
42	Vadocz	1997	Article	15	M&F	Non	Corr.	n/a	Simple	n/a	no	Roller Skating	Elite	CSAI-PER	54	0.03

SE_PER

Study#	Author	Year	Publication	Age	Gender	Assign	Design	Imagery -style	mani	Imagery type	total mins.	relax	type	ability	Test	'n'	Corrected"r"
2	Woolfolk	1985	Article	20.5	M	Random	Corr.	Ext.	Yes	Simple	25	No	Golf	Novice	SE-Perf	50	0.27
9	Feltz	1990	Article	20.5	M & F	Random	Corr.	n/a	Yes	Simple	20	No	Phant chair	Novice	SE-Perf	115	0.52
9		1990	Article	20.5	M & F	Random	Corr.	n/a	Yes	Simple	20	No	Phant chair	Novice	SE-Perf	115	0.34
9		1990	Article	20.5	M & F	Random	Corr.	n/a	Yes	Simple	20	No	Phant chair	Novice	SE-Perf	115	0.62
37	Kavanagh	1986	Article	20	M & F	Non	Corr.	Ext.	Yes	Simple	13	Yes	Dynamometer	Novice	SE-Perf	48	0.64
37		1986	Article	20	M & F	Non	Corr.	Ext.	Yes	Simple	13	Yes	Dynamometer	Novice	SE-Perf	48	0.67
37		1986	Article	20	M & F	Non	Corr.	Ext.	Yes	Simple	13	Yes	Dynamometer	Novice	SE-Perf	48	0.73
37		1986	Article	20	M & F	Non	Corr.	Ext.	Yes	Simple	7	Yes	Push ups	Novice	SE-Perf	36	0.49
37		1986	Article	20	M & F	Non	Corr.	Ext.	Yes	Simple	7	Yes	Push ups	Novice	SE-Perf	36	0.50
37		1986	Article	20	M & F	Non	Corr.	Ext.	Yes	Simple	7	Yes	Push ups	Novice	SE-Perf	36	0.52

AR-_PER

Study#	Author	Year	Publication	Age	Gender	Assign	Design	IM style	mani	IM style	total mins.	relax	type	ability	"n"	corrected"r"
6	Murphy	1988	Article	20.5	M	Random	Corr	Int.	No	Simple		Yes	Dyna.	Novice	24	0.11
13	Weinberg	1987	Article	21	M	Random	Con	Both	Yes	Simple	420	Yes/No	Karate (sk)	Novice	30	0.55
13		1987	Article	21	M	Random	Con	Both	Yes	Simple	840	Yes/No	Karate (sk)	Novice	30	0.63
13		1987	Article	21	M	Random	Con	Both	Yes	Simple	420	Yes/No	Karate(com)	Novice	30	0.28
13		1987	Article	21	M	Random	Con	Both	Yes	Simple	840	Yes/No	Karate(com)	Novice	30	0.90
13		1987	Article	21	M	Random	Con	Both	Yes	Simple	420	Yes/No	Karate(spa)	Novice	30	0.32
13		1987	Article	21	M	Random	Con	Both	Yes	Simple	840	Yes/No	Karate(spa)	Novice	30	0.25
13		1987	Article	21	M	Random	Con	Both	Yes	Simple	420	Yes/No	Sit-Ups	Novice	30	-0.89
13		1987	Article	21	M	Random	Con	Both	Yes	Simple	840	Yes/No	Sit-Ups	Novice	30	-0.61
13		1987	Article	21	M	Random	Con	Both	Yes	Simple	420	Yes/No	Wall-Kick	Novice	30	0.73
13		1987	Article	21	M	Random	Con	Both	Yes	Simple	840	Yes/No	Wall-Kick	Novice	30	0.56
31	Machlus	1986	Thesis	17	M	Non	Corr.	Both	Yes	-	-	-	100 Meter	Inter.	4	0.84
31		1986	Thesis	17	M	Non	Corr.	Both	Yes	-	-	-	3200 Meter	Inter.	6	0.52

AR+_PER

Study#	Author	Year	Publication	Age	Gender	Assign	Design	IM style	mani	IM type	total mins.	relax	type	ability	"n"	corrected"r"
6	Murphy	1988	Article	20.5	M	Random	Corr.	Int.	No	Simple		No	Dyna.	Novice	24	0.21
13	Weinberg	1987	Article	21	M	Random	Con	Both	Yes	Simple	420	Yes/No	Karate (sk)	Novice	30	0.92
13		1987	Article	21	M	Random	Con	Both	Yes	Simple	840	Yes/No	Karate (sk)	Novice	30	-0.98
13		1987	Article	21	M	Random	Con	Both	Yes	Simple	420	Yes/No	Karate(com)	Novice	30	0.89
13		1987	Article	21	M	Random	Con	Both	Yes	Simple	840	Yes/No	Karate(com)	Novice	30	0.83
13		1987	Article	21	M	Random	Con	Both	Yes	Simple	420	Yes/No	Karate(spa)	Novice	30	-0.65
13		1987	Article	21	M	Random	Con	Both	Yes	Simple	840	Yes/No	Karate(spa)	Novice	30	-0.83
13		1987	Article	21	M	Random	Con	Both	Yes	Simple	420	Yes/No	Sit-Ups	Novice	30	-0.87
13		1987	Article	21	M	Random	Con	Both	Yes	Simple	840	Yes/No	Sit-Ups	Novice	30	-0.84
13		1987	Article	21	M	Random	Con	Both	Yes	Simple	420	Yes/No	Wall-Kick	Novice	30	0.37
13		1987	Article	21	M	Random	Con	Both	Yes	Simple	840	Yes/No	Wall-Kick	Novice	30	0.39
33	Murphy	1985	Thesis	20	M	Non	Con	Int.	Yes	Simple	4	No	Strength	Novice	24	0.56
42	Vadocz	1997	Article	15	M & F	Non	Corr.	Both	n/a	-	n/a	n/a	Roller Skating	Elite	54	0.14

AN+_PER

Study #	Author	Year	Publication	Age	Gender	Assign	Design	IM style	mani	Im type	relax	Activity	ability	Test	"n"	Corrected "r"
6	Murphy	1988	Article	20.5	M	Random	Corr.	Int.	No	Simple	Yes	Dyna.	Novice	STAI	24	-0.22
6		1988	Article	20.5	M	Random	Corr.	Int.	No	Simple	Yes	Dyna.	Novice	STAI	24	-0.11
6		1988	Article	20.5	M	Random	Corr.	Int.	No	Simple	No	Dyna.	Novice	STAI	24	0.02
6		1988	Article	20.5	M	Random	Corr.	Int.	No	Simple	No	Dyna.	Novice	STAI	24	-0.24
6		1988	Article	20.5	M	Random	Corr.	Int.	No	Simple	Yes	Dyna.	Novice	STAI	24	-0.33
6		1988	Article	20.5	M	Random	Corr.	Int.	No	Simple	Yes	Dyna.	Novice	STAI	24	-0.23
31	Machlus	1986	Thesis	17	M	Non	Corr.	Both	Yes	-	-	100 Meter	Inter.	Perf	12	-0.48
31		1986	Thesis	17	M	Non	Corr.	Both	Yes	-	-	3200 Meter	Inter.	Perf	14	-0.16
33	Murphy	1985	Thesis	20	M	Non	Con	Int.	Yes	Simple	No	Strength	Novice	AN-STPI	24	0.88
33		1985	Thesis	20	M	Non	Con	Int.	Yes	Simple	Yes	Strength	Novice	AR-STPI	24	0.59