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**THE EFFECTS OF IMAGERY AND BELIEF
ON QUADRICEPS MOTOR PERFORMANCE**

By

Patricia M. Mangan

B.S.P.T. University of Washington, 1989

Presented in partial fulfillment of the requirements

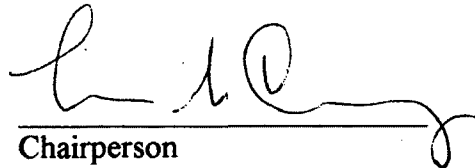
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1998

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Patricia M. Mangan, P.T., M.S., July 1998
Health and Human Performance-Exercise Psychology

The Effects of Imagery and Belief on Quadriceps Motor Performance

Director: Dr. Lewis A. Curry 

This study examined the effects of imagery and belief in imagery on concentric and eccentric quadriceps force production as measured by a Kin-Com isokinetic dynamometer over three consecutive weeks. Nineteen healthy female university students volunteered for this study and were divided into three groups: 1) imagery, 2) imagery + belief, and 3) control. Following week one baseline testing, groups 1 and 2 were instructed in imagery techniques and practiced an imagery script of the Kin-Com testing protocol for 3 to 5 minutes daily. Group 3 underwent a nonsense intervention and read selected articles daily. On week two, repeat isokinetic testing was performed. Group 2 underwent an intervention to promote belief in imagery, group 1 a second imagery intervention, and group 3 a second nonsense intervention. Groups 1 and 2 continued daily imagery, and group 3 daily reading. On week three, final isokinetic testing was performed. The Movement Imagery Questionnaire-Revised and a general questionnaire were administered to investigate imagery ability, belief in the imagery intervention, and spontaneous imagery by the control group. Two-way ANOVAs revealed a significant group by time interaction for average concentric force ($F = 2.75$, $p = 0.045$) and peak concentric force ($F = 2.91$, $p = 0.037$). Post-hoc Bonferroni t -tests showed a significant improvement in average concentric force for the imagery group between the first and third week ($t = 2.730$, $p = 0.017$); and the imagery + belief group between the first and second week ($t = 4.438$, $p = 0.0035$); and peak concentric force for the imagery + belief group between the first and second week ($t = 4.996$, $p = 0.002$); and the first and third week ($t = 3.465$, $p = 0.009$). No significant group by time interaction was found for average eccentric force ($F = 1.087$, $p = 0.379$) or peak eccentric force ($F = 1.578$, $p = 0.204$). Results of this study suggest that imagery is beneficial for improving concentric quadriceps motor performance. Promoting belief in imagery does not appear to be a necessary component for enhancing quadriceps force production.

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CHAPTER I

INTRODUCTION

Numerous cognitive strategies, including imagery, are commonly used to enhance physical performance. Imagery in sport and health care has been utilized in documented cases for the past century (Jastrow, 1892). Jacobson's historical studies (1930, 1932) investigated the effects of imagery on the neuromuscular system and found that mentally rehearsing a movement was shown to produce minute muscular contractions in appropriate muscle groups, as if the subject was actually performing the imagined movement. His work has prompted further research in assessing the efficacy of imagery in improving cognitive and physical performance.

A form of imagery which is characterized by the mental rehearsal of a physical performance is called mental practice (MP). MP is "the symbolic rehearsal of a physical activity in the absence of any gross muscular movements" (Richardson, 1967, p. 95). It involves symbolically executing a skill through visual imagery, internal dialogue, or a combination of these mental strategies. With regard to visual imagery, it may consist of performance imagery which involves mentally rehearsing the sequence of a performance or outcome imagery in which the specific outcome is imagined.

MP has been used extensively by 90-99% of elite athletes (Murphy, Jowdy, & Durtschi, 1989; Orlick & Partington, 1988). Despite its popularity in enhancing physical performance in sports, there have been few published studies on MP in the rehabilitation setting (Fansler, Poff, & Shepard, 1985; Warner & McNeill, 1988). Although the

majority of information has been anecdotal, studies of MP in the sport psychology literature involving the acquisition, retention, and improvement of motor skills provide a basis for future research in rehabilitation, including physical therapy.

There have been conflicting results in studies assessing the effects of MP on motor skill performance, specifically with regard to tasks involving quadriceps strength. Gould, Weinberg, and Jackson (1980) found that “psyching-up” was superior to imagery in increasing concentric quadriceps strength, although both were more effective than attentional-focus, cognitive distraction, or control rest. Wilkes and Summers (1984) examined the effects of five mental strategies on the “leg-kick task” and found significant improvement in quadriceps performance with the use of preparatory arousal and self-efficacy. However, imagery and attentional-focus were comparable to the control group.

Exploring the efficacy of MP in enhancing physical rehabilitation programs is warranted, and may provide an additional avenue in facilitating patient compliance (Green, 1992). There are numerous reasons why patients are noncompliant. In addition to insufficient knowledge of their presenting condition, noncompliant patients often lack intrinsic personal power. Specifically, these patients do not fully recognize or utilize their personal power, which results in decreased self-responsibility. These individuals in particular may benefit from a mind-body approach.

As health care professionals, we need to consider the psychological components of the rehabilitation process which can expedite or hinder patients’ recovery. In order for our patients to believe in their rehabilitation programs, we must be able to demonstrate that a particular method will be effective in achieving their goals (Duda, Smart, & Tappe, 1989). For imagery to be a useful adjunct, we must initially evaluate its effectiveness

clinically and functionally. If deemed acceptable, we need to communicate that information to our patients and promote belief in its benefits.

Since belief enhances commitment, which in turn provides direction and focus through active participation, patient motivation and compliance may increase. Theoretically, if patients consistently adhere to their rehabilitation programs, they would achieve greater functional outcomes. These outcomes would further heighten their intrinsic power and promote an attitude of self-responsibility regarding their health care.

THE PURPOSE

The purpose of this study is to determine if imagery, and belief in the imagery intervention will enhance quadriceps motor performance.

RESEARCH HYPOTHESES

Subjects instructed in imagery techniques will obtain higher average and peak isokinetic force values than subjects receiving nonsense interventions. Subjects instructed in imagery techniques and informed of the positive effects of imagery on motor performance will obtain higher average and peak isokinetic force values than subjects receiving only imagery interventions and subjects receiving nonsense interventions.

SIGNIFICANCE OF THE STUDY

Although the effectiveness of MP in enhancing motor performance has been supported by sport literature, there have been few published studies on MP in the rehabilitation setting. One of the reasons for the lack of transition of MP from the sport

arena to the medical field may be the difficulty in assessing its effectiveness in a quantitative manner. Although it is an inherent challenge to quantify conscious thought processes, exploring the efficacy of MP in simulated rehabilitation settings is warranted.

MP may prove to be a useful technique in the managed care environment as a cost-effective measure by potentially increasing patient motivation and compliance. The use of mastery rehearsal may improve the accuracy of motor skill execution, resulting in increased self-confidence through positive reinforcement (Moritz, Hall, Martin, & Vadocz, 1996), which also enhances motivation and compliance (Bull, 1991). Although MP cannot replace overt motor performance, it could be used when physical practice (PP) is not possible, as with traumatic injuries, fatigue (Weinberg, 1982), or as an adjunct when PP is limited by expense or time constraints.

DELIMITATIONS

This study will be delimited by the selection of subjects from a specific population, as all subjects will be college females with no history of knee injury and no current history of knee pain. Findings of this study will be limited to young, healthy females involved in recreational activities, and relating only to maximal strength performance.

This study will further be delimited by the standardized written imagery script given to the imagery and imagery + belief groups. The written script will be used to increase internal validity, but is a limitation, as imagery is a personalized experience and may incorporate other cognitive strategies such as “psyching-up” prior to an individual’s motor performance.

DEFINITIONS

Average Force: The amount of force generated by a muscle group measured in pounds.

Concentric Contraction: A shortening contraction of the muscle in which positive work is performed.

Continuous Mode: The warm-up mode for concentric and eccentric isokinetic testing, in which a concentric contraction is immediately followed by a eccentric contraction, as opposed to actual testing which involves isolated concentric and eccentric contractions.

Eccentric Contraction: A lengthening contraction of the muscle in which negative work is performed.

Motor Performance: An individual's maximal force values for the quadriceps muscle group measured concentrically and eccentrically by the Kin-Com.

Overlay Curves: The three, most consistent, maximal force curves (overlay) produced concentrically and eccentrically during isokinetic testing.

Peak Force: The amount of force generated by a muscle group measured in pounds.

CHAPTER II

REVIEW OF LITERATURE

Theories of Mental Practice

The four primary theories of MP are the neuromuscular theory, the attention-arousal theory, the symbolic theory, and the bioinformational theory (Suinn, 1993). The neuromuscular theory proposes that visual imagery produces neuromuscular efferent patterns which are identical in timing and activation of appropriate muscle groups, although at a lower intensity, when compared with actual physical movement of the imagined activity. In theory, MP results in low-gain muscle activity recorded by electromyography (EMG) (Jacobson, 1930, 1932), which provides visual and kinesthetic feedback to the motor cortex, strengthening the motor schema, thereby enhancing subsequent motor performance. Although this theory is commonly cited, including non-sport MP studies (Fansler et al., 1985; Warner & McNeill, 1988), there have been few controlled studies (Feltz & Landers, 1983), and may be the result of “muscle priming” in anticipation of movement according to the arousal-attention theory (Schmidt, 1982; Vealey, 1987).

However, studies performed after Feltz and Landers’ 1983 meta-analysis have reinforced the neuromuscular theory. Harris and Robinson’s (1986, p. 109) EMG studies noted that “significantly greater increases in the right deltoid activity were observed during imagery” of lateral arm raises. Jowdy and Harris (1990) reported significant increases in biceps EMG activity during imagery rehearsal of juggling, which were consistent with Hale’s (1982) earlier finding of increased biceps EMG activity when

weight lifters were instructed to visualize lifting a 25-pound dumbbell. Recent neurological studies have found that MP and actual task execution activate similar areas in the cerebral cortex (Decety, 1996; Roth, Decety, Raybaudi, Massarelli, Delon-Martin, Segebarth, Morand, Gemegnani, Decorps, & Jeannerod, 1996; Sirigu, Cohen, Duhamel, Pillon, Dubois, Agid, & Pierrot-Deseilligny, 1995). The supplementary motor area and cerebellum are also active during MP, but the regions of activation differ from those elicited during actual movement (Grafton, Arbib, Fadiga, & Rizzolatti, 1996).

The attention-arousal theory suggests that peak performance is dependent on obtaining a state of maximal arousal and attention, and that imagery provides an avenue to achieve this focused state (Hecker & Kaczor, 1988). Studies assessing the effect of arousal and relaxation on grip strength (Murphy, Woolfolk, & Budney, 1988) and on track sprinters' starts (Machlus & O'Brien, 1988) failed to support the arousal theory, as the use of arousal combined with imagery failed to enhance performance. However, it was effective in improving isokinetic quadriceps endurance and "phantom chair" duration (wall sits measuring isometric quadriceps endurance) when subjects were told their performance was substandard to a confederate's proposed performance (Feltz & Riessinger, 1990).

The symbolic learning theory (Morrisett, 1956; Sackett, 1934) proposes that MP enhances overt performance as it provides an avenue for the learner to rehearse the sequence of movement through the symbolic components (those which can be expressed verbally) of an activity as opposed to the nonsymbolic components (perceptual-motor). With continued MP of the symbolic components in combination with actual practice of the task, mental rehearsal facilitates the learning of new motor skills. The symbolic

learning theory coincides with the conclusion that MP is more effective in cognitive tasks versus motor and strength tasks (Schmidt, 1982), and with motor tasks that have a large cognitive component (Feltz & Landers, 1983; Minas, 1978; Morrisett, 1956; Ryan & Simons, 1981; Suinn, 1993; Wrisberg & Ragsdale, 1979). Modeling is another component of symbolic learning via observation (Bandura & Jefferies, 1973), which can be demonstrated through the use of videotapes. Although sample sizes were small, Gray (1990) assessed the efficacy of MP and modeling by using videotapes in beginning racquetball, as did Hall and Erffmeyer (1983) with basketball foul shooting. Both studies suggested that the combination of MP and modeling produced greater improvement of performance than with MP alone.

The bioinformational theory (Lang, 1977, 1979, 1985) proposes that imagery activates a series of stimulus and response propositions, which are stored in the brain's long-term memory. Stimulus propositions include the physical characteristics of a stimulus such as the texture of sports equipment. Response propositions include the physiological and motor aspects of the movement, including kinesthetic awareness. Imagery rehearsal facilitates appropriate pairing of the stimulus and response propositions.

Based on the bioinformational theory, internal imagery, in which an individual visualizes themselves actually performing the motor task from an internal perspective (first person visual and kinesthetic), would be primarily a response proposition. Due to this kinesthetic component, internal imagery would enhance motor performance more than external imagery (third person visual) (National Research Council, 1988, p. 238), which is supported by the findings of increased EMG activity with internal imagery

(Harris & Robinson, 1986). This is consistent with studies reporting more frequent use of internal imagery by elite athletes (Doyle & Landers, 1980; Hale, 1982; Mahoney & Avener, 1977), although other studies report athletes using a combination of internal and external imagery (Epstein, 1980; Jowdy & Harris, 1990). The use of internal versus external imagery may be skill dependent, with an internal perspective being more beneficial for beginners and an external perspective for skilled athletes in error assessment (Suinn, 1984), concentration, and confidence enhancement (Murphy et al., 1989). In contrast, according to the modeling theory, beginners may find it beneficial for to utilize external imagery as they may not be able to incorporate ideal kinesthetic awareness due to inexperience.

Mental Practice Studies

The literature on MP primarily examines the effects of imagery on performance by comparing results of various groups including PP alone, MP alone, combinations of PP and MP, and control groups. Numerous research variables are applied in the studies with variations of the type of MP, duration of MP, number of trials of MP, sequence of MP application in relation to PP, and ratio of PP to MP. The inconsistent combination of these variables as well as other methodological flaws are noted as factors when questioning the efficacy of MP (Feltz & Landers, 1983).

Weinberg (1982) reviewed 27 studies on MP and concluded that PP and MP combined is better than PP or MP alone, that PP is better than MP, and that individuals must possess a minimal proficiency for the motor skill being imagined for MP to be effective. Feltz and Landers (1983) performed a meta-analysis of MP which consisted of

statistically analyzing numerous individual studies to make general conclusions on the efficacy of MP. The meta-analysis included 60 studies of MP versus placebo, with the conclusion that “mentally practicing a motor skill influences performance somewhat better than no practice at all” (Feltz & Landers, 1983, p. 25) and that “mental practice effects are primarily associated with cognitive-symbolic rather than the motor elements of the task” (Feltz & Landers, 1983, p. 45-46).

The 146 effect sizes in Feltz and Landers' (1983) meta-analysis produced an overall effect size for MP of 0.48 (equivalent to half a standard deviation). There were increased effect sizes for studies involving cognitive tasks versus motor tasks including strength, which is consistent with the symbolic learning theory (Sackett, 1934). Although MP was effective in the early and later stages of motor learning, the effects may be task specific. However, no gender or age differences were noted. The larger effects were noted when MP was performed for at least 10 minutes and at least 20 sessions, and when post-tests were conducted at a later time rather than immediately after MP techniques were instituted. In contrast, a more recent study by Etnier and Landers (1996), investigating procedural variables concluded that subjects who received 1 or 3 minutes of MP improved more with basketball perimeter shooting than those receiving 5 or 7 minutes of MP, or when compared to the control group.

In 1984, by request of the Army Research Institute, the Committee on Techniques for the Enhancement of Human Performance was established to evaluate the efficacy of mental techniques with regard to learning and improving cognitive and motor skills. The committee consisted of 14 members appointed by the National Academy of Science

based on their expertise in the area of human performance. The committee's conclusions were:

- 1) MP is effective in enhancing motor skill performance by approximately half a standard deviation improvement over controls (NRC, 1988, p.70).
- 2) The larger the cognitive component of the motor skill, the greater the effect of MP (NRC, 1988, p. 70).
- 3) Vivid imagery including kinesthetic imagery was the most beneficial form of imagery for improving performance (NRC, 1988, p. 238).

The committee recommended future research in assessing the effectiveness of motor skill learning and retention based on different ratios of combined PP and MP such as 60:40 versus 70:30 ratios. They also suggested that it would be appropriate for the control group to participate in the same number of sessions as the MP and PP groups, practicing a non-relevant activity. This would decrease the Hawthorne Effect which has been cited as a potential methodological flaw in other studies (Drew, 1976).

Feltz, Landers, and Becker (NRC, 1988) performed a similar review of the same studies reviewed in 1983 and 14 additional studies using updated meta-analysis techniques. The studies involved primarily gross motor skills including dart throwing, basketball foul shooting, and golf shots. They concluded that PP resulted in the largest effect size of 0.79, followed by a combination of PP and MP (0.62), MP alone (0.47), which was comparable to the previously noted 0.48 (by Feltz and Landers (1983), and the control group with an effect size of 0.22 standard deviations.

Imagery and Motivation

No experimental research has been conducted on the efficacy of imagery as a motivational technique to increase the frequency and accuracy of overt motor skill performance. However, Paivio (1985) purports that MP influences behavior through cognitive and motivational mechanisms. This is consistent with the previously noted conclusion that MP is more effective in enhancing the cognitive aspect of the motor task. The motivational component of MP involves reducing anxiety and improving concentration, thereby increasing self-confidence and the resultant performance. Paivio also suggested that achievement and goal-related imagery would motivate an athlete to practice motor skills through the positive reinforcement of the visualized success.

Pre-Performance Routines, Visual Motor Behavior Rehearsal, and Belief

The majority of research on cognitive-behavioral interventions in sport have been conducted in contrived settings, or at best, in practice rather than game situations. However, the most crucial moments of sport performance is the few seconds immediately before the execution of a motor skill (Gould et al., 1980; Mahoney & Avener, 1977; Suinn, 1977). A form of MP commonly used by successful elite athletes to enhance motor skills are pre-performance routines (PPRs). PPRs have also been effective with beginners in learning specific motor tasks (NRC, 1991, p. 218). PPRs consist of “a set pattern of cue thoughts, actions, and images consistently carried out before performance of a skill” (Crews & Boutcher, 1986b, p. 291).

PPRs have been found to be effective in various sports including golf (Crews & Boutcher, 1986a, 1986b) and basketball free throw shooting (Lobmeyer & Wasserman,

1986). The MP aspects of the PPRs in these studies included focusing on the target, pre-shot rituals, verbal cues, visualizing the in-flight trajectory, and kinesthetic awareness of ideal execution of the shot.

The key to successful use of PPRs is proper training in the technique which enhances performance by prompting the athlete to completely focus on the mental routine, which facilitates consistent performances via automatic execution without mental interference, as “it is the mental interference which diverts the message sent from the brain to the muscles” (Vernacchia, McGuire, & Cook, 1996, p. 83). Vernacchia et al’s four-step MP routine consists of observation, strategy, visualization, and belief, which are part of two distinctly different strategies: mastery rehearsal and mental toughness routines.

Mastery rehearsal involves writing a script of the imagined perfect performance which includes every activity occurring the day of the event. It is recorded on audio-cassette tape in the athlete’s own voice and their preferred background music. The tape is 3 to 5 minutes duration and contains positive affirmations, in addition to the day’s itinerary, including the environmental factors of the performance setting. The athlete listens to it several times a day in attempt to promote belief in the visualized ideal performance.

Mental toughness routines are designed to prepare the athlete for potentially distracting factors which may diminish performance, by mentally rehearsing the most appropriate responses to the anticipated contingencies. The composition of the technique is similar to the script, tape, and utilization of the mastery rehearsal technique. Mastery rehearsal and mental toughness routines are designed to enhance performance by

heightening concentration and focus, which is consistent with the arousal-activation theory (Schmidt, 1982).

A specialized method of MP that is closely related to PPRs is visual motor behavior rehearsal (VMBR). VMBR is a standardized approach consisting relaxation followed by MP which attempts to incorporate a multi-dimensional image resembling those experienced in a dream, however, the athlete has conscious control of the entire event (Suinn, 1984). Although the majority of literature on VMBR is based on case reports and single subject design (Furlong, 1979; Lazarus, 1977; Nicklaus, 1974; Schleser, Meyers, & Montgomery, 1980; Titley 1976), the experimental studies using VMBR were found to eliminate or reduce erroneous cognitive responses such as inferior competitive thoughts (Gravel, Lemieux, & Ladouceur, 1980).

Factors influencing VMBR are the motor skill level and imagery ability of the performer, the task specific demands, and the length and content of the imagery. For instance, the literature suggests that repeated trials are the most beneficial (Weinberg, Seabourne, & Jackson, 1982), providing an opportunity to improve the learning curve of both the required motor task and the subject's imagery ability. Unskilled participants using VMBR may experience decreased performance (Noel, 1980), confirming that VMBR is a learned skill which requires careful instruction.

Belief

Self-responsibility and patient compliance is strongly influenced by belief. Not only does belief affect a patient's decision to participate in an exercise rehabilitation program, but it fosters ongoing commitment to program adherence. Health care

professionals attempting to enhance patient belief may find it beneficial to examine the literature on the placebo effect, or “faith in action” (Siegel, 1989). The placebo can be in the form of a pill, liquid, medical procedure, or in the health care practitioner administering the treatment (Hafen, 1996). Belief, which includes the placebo effect, has been shown to be effective in abolishing or reducing: pain, rheumatoid arthritis, cancer tumors, high blood pressure, high cholesterol, angina, ulcers, nausea, vomiting, constipation, skin rashes, headaches, hay fever, stress, insomnia, depression, panic attacks, schizophrenia, and the common cold. (Benson, 1984; Benson & Epstein, 1975; Dossey, 1991; Fox & Fox, 1988; Pearsall, 1987).

The power of the placebo effect varies with different diagnoses. The placebo effect has been found to decrease joint tenderness in 22 percent of patients with rheumatoid arthritis, provide significant pain relief in 33 percent of patients with severe pain, and reduce angina attacks by 82 to 93 percent (Hunt, 1991).

A profound example of belief is illustrated by a landmark case study in 1950, in which a patient with late stage lymphoma was treated with the drug Krebiozen (Hafen, Karren, Frandsen, & Smith, 1996). Krebiozen was heralded as a cure for cancer, and the patient requested that it be incorporated into his treatment. Within two days of receiving his first dosage, the large tumors throughout his body were “melting like snowballs”. Within 10 days, the cancer had been abolished, and he was released from the hospital.

A few months after his discharge, the patient read in a newspaper article that the drug was a farce, and his tumors returned. His physician recognized the patient’s strong sense of belief, and convinced him that the newspaper article was inaccurate. He told the patient that an improved, more potent form of Krebiozen was available and recommended

that the patient resume its usage. The patient agreed and was given distilled water in lieu of the drug. Within days, his tumors had once again disappeared. Three months after his second miraculous recovery, the patient read another newspaper article published by the American Medical Association denounced any cancer-curing effects of Krebiozen. The patient was immediately readmitted to the hospital as the tumors had returned and were progressing at an alarming rate. The patient's faith had been destroyed, and within 2 days of reading the article, he died.

Belief and Patient Compliance

Patient compliance is of utmost importance in the rehabilitation process. Over 200 factors are related to patient compliance (Sluijs, Kok, & van der Zee, 1993; van Campen & Sluijs, 1989), including motivation, the patient-practitioner relationship, and health beliefs (Merrill, 1994). Providing quality patient education is of paramount importance in promoting patient compliance. Patients who receive thorough information about their health status and the planned treatment approach demonstrate increased motivation and compliance, thereby achieving greater functional outcomes (Frank, 1978; Rimer, Glanz, & Lerman, 1991).

When a patient involved in an exercise rehabilitation program is not progressing as expected, initially the outlined program is assessed to ensure that all appropriate techniques have been utilized. If the proper treatment approach has been employed, patient motivation is then addressed. Specifically, noncompliance is suspected, as up to one third of patients do not follow physician advice (Becker & Maiman, 1975). A critical component of motivation and subsequent compliance is a patient's belief in the health

care provided (Dossey, 1991). Another critical component is the rehabilitation program's ability to provide an adequate avenue to achieve optimal recovery (Caplan, 1979).

Motivation, Belief, and Compliance

“Motivation ... is the psychological force that drives us to perform well” (Vernacchia et al., 1996, p. 61). The Health Needs Model assists in establishing a hypothesis in how motivation contributes to patient compliance (Caplan, 1979). The model investigates the relationships among the patient's subjective need for improved health, motivation to respond, and the conscious and unconscious responses to the perceived need for improved health.

The motivation to respond component of the Health Needs Model consists of the expectancy and belief that the effort expended will be adequate to achieve the desired outcome. The patient's response to the perceived health need includes unconscious psychological and physiological defenses, as well as conscious behavioral and cognitive coping strategies. The defenses and strategies employed by the patient affect adherence to the rehabilitation program. Discrepancies arise if the patient's perceived health need does not correspond with the medical diagnosis. This may be the result of poor patient education provided by the health care practitioner, or the patient's lack of belief that an actual health need exists.

The Health Needs Model assists the health care professional in identifying potential motivational factors which may be responsible for patient noncompliance. The underlying factor in the motivation to respond component is the patient's belief that they possess or have access to adequate resources to effectively address the perceived health

need. Since this is the initial step in program compliance, it is extremely important that the health care professional create an environment conducive to establishing satisfactory patient rapport.

Implicit in establishing patient rapport is patient education. Patient education must consist of a thorough explanation of the pathology, benefits of the rehabilitation program, and potential risks of nonadherence to the outlined program. Patients must be given the opportunity to ask for additional information and to voice concerns regarding perceived and actual barriers which compromise their ability to adhere to the proposed program. Sensitivity to cultural differences and corresponding values which may influence compliance should also be addressed. These factors should be considered in the initial stage and throughout the rehabilitation process. Once these measures have been taken, a specific treatment plan and consensual goals must be established.

A second motivational model which examines patient compliance is the Intention-Behavior Model (Fishbein & Ajzen, 1975). This model illustrates how patient belief provides the foundation for resultant attitudes, intentions, and behaviors. This model has been applied specifically to health beliefs and patient attitudes (DiMatteo & DiNichola, 1982). The advantage of this model is that it readily incorporates the influence of the health care practitioner at an early stage. However, this model is based on a one-time behavior modification versus the commitment often required of patients to make enduring lifestyle changes in the rehabilitation process.

Although the Health Needs Model and the Intention-Behavior Model provide a conceptual framework in identifying motivational factors contributing to patient compliance, they do not illustrate the elements required to progress from intention to

actual behavior. An important aspect to consider is the patient's and the practitioner's ability to recognize and facilitate resolution of barriers which may impede the transition from intention to actual behavior.

The Health Care Professional and Belief

Health care professionals play a vital role in enhancing patients' internalization of their rehabilitation programs (Cousins, 1989; Cousins, 1979), specifically by influencing patients through persuasion and trust (DiMatteo & DiNichola, 1982). Successful persuasion is based upon four characteristics of the health care practitioner including: 1) level of expertise; 2) the ability to communicate genuine warmth and concern; 3) confidence and enthusiasm in the suggested treatment plan; and 4) trustworthiness. These four characteristics are fundamental in establishing an optimal patient-practitioner relationship. The result of an optimal relationship has been shown to enhance patient belief and strongly affect functional outcomes (Dossey, 1993; Ornstein & Sobel, 1987; Siegel, 1989; Spiro, 1991; Williams & Keefe, 1991; Wilson, 1995).

Health care professionals' belief in the proposed treatment and their ability to communicate that information in an optimistic manner is an essential factor in cultivating patient belief. This is clearly demonstrated in the scenario in which two oncologists used the same drugs, dosage, schedule, and criteria for treating patients with metastatic lung disease. One physician noted a 22 percent positive response rate while the other obtained a 74 percent positive response rate. The less successful oncologist requested an explanation from his colleague regarding the outcome. The successful oncologist, William M. Bucholtz, M.D., attributed his success to the differences in explanatory style:

We're both using Etoposide, Platinol, Oncovin, and hydroxyurea. You call yours EPOH. I tell my patients I'm giving them HOPE. Sure, I tell them this is experimental, and we go over the long list of side effects together. But I emphasize that we have a chance. As dismal as the statistics are for non-small cell, there are always a few percent who do really well (Cousins, 1989, p. 99).

Well-informed patients gain intrinsic personal power through increased knowledge of their condition and awareness of options. Informed patients are able to make the most favorable decisions regarding their treatment. Increased knowledge and intrinsic power promotes patient belief in treatment, and enhances patient commitment to the rehabilitation program via self-responsibility. Their increased compliance facilitates achievement of the proposed goals, which further heightens self-efficacy, performance, intrinsic power, and self-responsibility. As success is reinforced in patients' rehabilitation programs, intrinsic power, self-efficacy, and self-responsibility regarding their overall health should also increase.

CHAPTER III

METHODOLOGY

Subjects

The subjects involved in this study consisted of 19 female University of Montana students between 18 and 26 years of age (mean 21.8 years) pursuing undergraduate or graduate degrees in Pre-Physical Therapy and/or Health and Human Performance. Subjects were recruited by announcements made via professors in the Health and Human Performance classes, and Anatomy and Physiology undergraduate classes. The potential subjects were recreational athletes with no previous history of knee injury. Upon voluntary agreement to participate in the study, potential subjects were interviewed regarding their current and past knee history and relevant medical history (Appendix A). Potential subjects were not asked to participate if they had a past history of knee injury or any knee pain within the past five years pertaining to the knee to be tested. A University of Montana and St. Patrick Hospital IRB-approved informed consent was obtained (Appendix B).

Subjects were asked to continue with their usual recreational sport activities, but to avoid initiating any new training programs including lower extremity strengthening. They were instructed to refrain from physical activity for 48 hours prior to the three trials of isokinetic testing.

Subjects were randomly assigned to a control group (n=6), imagery group (n=7) or an imagery + belief group (n=6). Initially 18 subjects were recruited. However, to account for attrition and potential knee pain during testing, three additional subjects were

recruited for each group. Two of those subjects were dropped prior to the study during the practice session two days prior to baseline testing, as one was unable to attend due to personal obligations, and the other experienced knee pain during the eccentric mode.

Instruments

Quadriceps muscle strength was the motor task measured in this study because it is a commonly recruited muscle group in a variety of activities of daily living. Specifically, the majority of functional movements controlled by the quadriceps such as descending stairs and going from a standing to sitting position involves an eccentric contraction. However, since quadriceps strength has been commonly assessed concentrically, both concentric and eccentric isokinetic measurements were recorded using a computer-controlled computerized dynamometer (Kin-Com 125AP, Chattecx, Corp., Chattanooga, TN). An analysis of the reliability and validity of the Kin-Com have found force measurements averaging a difference of 3.2% or less and a lever arm speed within 1.5% of target speed (Farrell & Richards, 1986). Arnold, Perrin, and Hellwig (1993) investigated the reliability of the Kin-Com in 25 female university students performing concentric knee extension at 60 degrees per second with a intraclass correlation coefficient 0.87 ($p < .01$).

The Fitron Cycle Ergometer (Cybex, Ronkonkoma, NY), an isokinetic lower extremity stationary bicycle, was used during warm-up sessions prior to isokinetic testing. This particular model was used as the resistance can be varied. The resistance was set at 150 rpm isokinetically so that subjects would have to pedal very fast before any resistance would be applied. Since subjects were asked to pedal below 150 rpm, only the

consistent inherent resistance of the ergometer was experienced, thereby preventing fatigue during the warm-up.

The Movement Imagery Questionnaire-Revised (MIQ-R) (Appendix C) was used to assess visual and kinesthetic imagery ability, with noted test-retest reliability of .80 and .81 respectively (Vadocz, Moritz, & Hall, 1997). The original Movement Imagery Questionnaire (MIQ) (Hall & Pongrac, 1983) was noted to have a reliability coefficient of .83 with Cronbach alpha internal consistency coefficients of .87 (visual subscale) and .91 (kinesthetic subscale) (Hall, Pongrac, & Buckholz, 1985). MIQ-R (Hall & Martin, 1997) is a revised version of the MIQ with significant visual ($r = -.77, p < 0.001$) and kinesthetic ($r = -.77, p < 0.001$) subscale correlations noted between the two questionnaires.

A general questionnaire (Appendix D) was administered to all subjects to investigate personal perceptions of imagery ability, belief in the imagery intervention in enhancing their motor performance, spontaneous imagery performed by the control group, spontaneous goal setting by experimental and control groups, and subjects' compliance with imagery and nonsense practice sessions.

Procedures

Testing Site

Isokinetic testing was conducted at St. Patrick Hospital's Outpatient Physical Therapy Department and at McGill Hall at The University of Montana for the nonsense, imagery, and imagery + belief interventions.

Learning Curve Procedure

Two days prior to baseline measurements, all subjects underwent a practice session to account for a learning curve on the Kin-Com. The learning curve procedure and testing warm-up was according to recommendations obtained from the Chattecx Corporation (Chattanooga, TN), the Kin-Com manufacturers. A 10 minute warm-up was performed on a Fitron cycle ergometer at low intensity (150 rpm). Subjects were then placed on the Kin-Com and performed three submaximal contractions at 25%, 50%, and 75%, followed by one perceived maximal (100%) concentric and one perceived maximal (100%) eccentric contraction (continuous mode), at a speed of 60 degrees per second, between 10 and 80 degrees of knee flexion. The Kin-Com warm-up procedure was repeated, thus concluding the practice session.

Testing Protocol

Eleven subjects underwent isokinetic testing of the right knee. The left knee was tested on the remaining eight subjects. The knee tested was based upon the knee history questionnaire to insure pain-free and injury-free status. If a subject had a previous history involving the right knee, their left knee was tested. The remaining subjects with no previous knee history were randomly assigned to right or left knee testing. The two potential subjects dropped prior to the initiation of baseline data collection were to have their left knee tested, resulting in the discrepancy between the number of subjects assigned to right versus left knee testing.

Each subject was placed on the cycle ergometer for a 10 minute warm-up. The subject was then placed on the Kin-Com in a standardized position: 1) Seated in a upright position with the seat back placed at a 75 degree angle, and the subject stabilized

with a pelvic strap, sternal pad, and thigh pad; 2) the mechanical axis of the lever arm was aligned with the femoral condyle of the test knee; and 3) the shin pad was positioned two finger widths above the medial malleolus.

The subject performed a warm-up procedure consisting of three submaximal concentric and eccentric contractions (continuous mode) followed by one perceived maximal concentric and eccentric contraction at 60 degrees per second, within 10-80 degrees of knee flexion. Baseline measurements were taken at the same speed and range of motion, utilizing the overlay mode. As stated a priori, three concentric and three eccentric overlay curves were preferred with two overlay curves accepted as test data. The overlay curves were only accepted if a co-efficient of variance of 15% or less was achieved, as this represented the subjects' best, most consistent, maximal efforts. A 20 second rest period was given between each perceived maximal concentric and eccentric effort on the Kin-Com.

Following baseline testing on Week 1, an imagery intervention of 35-45 minutes was introduced to the imagery and imagery + belief groups in the form of verbal and written instruction. Each subject in the imagery and imagery + belief group were given a step-by-step written imagery script of the Kin-Com testing protocol, as outlined in Appendix E. Subjects were asked to practice the imagery scripts for 3 to 5 minutes on a daily basis, prior to isokinetic testing, and during 20 second rest periods on the Kin-Com.

To help control for the Hawthorne Effect, the control group underwent a nonsense intervention which consisted of reading recreation-related articles as a group for a length of time comparable to the imagery intervention. The control group was given additional recreation-related and physiology articles, each of 3 to 5 minute duration, to read on a

daily basis during the following week, as well as excerpts of an article to read during the 20 second rest periods on the Kin-Com during testing.

Repeat isokinetic testing on Week 2 consisted of an identical warm-up and testing procedures performed during baseline testing on Week 1. Following repeat testing on Week 2, the imagery group underwent an imagery intervention as in Week 1. The intervention in Week 2 consisted of practicing various imagery scenarios, including a past peak performance. The imagery group was asked to continue daily practice of the original imagery script of the Kin-Com testing protocol. The imagery + belief group underwent the same intervention as the imagery group. To promote belief in imagery, this group was also informed of the positive effects of imagery on motor performance. The belief intervention consisted of 1) the imagery exercises practiced by the imagery group; 2) a verbal review of imagery literature denoting the positive effects of imagery, including EMG studies; and 3) a demonstration of increased EMG activity in an appropriate muscle group during imagery. The imagery + belief subjects were also asked to continue with the daily imagery practice of the Kin-Com testing protocol. The control group underwent a nonsense intervention similar to Week 1 and was asked to continue with the 3 to 5 minute daily readings.

Final isokinetic testing was performed on Week 3, with identical warm-up and testing procedures utilized during the previous weeks. The MIQ-R and a general questionnaire regarding imagery, belief, and compliance were administered, which concluded testing.

Analysis of Data

Four 3x3 Two-way Mixed Design Analysis of Variance (ANOVA) (One Factorial Independent Variable and One Repeated Measures Independent Variable) were used to determine significance among the imagery, imagery + belief, and control groups over the three weekly Kin-Com trials, to assess standardized average and peak concentric and eccentric force. Statistical significance was established a priori at $p < 0.05$. As previously reported in muscle performance literature (Brown, Sinacore, & Host, 1995; Gajdosik, Vander Linden, & Williams, 1996), force values were standardized to body weight to account for the difference in individual body weight relative to force output.

Post-hoc Bonferroni *t*-tests were performed to identify which pair(s) of the three groups' means differed significantly at $p < 0.017$ ($0.05/3$) one-tailed level of significance. A one-tailed level of significance was used, as positive effect sizes have been found with the use of imagery (Feltz & Landers, 1983; NRC, 1988).

Frequency and percentage distributions were conducted on the general questionnaire and the MIQ-R. These questionnaires were used primarily to investigate subjects' reported compliance with daily intervention, belief in the imagery intervention, and potential spontaneous imagery by the control group.

CHAPTER IV

RESULTS

Nineteen subjects completed the three weekly isokinetic trials. The subjects' mean age was 21.8 years \pm 2.35. Table 4.1 delineates the subjects' descriptive data by group.

Table 4.1 Subject Demographics

Subjects	Total (N=19)		Control (N=6)		Imagery (N=7)		Imagery + Belief (N=6)	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Weight (lbs.)	137.8	20.0	139.3	23.6	133.9	17.8	140.8	21.5
Height (in.)	66.1	2.4	65.3	1.9	65.4	3.3	67.5	.8

Four 3x3 Two-way Mixed Designed ANOVAs were performed to compare the standardized average concentric, peak concentric, average eccentric, and peak eccentric force of the three isokinetic trials. Subsequent data results are based on the standardized body weight method.

There was a significant group by time interaction at $p < 0.05$ for the average concentric force ($F = 2.75$, $p = 0.045$) and the peak concentric force ($F = 2.91$, $p = 0.037$). There was no group by time interaction at $p < 0.05$ for the average eccentric force ($F = 1.087$, $p = 0.379$) or the peak eccentric force ($F = 1.578$, $p = 0.204$). There was a significance difference for the average eccentric force between time ($F = 5.761$, $p = 0.007$), but not group ($F = 0.117$, $p = 0.89$), indicating that all groups improved over time. There was a similar significant difference between time ($F = 9.139$, $p = 0.001$) but not group

($F=0.049$, $p= 0.952$) for peak eccentric force. Figures 4.1-4.6 depict the results of the three isokinetic trials.

Figure 4.1

AVERAGE CONCENTRIC

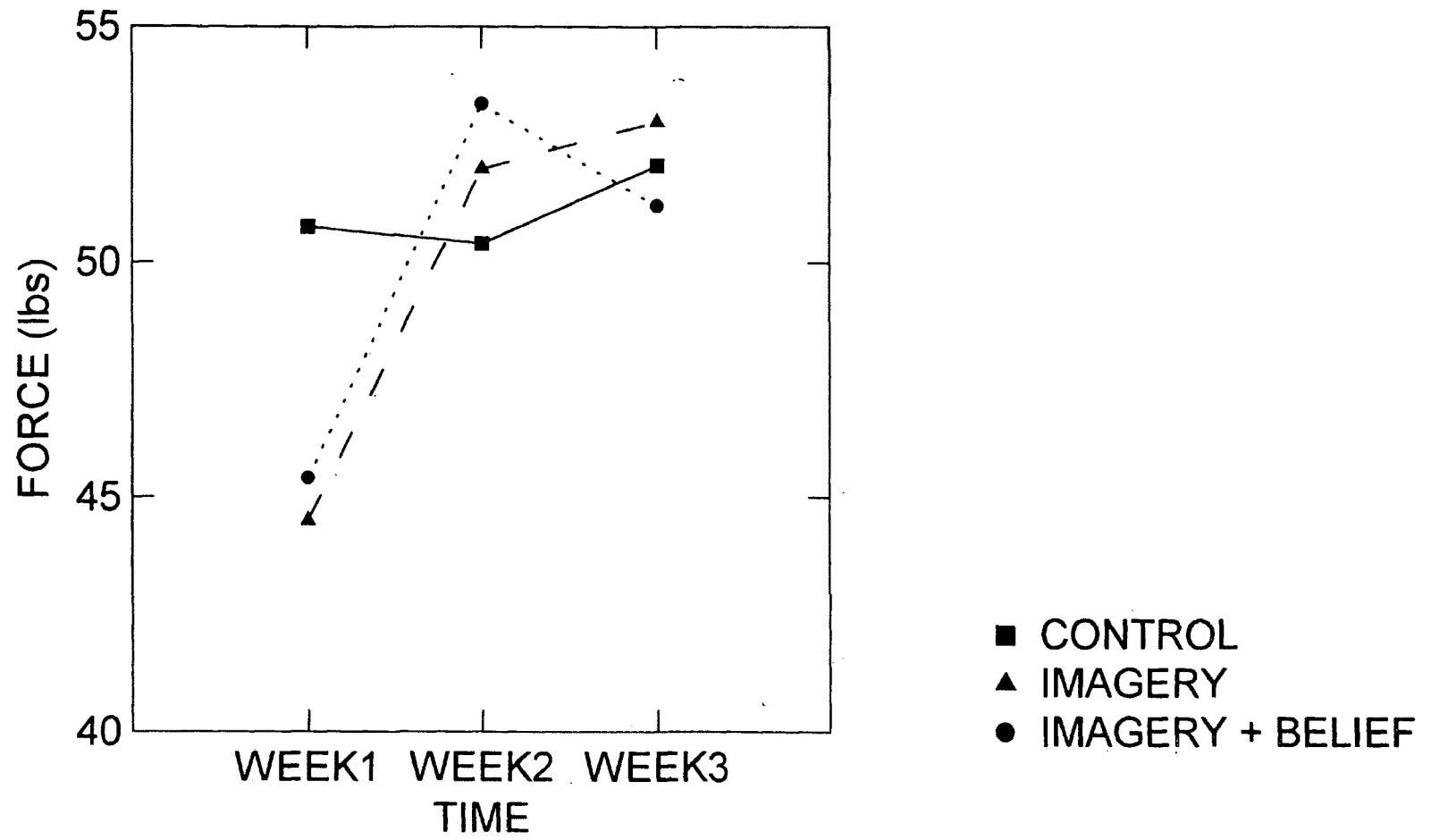


Figure 4.2

PEAK CONCENTRIC

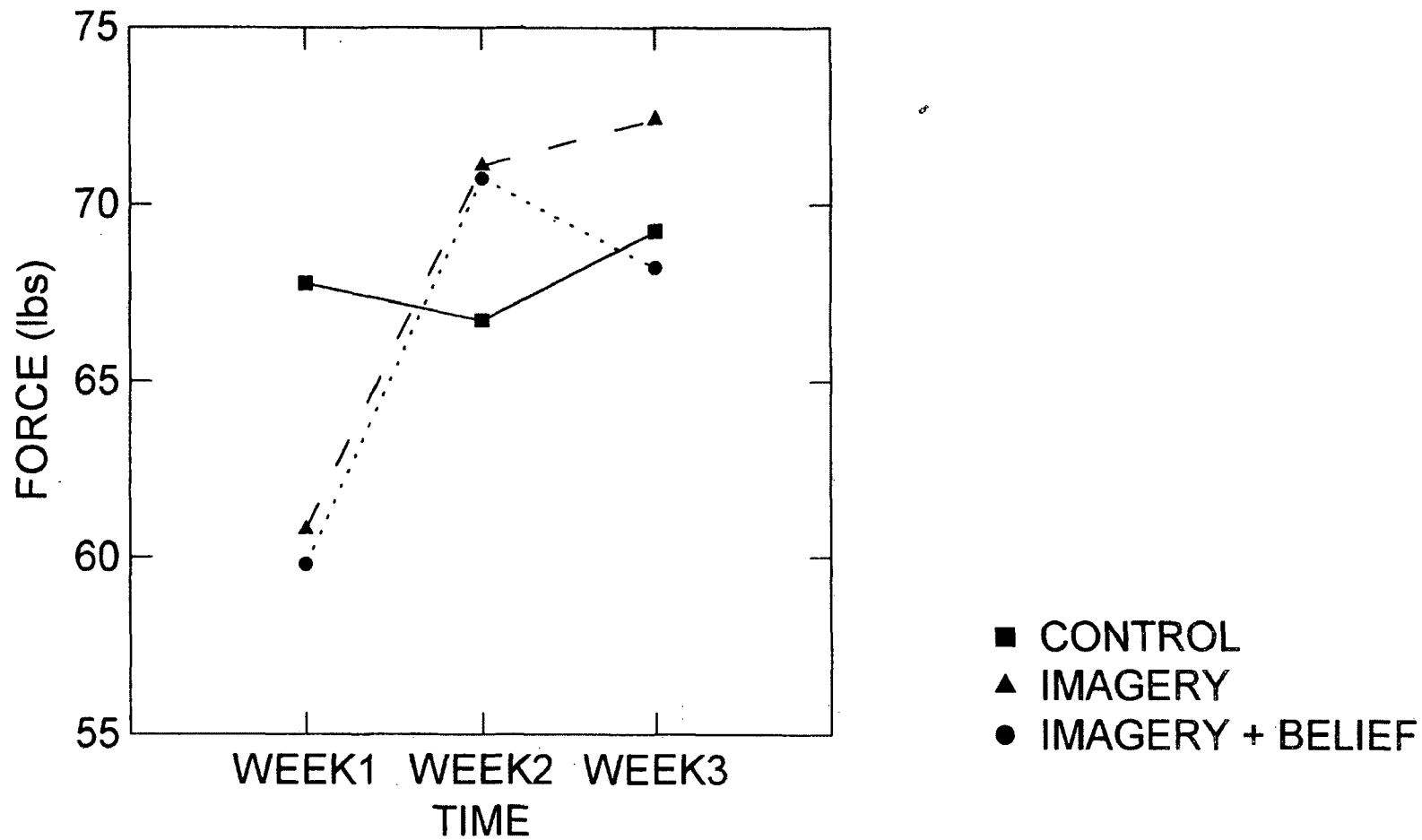


Figure 4.3

CONCENTRIC OVERLAY

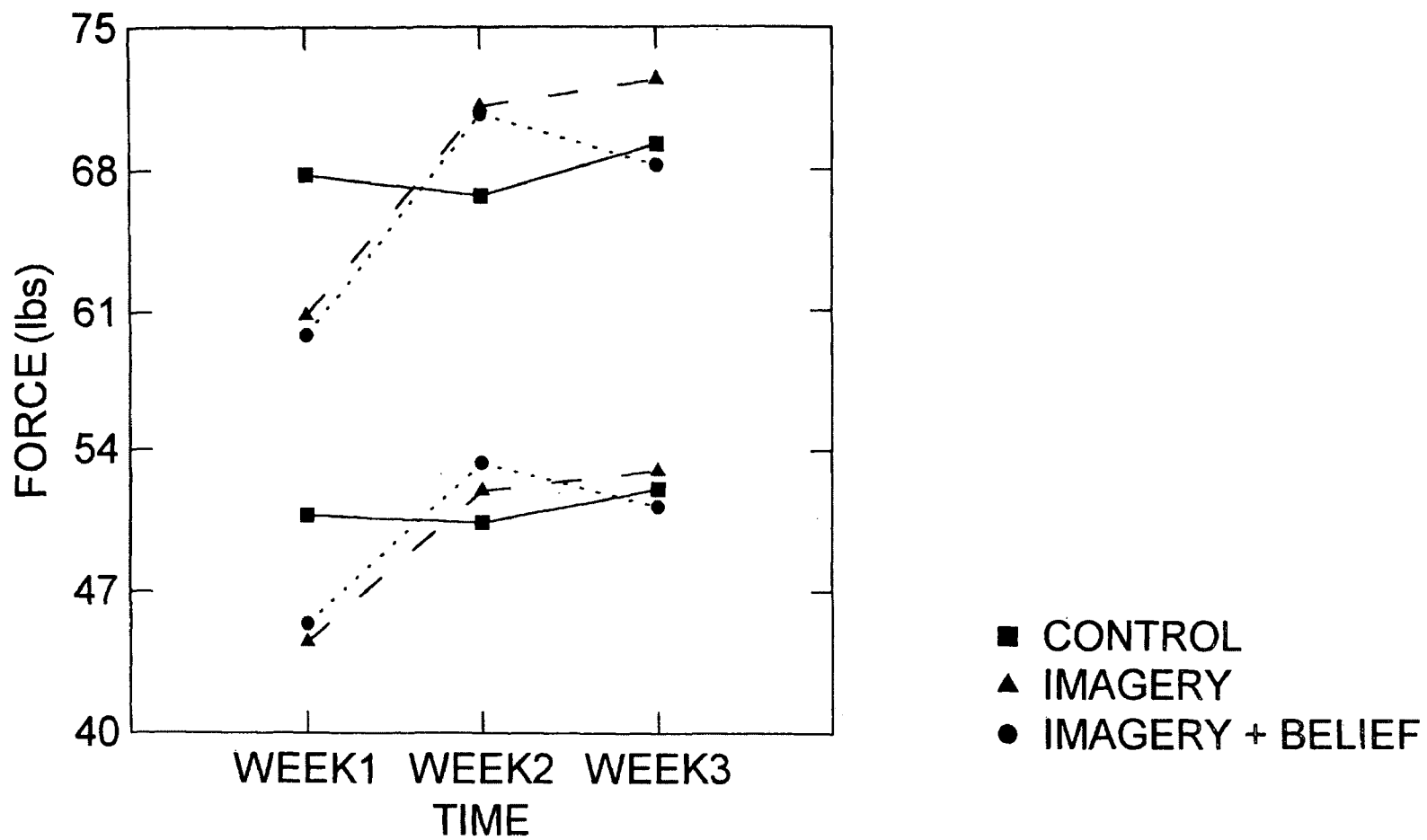


Figure 4.4

AVERAGE ECCENTRIC

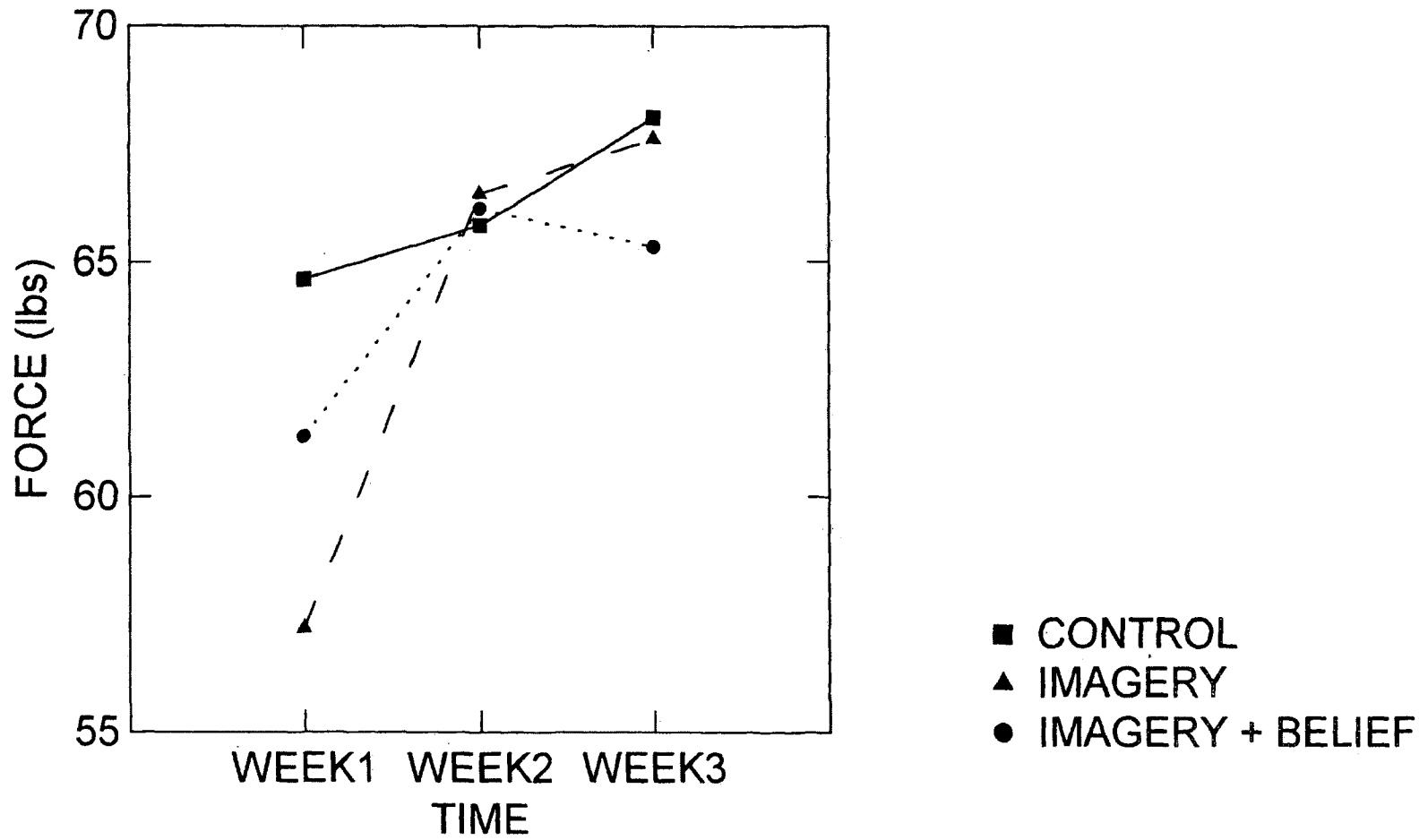


Figure 4.5

PEAK ECCENTRIC

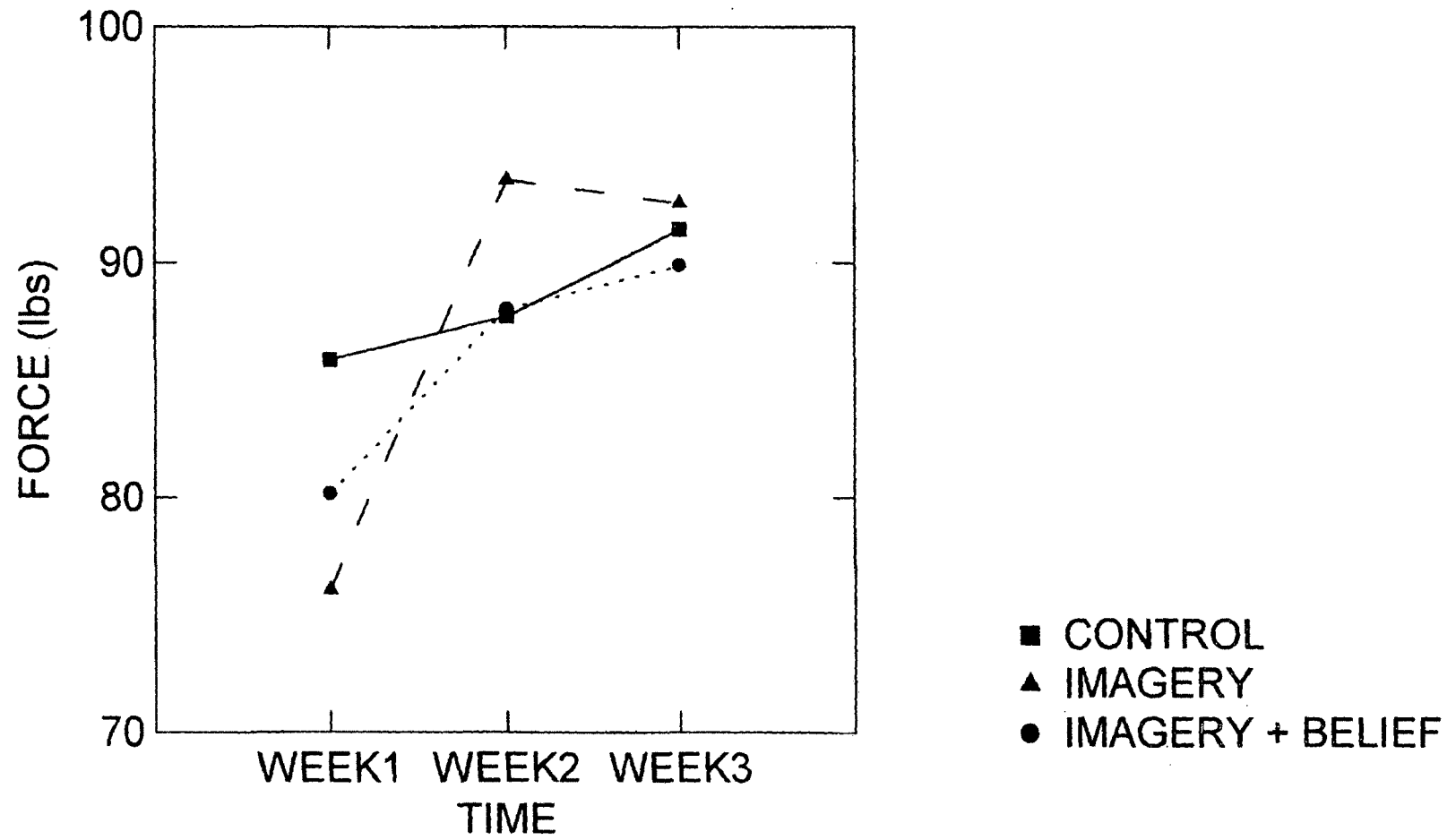
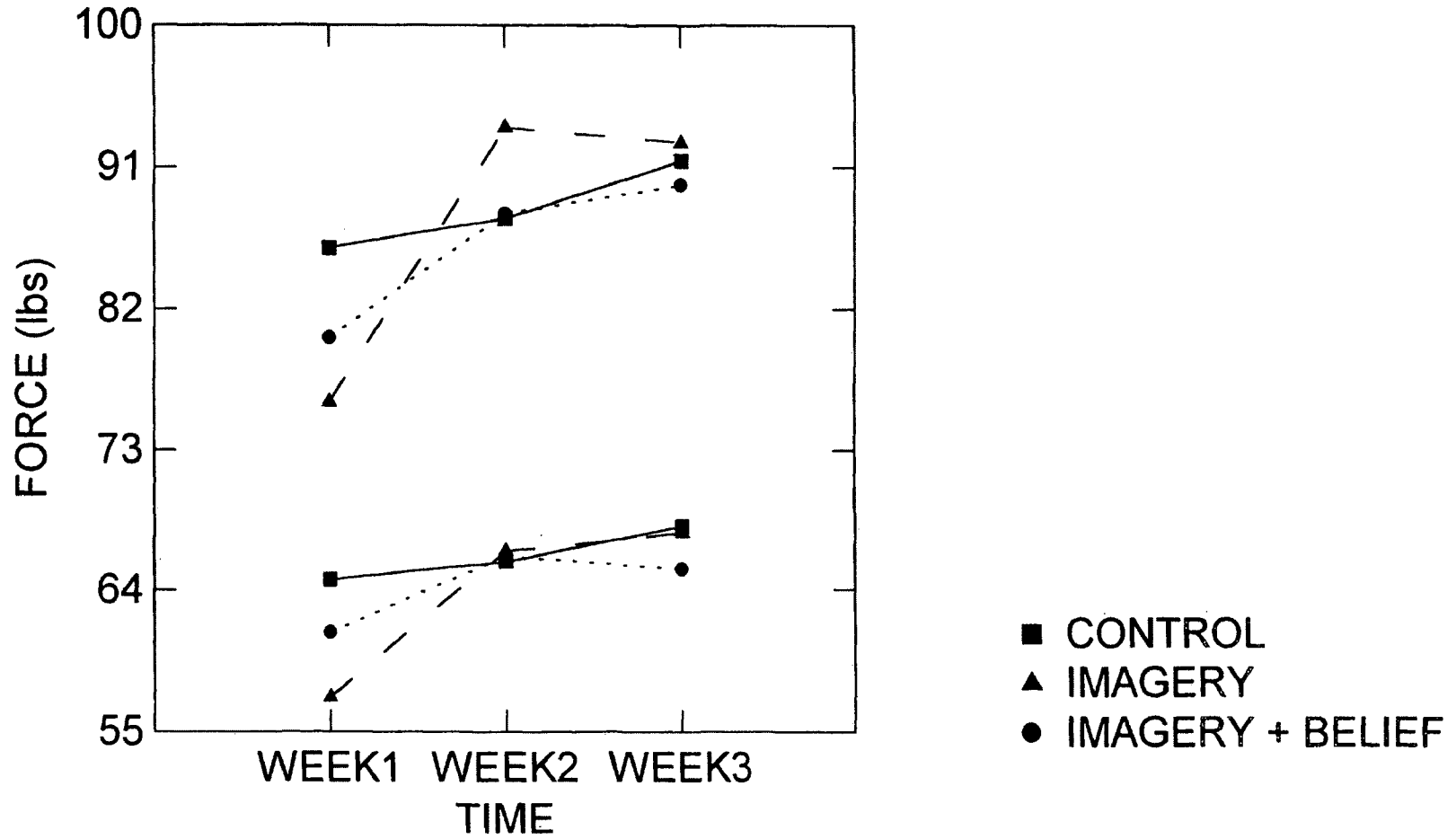


Figure 4.6

ECCENTRIC OVERLAY



To examine simple main effects, separate Bonferroni *t*-tests were performed for the average concentric, and peak concentric forces for the three isokinetic trials, noting the difference in force for each group between the first and second week, second and third week, and the first and third week. To control for Type I errors, a Bonferroni adjustment to alpha was performed, establishing a one-tailed level of significance of $p < 0.017$ (0.05/3). A significant difference was found with the Bonferroni *t*-test for the imagery group's average concentric force between the first and third week ($t = 2.730$, $p = .017$), but not between the first and second week ($t = 2.233$, $p = 0.0335$) or the second and third week ($t = .0687$, $p = 0.259$). A significance difference was found for the imagery + belief group's average concentric force between the first and second week ($t = 4.438$, $p = 0.0035$), but not between the second and third week ($t = -1.296$, $p = 0.1255$) or the first and third week ($t = 2.648$, $p = 0.023$). No significant difference was found for the control group's average concentric force between the first and second week ($t = -0.352$, $p = 0.37$), between the second and third week ($t = 1.271$, $p = 0.13$), or between the first and third week ($t = 1.094$, $p = 0.162$).

A significant difference was found with the Bonferroni *t*-test for the imagery + belief group's peak concentric force between the first and second week ($t = 4.996$, $p = 0.002$) and the first and third week ($t = 3.465$, $p = 0.009$), but not between the second and third week ($t = -1.522$, $p = 0.094$). There was no significant difference for the imagery group's peak concentric force between the first and second week ($t = 2.027$, $p = 0.0445$), the second and third week ($t = 0.598$, $p = 0.286$), or the first and third week ($t = 2.723$, $p = 0.0175$). There was no significant difference for the control group's peak concentric

between the first and second week ($t = -0.710$, $p = 0.255$), the second and third week ($t = 1.265$, $p = 0.131$), or the first and third week ($t = 0.961$, $p = 0.191$).

When the imagery and imagery + belief groups were combined as one experimental group, a significant difference was found for the average concentric force between the first and second week ($t = 4.031$, $p = 0.001$), and the first and third week ($t = 3.781$, $p = 0.0015$), but not between the second and third week ($t = -0.402$, $p = 0.348$). A significant difference was also noted for the peak concentric force between the first and second week ($t = 3.773$, $p = 0.0015$), and the first and third week ($t = 4.056$, $p = 0.001$), but not between the second and third week ($t = -0.312$, $p = 0.381$).

To account for Type II errors and to examine the treatment effect for clinical effectiveness, an effect size formula was employed ($\text{Mean}_{T_2} - \text{Mean}_{T_1} / \text{SD}_{\text{pooled}}$) (Harris, 1998). Cohen (1988) established that 0.2 is a small effect size, 0.5 a medium effect size, and 0.8 a large effect size. Positive treatment effects were found for the imagery group's average concentric force between the first and second week (1.1), the second and third week (0.2), and between the first and third week (1.5); and peak concentric force between the first and second week (1.0), and the first and third week (1.2). Positive treatment effects were also found for the imagery + belief group's average concentric force between the first and second week (1.1), and the first and third week (1.0); and peak concentric force between the first and second week (1.0), and the first and third week (0.9). Using this analysis, no small, medium, or large positive treatment effect was noted for the control group's average or peak concentric force values.

Although significance was not achieved at the $p < 0.05$ level, positive treatment effects were found for the imagery group's average eccentric force between the first and

second week (1.0) and first and third week (1.2); and the peak eccentric force between the first and second week (1.1) and the first and third week (1.1). Positive effect sizes were found for the imagery + belief group's average eccentric force between the first and second week (0.8) and the first and third week (0.6); and peak eccentric force between the first and second week (0.9), the second and third week (0.2), and the first and third week (0.9). There were small positive effect sizes noted for the control group's average eccentric force between the first and third week (0.2); and the peak eccentric force between the second and third week (0.2) and the first and third week (0.3).

When the imagery and imagery + belief group was combined and the effect size formula was utilized, positive treatment effects were found for the average concentric force between the first and second week (1.1) and the first and third week (1.2); and for the peak concentric force between the first and second week (1.0) and the first and third week (1.1).

Frequencies and percentage distributions for the MIQ-R are displayed in Appendix F. Visual representation of the frequencies for the MIQ-R are shown in Appendix G. Frequencies and percentages are listed for the general questionnaire for the imagery, imagery + belief, and control groups in Appendix H, with the visual representation of the frequencies depicted in Appendix I. These questionnaires were administered to provide a basis for explanations in the discussion section.

CHAPTER V

DISCUSSION

The purpose of this study was to determine if imagery and belief in the imagery intervention would significantly improve quadriceps motor performance. Results of this study indicate that imagery and imagery + belief interventions can enhance concentric quadriceps performance, as significant improvement was noted for the average concentric and peak concentric force output. However, no significant improvement was noted for average eccentric and peak eccentric force. The results of this study demonstrating significant improvement in average and peak concentric force support the findings of Gould et al. (1980) who also found increases in concentric quadriceps strength when imagery was used during the 20 second rest periods between perceived maximal efforts on an isokinetic dynamometer. The results of this study are in contrast to Wilkes and Summers' (1984) study which revealed a non-significant (0.2%) improvement in concentric quadriceps strength as measured by an isokinetic dynamometer when imagery was utilized.

The significant improvement found for group by time average concentric force ($p = 0.045$) and peak concentric force ($p = 0.037$) was further supported by post-hoc Bonferroni *t*-tests and positive effect sizes. Utilizing the effect size analysis is beneficial as it expresses the treatment effect as a standard deviation, providing the researcher and reader with a clear perspective of the results when considering the clinical application of the intervention. Examining the effect size is important when the study involves a small sample size, as achieving alpha may be difficult, although the treatment may be

beneficial. The large positive effect sizes noted for the imagery group's average concentric force between the first and second week (1.1), and the first and third week (1.52) indicate a 36.4% and 43.6% improvement in quadriceps strength performance respectively. Additional large effect sizes were noted for the imagery group's peak concentric force between the first and second week (0.97) and the first and third week (1.18) corresponding to a 33.4% and 38.1% improvement in quadriceps motor performance respectively.

Large positive effect sizes were also found for the imagery + belief group's average concentric force between the first and second week (1.11) and the first and third week (1.03) indicating a 36.7% and 34.9% improvement in quadriceps strength. The imagery + belief group's peak concentric force indicated large positive effect sizes between the first and second week (1.0) and the first and third week (0.9) correspond to a 34.1% and 32.6% improvement in quadriceps force output.

Although significance was not achieved at the $p < 0.05$ level, large positive effect sizes were found for the imagery group's average eccentric force between the first and second week (1.0) and first and third week (1.2). indicating a 33.9% and 37.9% improvement in quadriceps force, respectively. Large positive effect sizes were also noted for the imagery group's peak eccentric force between the first and second week (1.15) and the first and third week (1.08), representing a 37.5% and 36% increase in force.

A large positive effect size was found for the imagery + belief group's average eccentric force between the first and second week (0.8) corresponding to a 29.4% increase in force, and a medium to large positive effect size between the first and third

week (0.6), corresponding to a 23.9% increase in force. Large positive effect sizes were also found for the imagery + belief group's peak eccentric force between the first and second week (0.86) and the first and third week (0.91), representing a 30.5% and 31.9% increase in force respectively. There was a small positive effect size noted for the imagery + belief group's peak eccentric force between the second and third week of (0.2) corresponding to a 7.5% improvement in quadriceps motor performance.

Although statistical significance was achieved with average concentric ($p = 0.045$) and peak concentric force ($p = 0.037$), examination of the effect size revealed a 33%-44% improvement in concentric quadriceps motor performance, which advocates the use of imagery when attempting to enhance concentric quadriceps motor performance.

Although no significant improvement was achieved with average and peak eccentric force at $p < 0.05$ level of significance, the large positive effect sized corresponding to a 29%-38% improvement in eccentric quadriceps motor performance, and small to medium effect sizes representing an 8%-24% increase in eccentric quadriceps force. The large positive effect sizes in relation the alpha indicate that power was limited, most likely due to the small sample size of each group.

In addition to employing the effect size method, assessing concentric quadriceps performance for the imagery and imagery + belief groups combined also suggests that a small sample size may have been a limiting factor of this study. When the experimental groups were combined, the achieved level of significance improved with the post-hoc Bonferroni *t*-test for the average and peak concentric force between the first and second week and the first and third week ranged from $p = 0.001$ to $p = 0.0015$. However, the positive effect sizes of (1.0 to 1.2) with a 34%-39% quadriceps strength improvement

remained comparable to the previously noted effect sizes when the experimental groups were examined separately. In this case, although alpha improved dramatically, the positive effect sizes were essentially unchanged, again displaying the value of utilizing the effect size method.

In this study there was no statistical improvement in the average concentric or peak concentric force between the second and third week for all groups. Since the control group did not improve significantly between the first and second week or the first and third week, it is not surprising that there was no improvement between the second and third week for the average and peak concentric force values for this group. The lack of improvement between the second and third week may be due to imagery's potential contribution to neural adaptation. Imagery may be more effective in enhancing motor performance in the early stages of strength gains, as shown by improved motor performance within the first week, but not over longer time periods. However, if imagery was only effective in the early stages of learning a motor skill and in the early stages of a training program, this does not account for the number of elite athletes' apparent benefit from the continued use of imagery (Murphy et al., 1989).

Subjects in this study were asked to continue with their usual exercise programs and recreational activities, as refraining from their usual routine may have effected their motor performance. Due to this defining factor, the isokinetic trials were more likely to constitute learning a motor skill as opposed to the initiation of a training program. Hence, this study advocates the use of imagery in learning a concentric quadriceps motor skill.

The non-significant decrease in average and peak concentric quadriceps motor performance for the imagery + belief group is particularly interesting, as the intervention outlining the positive effects of imagery was performed between the second and third week of isokinetic testing. An explanation is that the imagery + belief group did not believe the information presented on the positive effects of imagery. However, results of the general questionnaire (Appendix H) indicate that 100% (n=6) of the subjects believed the material presented, with 66.7% of those indicating a strong belief in the intervention. Forty-four percent of the imagery + belief group agreed that the education improved their performance, with 16.7% of them strongly agreeing. Only one subject selected the neutral response and wrote on the questionnaire that she believed the intervention, but was unsure it enhanced her performance.

Another possible explanation for the lack of improvement in quadriceps strength in the imagery + belief group between the second and third week is that the first imagery intervention was adequate in promoting belief. The additional information presented in the belief intervention may have caused the subjects to focus on other aspects of imagery instead of concentrating solely on the Kin-Com imagery script. Although the lack of improvement during the second and third week for the imagery + belief group does not allow the secondary hypothesis of this study to be accepted, the finding is of clinical relevance. Since concentric quadriceps motor performance was enhanced by introducing and practicing the imagery script alone, and was not improved by the belief intervention, no additional education regarding the positive effects of imagery appear to be warranted.

The first component of the primary hypothesis was accepted in that significant improvement was noted in average and peak concentric force for the imagery and

imagery + belief groups. However, the second aspect of the primary hypothesis was rejected, as two-way ANOVAs demonstrated no significant group by time interaction for the average and peak eccentric force production. A possible explanation that is often observed in the clinical setting is the difficulty experienced when initially performing isokinetic eccentric quadriceps contraction. Open chain eccentric quadriceps contraction against an isokinetic resistance can be a complex motor task. As a result, co-contraction of the hamstrings may occur, and potentially cause reciprocal inhibition of the quadriceps, resulting in decreased force output. Considering the complexity of eccentric activation, initial isokinetic eccentric performance could be considered a new skill, and learning the skill should be enhanced by the use of imagery (Morrisett, 1956; Sackett, 1934). On the other hand, if open chain eccentric quadriceps contraction is more challenging than concentric muscle activation, the subjects in this study may have been concentrating on performing the mechanics of the movement, thereby decreasing their ability to focus on the imagery script. Since eccentric activation involves parallel and series elastic (non-contractile) components in addition to the contractile components, imagery may only be effective in enhancing the contractile components including neural recruitment, but not the non-contractile components. This may account for the lack of significant improvement in eccentric quadriceps performance.

The most likely reason for the lack of improvement in eccentric quadriceps performance may be attributed to the actual movement occurring during open chain eccentric contraction, in that the subject attempts to resist the lowering lever arm. The lever arm continues to drop at a consistent speed despite the amount of effort exerted. Mental imagery typically consists of imagining a positive outcome. However, with open

chain eccentrics, it is impossible to slow down the lever arm, let alone reverse the direction of the machine. The subjects receive immediate feedback that they are unable to achieve the attempted goal. This realization can cause mental discourse, as the imagined positive outcome of “kicking up as hard and as fast as possible, slowing the lever arm down” (Appendix E) is in direct contrast to the actual outcome. As noted by Wilkes and Summers (1984) when utilizing imagery, emphasizing task achievement may be more beneficial than focusing on task execution. This explanation is also supported by a subject’s comment in the general questionnaire expressing difficulty in performing imagery for the eccentric movement. The inconsistency in the imagined and actual outcomes may create a lack of belief in the cognitive strategy used during the unsuccessful performance. However, this explanation was not confirmed by responses in the general questionnaire. Although one subject was unsure if imagery enhanced motor performance, all of the remaining subjects in the imagery and imagery + belief group either agreed or strongly agreed that imagery improved their quadriceps performance.

Another reason for the lack of significance with the use of imagery during eccentric quadriceps performance was that the content of the imagery script was inadequate. Although not stated by the authors, the content of the verbal imagery instructions may have contributed to a lack of improvement in the Wilkes and Summers (1984) study assessing quadriceps performance. To promote external validity, the imagery script used in this study contained verbal instructions typically used in the rehabilitation setting during isokinetic testing. As previously noted, performing open chain eccentric quadriceps contraction on the Kin-Com is a difficult motor task, so an

external imagery perspective may have been more beneficial for learning this new skill (Suinn, 1984)

As outlined by the general questionnaire, some subjects in the control group performed spontaneous imagery during rest periods on the Kin-Com (n=3) and during the weeks between testing (n=2). Although this may have contributed to the lack of significance with group by time interaction for average and peak eccentric force, this would not explain the significant findings of the imagery and imagery + belief groups for average and peak concentric force increases.

As illustrated in Figures 4.1-4.6, the baseline measurements for the control group were consistently higher for all dependent variables. Subject descriptive data (Table 4.1) was examined and could not account for this phenomenon. Two individuals in the control group, an athletic trainer and student trainer, had previous personal experience on isokinetic equipment. Since they were more familiar with isokinetic testing, this may have accounted for a more accurate representation of baseline measurements and no significant improvement over time. Past experience on isokinetic equipment was not included in the knee history/pre-screening interview as eliminating criteria, but should be considered in future studies.

Suggestions For Future Research

Future studies assessing the effects of imagery in enhancing quadriceps motor performance should have a larger sample than that used in this study, as a larger sample size would increase the power in achieving alpha. Further exploration of the effects of imagery on eccentric force is warranted, as no previous eccentric quadriceps studies were

found in the literature. Specifically, it would be beneficial to assess a closed chain motor task, as this a more complex and functional activity for eccentric quadriceps contraction.

Due to the lack of significant improvement in average and peak concentric force between the second and third week, a study of longer duration may help explain the role of imagery in neural adaptation. Utilization of EMG could also help outline imagery's potential contribution to enhanced force output due to early neural adaptations. A future study involving similar methods employed in this study, but also including EMG recordings of quadriceps and hamstring activity would examine the suspected reciprocal inhibition of the quadriceps by the hamstrings with open chain eccentric motor tasks.

Conclusion

Results of this study demonstrated improved isokinetic concentric quadriceps performance with the use of imagery. Although significant improvement was not found for the imagery + belief group following the belief intervention, this finding is of clinical relevance. Specifically, this study demonstrated that presenting the positive effects of imagery is not necessary when instructing individuals in imagery techniques for enhancing concentric quadriceps. This is important in the rehabilitation setting, as treatment time is limited. If the success of imagery required a lengthy explanation of its benefits in addition the outlining basic techniques, health care professionals may avoid incorporating imagery into the treatment plan. This study advocates the use of imagery in enhancing concentric quadriceps performance, especially considering that the treatment consisted only of 3 to 5 minutes of imagery practice daily, and did not require actual physical practice (PP). This is of particular clinical relevance when PP is limited by time,

expense, or physical status which may prevent individuals from achieving full functional outcomes if imagery was not utilized.

REFERENCE LIST

Arnold, B.L., Perrin, D. H., & Hellwig, E.V. (1993). The reliability of three isokinetic knee-extension angle-specific torques. *Journal of Athletic Training*, 28(3), 227-229.

Bandura, A., & Jefferies, R.W. (1973). Role of symbolic coding and rehearsal processes in observational learning. *Journal of Personality and Social Psychology*, 26, 122-130.

Becker, M.H., & Maiman, L.A. (1975). Sociobehavioral determinants of compliance with health and medical care recommendations. *Medical Care*, 13, 10-21.

Benson, H. (1984). *Beyond the relaxation response*. New York, NY: Time Books.

Benson, H., & Epstein, M.D. (1975). The placebo effect: A neglected asset in the care of patients. *Journal of the American Medical Association*, 232, 1225-1226.

Bull, S.J. (1991). Personal and situational influences on adherence to mental skills training. *Journal of Sport & Exercise Psychology*, 13, 121-132.

Brown, M., Sinacore, D.R., & Host, H.H. (1995). The relationship of strength to function in the older adult. *The Journals of Gerontology Series A*, 50A (Special Issue), 55-59.

Caplan, R.D. (1979). Patient, provider, and organization: Hypothesized determinants of adherence. In Cohen, S.J. (Ed). *New Directions in Patient Compliance*. Lexington, MA: Lexington Books, 75-110.

Cousins, N. (1989). *Head first: The biology of hope*. New York, NY: E.P. Dutton.

Cousins, N. (1979). *Anatomy of an illness as perceived by the patient: Reflections on healing and regeneration*. New York, NY: W.W. Norton and Company, Inc.

Crews, D.J., & Boutcher, S.H. (1986a). An exploratory observational analysis of professional golfers during competition. *Journal of Sport Behavior*, 9, 51-58.

Crews, D.J., & Boutcher, S.H. (1986b). Effects of structured preshot behaviors on beginning golf performance. *Perceptual and Motor Skills*, 62, 291-294.

Decety, J. (1996). Do imagined and executed actions share the same neural substrate? *Brain Research Cognitive Brain Research*, 3, 87-93.

DiMatteo, R.M., & DiNichola, D.D. (1982). *Achieving patient compliance*. New York, NY: Pergamon Press.

Dossey, L. (1993). *Healing Words*. San Francisco, CA: Harper San Francisco.

Dossey, L. (1991). *Meaning and Medicine: A doctor's tales of breakthrough and healing*. New York, NY: Bantam Books.

Doyle, L.A., & Landers, D.M. (1980). *Psychological skills in elite and subelite shooters*. Unpublished manuscript.

Duda, J.L., Smart, A.E., and Tappe, M.K. (1989). Predictors of adherence in the rehabilitation of athletic injuries: An application of personal investment theory. *Journal of Sport and Exercise Psychology*, 11, 367-381.

Epstein, M.L. (1980). The relationship of mental imagery and mental rehearsal to performance of a motor task, *Journal of Sport Psychology*, 2, 211-220.

Etnier, J.L., & Landers, D.M. (1996). The influence of procedural variables on the efficacy of mental practice. *The Sport Psychologist*, 10, 48-57.

Fansler, C.L., Poff, C.L., & Shepard, K.F. (1985, September). Effects of mental practice on balance in elderly women. *Physical Therapy*, 65 (9), 1332-1338.

Farrell, M., & Richards, J.G. (1986). Analysis of the reliability and validity of the kinetic communicator exercise device. *Medicine and Science in Sports and Exercise*, 18(1), 44-49.

Feltz, D.L., & Landers, D.M. (1983). The effects of mental practice on motor skill learning and performance: A meta-analysis. *Journal of Sport Psychology*, 5, 25-57.

Feltz, D.L., & Riessinger, C.A. (1990). Effects of in vivo emotive imagery and performance feedback on self-efficacy and muscular endurance. *Journal of Sport & Exercise Psychology*, 12, 132-143.

Fishbein, M., & Ajzen, I. (1975). *Belief, attitude, intention and behavior: An introduction to theory and research*. Reading, MA: Addison-Wesley Publishing Company.

Fox, A., & Fox, B. (1988). *Wake Up! You're alive*. Deerfield Beach, FL: Health Communications, Inc.

Frank, J.D. (1978). The medical power of faith. *Human Nature*, August, 40-47.

Furlong, W. (1979). Coping, the power of imagination. *Quest*, 30, 95-96.

Gajdosik, R.L., Vander Linden, D.W., & Williams, A.K. (1996). Influence of age on concentric isokinetic torque and passive extensibility variables of the calf muscles of women. *European Journal of Applied Physiology and Occupational Physiology*, 74, 279-286.

- Gould, D., Weinberg, R., & Jackson, A. (1980). Mental preparation strategies, cognitions, and strength performance. *Journal of Sport Psychology*, 2, 329-339.
- Grafton, S.T., Arbib, M.A., Fadiga, L., & Rizzolatti, G. (1996). Localization of grasp representations in humans by positron emission tomography. Observation compared with imagination. *Experimental Brain Research*, 112, 103-111.
- Gravel, R., Lemieux, G., & Ladouceur, R. (1980). Effectiveness of a cognitive behavioral treatment package for cross-country ski racers. *Cognitive Therapy and Research*, 4, 83-90.
- Gray, S.W. (1990). Effect of visuomotor rehearsal with videotaped modeling on racquetball performance of beginning players. *Perceptual and Motor Skills*, 70, 379-385.
- Green, L.B. (1992). The use of imagery in the rehabilitation of injured athletes. *The Sport Psychologist*, 6, 416-428.
- Hafen, B.Q., Karren, K.J., Frandsen, K.J., & Smith, N.L. (1996). *Mind/body health: The effects of attitudes, emotions, and relationships*. Needham Heights, MA: Simon and Schuster Company.
- Hale, B.D. (1982). The effects of internal and external imagery on muscular and ocular concomitants. *Journal of Sport Psychology*, 4, 379-387.
- Hall, C.R., & Martin, K.A. (1997). Measuring movement imagery abilities: A revision of the Movement Imagery Questionnaire. *Journal of Mental Imagery*, 21, 143-154.
- Hall, C.R., & Pongrac, J. (1983). *Movement Imagery Questionnaire*. London, Ontario: The University of Western Ontario.
- Hall, C.R., Pongrac, J., & Buckholz, E. (1985). The measurement of imagery ability. *Human Movement Science*, 4, 107-118.
- Hall, E.G., & Erffmeyer, E.S. (1983). The effect of visuo-motor behavior rehearsal with videotaped modeling on free throw accuracy of intercollegiate female basketball players. *Journal of Sport Psychology*, 5, 343-346.
- Harris, M.B. (1998). *Basic Statistics for Behavioral Science Research* (2nd ed.). Boston, MA: Allyn & Bacon., p. 282.
- Harris, D.V., & Robinson, W.J. (1986). The effects of skill level on EMG activity during internal and external imagery. *Journal of Sport Psychology*, 8, 105-111.
- Hecker, J.E., & Kaczor, L.M. (1988). Application of imagery theory to sport psychology: Some preliminary findings. *Journal of Sport Psychology*, 10, 363-373.

Hunt, M. (1991). Faith, hope and placebos. *Longevity*, May, 68-70.

Jacobson, E. (1930). Electrical measurements of neuromuscular states during mental activities. *American Journal of Physiology*, 94, 22-34.

Jacobson, E. (1932). Electrophysiology of mental activities. *American Journal of Psychology*, 44, 677-694.

Jastrow, J.A. (1892). Study of involuntary movements. *American Journal of Psychology*, 4, 398-407.

Jowdy, D.P., & Harris, D.V. (1990). Muscular responses during mental imagery as a function of motor skill level. *Journal of Sport & Exercise Psychology*, 12, 191-201.

Lang, P.J. (1977). Imagery in therapy: An information processing analysis of fear. *Behavior Therapy*, 8, 862-886.

Lang, P.J. (1979). A bio-informational theory of emotional imagery. *Psychophysiology*, 16, 495-512.

Lang, P.J. (1985). The cognitive psychophysiology of emotion: Fear and anxiety. In A.H. Tuma and J.D. Maser (Eds.), *Anxiety and the anxiety disorders* (pp. 131-170). Hillsdale, NJ: Erlbaum.

Lazarus, L. (1977). *In the mind's eye*. New York, NY: Rawson.

Lobmeyer, D.L., & Wasserman, E.A. (1986). Preliminaries to free throw shooting: superstitious behavior? *Journal of Sport Behavior*, 9, 70-78.

Machlus, S.D., & O'Brien, R.M. (August 1988). *Visuo-motor behavior rehearsal and preparatory arousal in improving athletic speed*. Paper presented to the annual meeting of the American Psychological Association, Atlanta, GA.

Mahoney, M.J., & Avenier, M. (1977). Psychology of the elite athlete: An exploratory study. *Cognitive Therapy and Research*, 1, 135-141.

Merrill, B.A. (1994). A global look at compliance in health/safety and rehabilitation. *Journal of Orthopedic and Sports Physical Therapy*, 19(5), 242-248.

Minas, SC (1978). Mental practice of a complex perceptual-motor skill. *Journal of Human Movement Studies*, 4, 102-107.

Moritz, S.E., Hall, C.R., Martin, K.A., & Vadocz, E. (1996). What are confident athletes imaging?: An examination of image content. *The Sport Psychologist*, 10, 171-179.

- Morrisett, L.N. (1956). *The role of implicit practice in learning*. Unpublished doctoral dissertation, Yale University.
- Murphy, S.M., Jowdy, D.P., & Durtschi, S.K. (1989). *Report on the United States Olympic Committee survey on imagery use in sport: 1989*. Colorado Springs, CO: U.S. Olympic Training Center.
- Murphy, S.M., Woolfolk, R.L., & Budney, A.J. (1988). The effects of emotive imagery on strength performance. *Journal of Sport & Exercise Psychology*, 10, 334-345.
- National Research Council (1988). *Enhancing Human Performance: Issues, theories, and techniques*. Washington, DC: National Academy Press.
- National Research Council (1991). *In the mind's eye: Enhancing human performance*. Washington, DC: National Academy Press.
- Nicklaus, J. (1974). *Golf my way*. New York, NY: Simon & Schuster.
- Noel, R.C. (1980). The effect of visuo-motor behavior rehearsal on tennis performance. *Journal of Sport Psychology*, 2, 220-226.
- Orlick, T., & Partington, J. (1988). Mental links to excellence. *Sport Psychologist*, 2, 105-130.
- Ornstein, R., & Sobel, D. (1987). *Healthy pleasures*. Reading, MA: Addison-Wesley Publishing Company, Inc.
- Paivio, A. (1985). Cognitive and motivational functions of imagery in human performance. *Canadian Journal of Applied Sport Science*, 10(4), 22s-28s.
- Pearsall, P. (1987). *Super immunity*. New York, NY: McGraw-Hill Book Company.
- Richardson, A. (1967). Mental practice: A review and discussion. *Research Quarterly*, 38, 95-107, 263-273.
- Rimer, B.K., Glanz, K., and Lerman, C. (1991). Contributions of public health to patient compliance. *Journal of Community Health*, August, 16(4), 225-240.
- Roth, M., Decety, J., Raybaudi, M., Massarelli, R., Delon-Martin, C., Segebarth, C., Morand, S., Gemegnani, A., Decorps, M., & Jeannerod, M. (1996). Possible involvement of primary motor cortex in mentally simulated movement: a functional magnetic resonance imaging study. *Neuroreport*, 7(7), 1280-1284.

Ryan, D.E., & Simons, J. (1981). Cognitive demand, imagery, and frequency of mental rehearsal as factors influencing acquisition of motor skills. *Journal of Sport Psychology*, 3, 35-45.

Sackett, R.S. (1934). The influences of symbolic rehearsal upon the retention of maze habit. *Journal of General Psychology*, 10, 376-395.

Schleser, R., Meyers, A.W., & Montgomery, T. (1980, November). *A cognitive behavioral intervention for improving basketball performance*. Paper presented to the Association for the Advancement of Behavior Therapy, 18th Annual Convention, New York, NY.

Schmidt, R.A. (1982). *Motor control and learning: A behavioral emphasis*. Champaign, IL: Human Kinetics.

Siegel, B. (1989). *Peace, love, and healing*. New York, NY: Harper and Row.

Sirigu, A., Cohen, L., Duhamel, J., Pillon, B., Dubois, B., Agid, Y., & Pierrot-Deseilligny, C. (1995). Congruent unilateral impairments for real and imagined hand movements. *Neuroreport* 6(7), 997-1001.

Sluijs, E.M., Kok, G.J., & van der Zee, J. (1993). Correlates of exercise compliance in physical therapy. *Physical Therapy*, 73(11), 771-782.

Spiro, H.M., (1991). Are placebos legitimate therapy? *Patient Care*, May 15, 69.

Suinn, R.M. (1977). Behavioral methods of winter games. *Behavior Therapy*, 8, 283-284.

Suinn, R. M. (1984). Visual motor behavior rehearsal: The basic technique. *Scandinavian Journal of Behavior Therapy*, 13, 131-142.

Suinn, R.M. (1993). Imagery. In R.N. Singer, M. Murphey, and L.K. Tennant (Eds.), *Handbook on research on sport psychology* (p. 492-510). Sponsored by the International Society of Sport Psychology. New York, NY: Macmillian Publishing Company.

Titley, R. W. (1976, September). The loneliness of a long distance kicker. *The Athletic Journal*, 74-80.

van Campen, C., & Sluijs, E.M. (1989). *Patient compliance: A survey of reviews (1979-1989)*. Utrecht, the Netherlands: NIVEL.

Vealey, R.S. (1987, June). *Imagery training for performance enhancement*. Paper presented at the Sport Psychology Institute, Portland, ME.

- Vernacchia, R. A., McGuire, R.T., & Cook, D.L. (1996). *Coaching mental excellence: It does matter whether you win or lose*. Protola Valley, CA: Warde Publishers, Inc., p. 61, 81-92.
- Vadocz, E.A., Moritz, S.E., & Hall, C.R. (1997). Factor structure and reliability of the Movement Imagery Questionnaire-Revised. Unpublished manuscript.
- Warner, L., & McNeill, M.E. (1988, April). Mental imagery and its potential for physical therapy. *Physical Therapy*, 68(4), 516-521.
- Weinberg, R.S. (1982). The relationship of mental preparation strategies and performance: A review and critique. *Quest*, 33, 195-213.
- Weinberg, R.S., Seabourne, T., & Jackson, A. (1982). Effects of visuo-motor behavior rehearsal, relaxation, and imagery on state-trait anxiety and performance: Is practice important? *Journal of Sport Behavior*, 5, 209-219.
- Wilkes, R.L., & Summers, J.J. (1984). Cognitions, mediating variables, and strength performance. *Journal of Sport Psychology*, 6, 351-359.
- Williams, D.A., & Keefe, F.J. (1991). Pain beliefs and the use of cognitive-behavioral coping strategies. *Pain*, August, 46(2), 185-190.
- Wilson, B.M. (1995). Promoting compliance: The patient-provider partnership. *Advances in Renal Replacement Therapy*, July, 2(3), 199-206.
- Wrisberg, C.A., & Ragsdale, M.R. (1979). Cognitive demand and practice level: Factors in the mental rehearsal of motor skills. *Journal of Human Movement Studies*, 5, 201-208.

Appendix B

INFORMED CONSENT

Patsy Mangan, Alicia Kuhl, and Brian Miller are conducting a dual graduate research study. One component of the study will involve a comparison of two instruments used to measure quadriceps muscle strength, a hand-held dynamometer and the Kin-Com, an isokinetic machine. The second component of the study will investigate the effects of cognitive strategies on physical performance. You have been asked to participate in this study because you are a healthy individual involved in recreational activities and do not have a history of knee pain.

If you agree to participate in this study, the following will happen on three consecutive weeks:

1. You will be randomly assigned to control or experimental groups.
2. You will be positioned on the Kin-Com, stabilized with waist and thigh straps.
3. You will be asked to straighten your leg into resistance provided by the examiner (with no movement occurring), who will position the hand-held dynamometer (HHD) on the front of your lower leg, near the ankle. Measurements will be taken.
4. You will repeat this procedure on the Kin-Com with no movement occurring.
5. The order of testing with the Kin-Com and HHD may be reversed.
6. You will then be asked to perform various movements with resistance applied by the Kin-Com machine. The Kin-Com will record the amount of force you produce.
7. You will listen to a lecture, and/or be given literature to read between the weekly testing procedures with the HHD and Kin-Com.

Potential for discomfort and/or a risk of injury as a result of participation may include:

1. Discomfort on the front of your leg due to HHD placement.
2. Muscle soreness on the day of testing and/or delayed onset of muscle soreness in the few days following testing.
3. As with any testing of a joint, there is a slight potential for swelling, pain, and/or injury.

As with any experiment, there may be some unknown risks which are unforeseeable at this point. Upon realization of any known risks, you will be informed at that time. As a result of participation in this study, there may be no direct benefit to you. However, the researchers, medical, and psychological communities may benefit from the findings in this study. You will not receive any monetary compensation for participation in this study.

In the event that you are injured as a result of this research, you should individually seek appropriate medical treatment. If the injury is caused by the negligence of the University of Montana or any of its employees, you may be entitled to reimbursement or compensation pursuant to the Comprehensive State Insurance Plan established by the Department of Administration under the authority of M.C.A., Title 2, Chapter 9. In the event of a claim for such injury, further information may be obtained from the University's Claims Representative or University Legal Counsel. The researchers and/or St. Patrick Hospital will not provide any form of compensation or medical care to you if you are injured.

The components of this dual study have been explained to you and your questions answered, if you have any other question or research-related problems, you may reach Patsy Mangan at 721-2619, Brian Miller at 542-4757, or Alicia Kuhl at 721-5474. If you have any inquiries concerning the methods or outcomes of this procedure or your rights as a research subject, you may contact the Joint Investigational Review Board at St. Patrick Hospital at 329-5669; Beth Ikeda, 106B McGill Hall at 243-5190; or Lew Curry, 220A McGill Hall at 243-5242.

Research participation is entirely voluntary. You may refuse to participate or withdraw at any time during the study. Research records will be kept confidential to the extent provided by law. You have received a copy of this consent document to keep and you agree to participate in this dual study.

Subject's signature

Witness

Date

Appendix C

MOVEMENT IMAGERY QUESTIONNAIRE-REVISED

Instructions

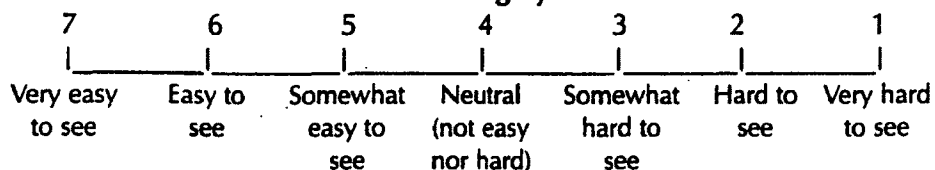
This questionnaire concerns two ways of *mentally* performing movements which are used by some people more than by others, and are more applicable to some types of movements than others. The first is attempting to form a visual image or picture of a movement in your mind. The second is attempting to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

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

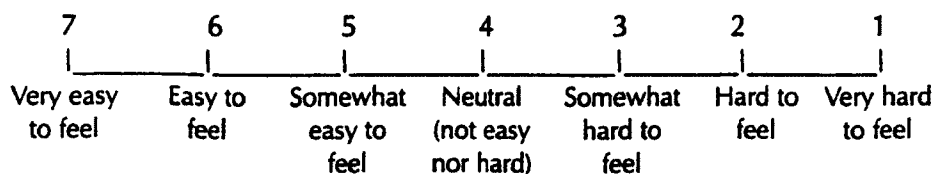
After you have completed the mental task required, rate the ease/difficulty with which you were able to do the task. Take your rating from the following scale. Be as accurate as possible and take as long as you feel necessary to arrive at the proper rating for each movement. You may choose the same rating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

RATING SCALES

Visual Imagery Scale



Kinesthetic Imagery Scale



Appendix C

- 1. STARTING POSITION:** Stand with your feet and legs together and your arms at your sides.
- ACTION:** Raise your right knee as high as possible so that you are standing on your left leg with your right leg flexed (bent) at the knee. Now lower your right leg so that you are again standing on two feet. Perform these actions slowly.
- MENTAL TASK:** Assume the starting position. Attempt to feel yourself making the movement just performed without actually doing it. Now rate the ease/difficulty with which you were able to do this mental task.
- RATING:** _____
- 2. STARTING POSITION:** Stand with your feet slightly apart and your hands at your sides.
- ACTION:** Bend down low and then jump straight up in the air as high as possible with both arms extended above your head. Land with your feet apart and lower your arms to your sides.
- MENTAL TASK:** Assume the starting position. Attempt to see yourself making the movement just performed with as clear and vivid a visual image as possible. Now rate the ease/difficulty with which you were able to do this mental task.
- RATING:** _____
- 3. STARTING POSITION:** Extend the arm of your nondominant hand straight out to your side so that it is parallel to the ground, palm down.
- ACTION:** Move your arm forward until it is directly in front of your body (still parallel to the ground). Keep your arm extended during the movement and make the movement slowly.
- MENTAL TASK:** Assume the starting position. Attempt to feel yourself making the movement just performed without actually doing it. Now rate the ease/difficulty with which you were able to do this mental task.
- RATING:** _____
- 4. STARTING POSITION:** Stand with your feet slightly apart and your arms fully extended above your head.
- ACTION:** Slowly bend forward at the waist and try and touch your toes with your fingertips (or if possible, touch the floor with your fingertips or hands). Now return to the starting position, standing erect with your arms extended above your head.
- MENTAL TASK:** Assume the starting position. Attempt to see yourself making the movement just performed with as clear and vivid a visual image as possible. Now rate the ease/difficulty with which you were able to do this mental task.
- RATING:** _____

Appendix C

- 5. STARTING POSITION:** Stand with your feet slightly apart and your hands at your sides.
- ACTION:** Bend down low and then jump straight up in the air as high as possible with both arms extended above your head. Land with your feet apart and lower your arms to your sides.
- MENTAL TASK:** Assume the starting position. Attempt to feel yourself making the movement just performed without actually doing it. Now rate the ease/difficulty with which you were able to do this mental task.
- RATING:** _____
- 6. STARTING POSITION:** Stand with your feet and legs together and your arms at your sides.
- ACTION:** Raise your right knee as high as possible so that you are standing on your left leg with your right leg flexed (bent) at the knee. Now lower your right leg so that you are again standing on two feet. Perform these actions slowly.
- MENTAL TASK:** Assume the starting position. Attempt to see yourself making the movement just performed with as clear and vivid a visual image as possible. Now rate the ease/difficulty with which you were able to do this mental task.
- RATING:** _____
- 7. STARTING POSITION:** Stand with your feet slightly apart and your arms fully extended above your head.
- ACTION:** Slowly bend forward at the waist and try and touch your toes with your fingertips (or if possible, touch the floor with your fingertips or hands). Now return to the starting position, standing erect with your arms extended above your head.
- MENTAL TASK:** Assume the starting position. Attempt to feel yourself making the movement just performed without actually doing it. Now rate the ease/difficulty with which you were able to do this mental task.
- RATING:** _____
- 8. STARTING POSITION:** Extend the arm of your nondominant hand straight out to your side so that it is parallel to the ground, palm down.
- ACTION:** Move your arm forward until it is directly in front of your body (still parallel to the ground). Keep your arm extended during the movement and make the movement slowly.
- MENTAL TASK:** Assume the starting position. Attempt to see yourself making the movement just performed with as clear and vivid a visual image as possible. Now rate the ease/difficulty with which you are able to do this mental task.
- RATING:** _____

Imagery**Appendix D****GENERAL QUESTIONNAIRE**

The following questionnaire will be used to evaluate your participation in various components of this study. Please be honest with your responses.

1. I was able to perform vivid imagery during daily practice sessions.

Strongly Agree Agree Neutral Disagree Strongly Disagree

Comments:

2. I was able to perform vivid imagery during rest periods between Kin-Com trials.

Strongly Agree Agree Neutral Disagree Strongly Disagree

Comments:

3. I believe the imagery techniques helped me perform better on the Kin-Com trials.

Strongly Agree Agree Neutral Disagree Strongly Disagree

Comments:

4. I was compliant with performing my daily imagery techniques (please be honest).

Strongly Agree Agree Neutral Disagree Strongly Disagree

Comments:

5. The average length of time I performed my visualization per day was minutes.

Comments:

6. I was compliant with not exercising for 48hours prior to testing.

Strongly Agree Agree Neutral Disagree Strongly Disagree

Belief

Appendix D
GENERAL QUESTIONNAIRE

The following questionnaire will be used to evaluate your participation in various components of this study. Please be honest with your responses.

1. I was able to perform vivid imagery during daily practice sessions.

Strongly Agree Agree Neutral Disagree Strongly Disagree

Comments:

2. I was able to perform vivid imagery during rest periods between Kin-Com trials.

Strongly Agree Agree Neutral Disagree Strongly Disagree

Comments:

3. I believe the imagery techniques helped me perform better on the Kin-Com.

Strongly Agree Agree Neutral Disagree Strongly Disagree

Comments:

4. I believed the education I received regarding the positive effects of imagery on motor performance.

Strongly Agree Agree Neutral Disagree Strongly Disagree

Comments:

5. My performance on Kin-Com trials increased the last week due to the education I received regarding the positive effects of imagery on motor performance.

Strongly Agree Agree Neutral Disagree Strongly Disagree

Comments:

6. I was compliant with performing daily imagery techniques (please be honest).

Strongly Agree Agree Neutral Disagree Strongly Disagree

Comments:

7. I was compliant with not exercising for 48 hours prior to testing.

Strongly Agree Agree Neutral Disagree Strongly Disagree

8. The average length of time I performed my visualization was ___ minutes.

Strongly Agree Agree Neutral Disagree Strongly Disagree

Control**Appendix D****GENERAL QUESTIONNAIRE**

The following questionnaire will be used to evaluate your participation in various components of this study. Please be honest with your responses.

1. I spontaneously visualized myself performing the Kin-Com test during the week between each of the weekly Kin-Com testing sessions.

Strongly Agree Agree Neutral Disagree Strongly Disagree

Comments:

2. I spontaneously visualized myself performing well immediately before my Kin-Com tests, during rest periods on the Kin-Com, or during actual testing.

Strongly Agree Agree Neutral Disagree Strongly Disagree

Comments:

3. I spontaneously set personal best goals (attempting to exceed previous strength trials) while being tested on the Kin-Com.

Strongly Agree Agree Neutral Disagree Strongly Disagree

Comments:

4. I was compliant with my daily reading (please be honest).

Strongly Agree Agree Neutral Disagree Strongly Disagree

Comments:

5. I was compliant with not exercising for 48 hours prior to testing.

Strongly Agree Agree Neutral Disagree Strongly Disagree

Appendix E. Daily Imagery Script

DAILY PRACTICE

When performing the following imagery exercise, please sit in a quiet room with no distractions.

Now imagine that you are at the Providence Center for testing on the Kin-Com machine . . . Visualize warming-up on the stationary bicycle . . . then visualize yourself sitting on the Kin-Com with your knees bent . . . note the temperature of the room . . . feel the seat belt around your waist and the stabilizing pad lowered onto your thigh . . . notice the chest restraint in place . . . feel the pad securely fastened on your shin, where the resistance from the machine will be applied . . . listen to the familiar sounds of the machine and the instructions from the researchers . . . you will be asked to kick up throughout the entire range several times . . . imagine yourself setting a new personal best for each strength trial.

Visualize yourself kicking up as hard and as fast as you can from a bent knee position to a straight knee position . . . Imagine yourself kicking up as hard and as fast as you can, as if you were kicking a ball as hard and as far as possible, giving your best effort . . . as the machine reverses, visualize yourself kicking up as hard and as fast as you can, slowing the machine down as much as you can, giving your best effort.

During actual testing on the Kin-Com when you are kicking throughout the entire range, you will be given a 20 second rest period between each strength trial to perform your imagery techniques. When given the command to rest, visualize yourself kicking up as hard and as fast as you can setting a new personal best for each trial. To help you focus, you may also silently rehearse the key words:

"See It, Feel It" immediately before and after performing visualization during daily practice sessions and before and after visualization during 20 second rest periods on days of actual strength testing.

Appendix F. MIQ-R Percent & Frequencies

Frequencies

Q1 (rows) by ID (columns)

	1	2	3	Total
4	0	1	1	2
5	3	0	0	3
6	1	5	3	9
7	2	1	2	5
Total	6	7	6	19

Percents of total count

Q1 (rows) by ID (columns)

	1	2	3	Total	N
4	0.0	5.263	5.263	10.526	2
5	15.789	0.0	0.0	15.789	3
6	5.263	26.316	15.789	47.368	9
7	10.526	5.263	10.526	26.316	5
Total	31.579	36.842	31.579	100.000	19
N	6	7	6		

Frequencies

Q2 (rows) by ID (columns)

	1	2	3	Total
5	1	0	1	2
6	5	2	2	9
7	0	5	3	8
Total	6	7	6	19

Percents of total count

Q2 (rows) by ID (columns)

	1	2	3	Total	N
5	5.263	0.0	5.263	10.526	2
6	26.316	10.526	10.526	47.368	9
7	0.0	26.316	15.789	42.105	8
Total	31.579	36.842	31.579	100.000	19
N	6	7	6		

Frequencies

Q3 (rows) by ID (columns)

	1	2	3	Total
3	0	0	1	1
4	0	0	1	1
5	2	2	1	5
6	3	2	1	6
7	1	3	2	6
Total	6	7	6	19

Percents of total count

Q3 (rows) by ID (columns)

	1	2	3	Total	N
3	0.0	0.0	5.263	5.263	1
4	0.0	0.0	5.263	5.263	1
5	10.526	10.526	5.263	26.316	5
6	15.789	10.526	5.263	31.579	6
7	5.263	15.789	10.526	31.579	6
Total	31.579	36.842	31.579	100.000	19
N	6	7	6		

Appendix F. MIQ-R Percent & Frequencies

Frequencies
Q4 (rows) by ID (columns)

	1	2	3	Total
3	1	0	0	1
5	1	0	1	2
6	4	2	2	8
7	0	5	3	8
Total	6	7	6	19

Percents of total count
Q4 (rows) by ID (columns)

	1	2	3	Total	N
3	5.263	0.0	0.0	5.263	1
5	5.263	0.0	5.263	10.526	2
6	21.053	10.526	10.526	42.105	8
7	0.0	26.316	15.789	42.105	8
Total	31.579	36.842	31.579	100.000	
N	6	7	6		19

Frequencies
Q5 (rows) by ID (columns)

	1	2	3	Total
3	1	0	1	2
4	0	1	1	2
5	3	1	3	7
6	1	4	1	6
7	1	1	0	2
Total	6	7	6	19

Percents of total count
Q5 (rows) by ID (columns)

	1	2	3	Total	N
3	5.263	0.0	5.263	10.526	2
4	0.0	5.263	5.263	10.526	2
5	15.789	5.263	15.789	36.842	7
6	5.263	21.053	5.263	31.579	6
7	5.263	5.263	0.0	10.526	2
Total	31.579	36.842	31.579	100.000	
N	6	7	6		19

Frequencies
Q6 (rows) by ID (columns)

	1	2	3	Total
5	1	1	0	2
6	4	1	4	9
7	1	5	2	8
Total	6	7	6	19

Percents of total count
Q6 (rows) by ID (columns)

	1	2	3	Total	N
5	5.263	5.263	0.0	10.526	2
6	21.053	5.263	21.053	47.368	9
7	5.263	26.316	10.526	42.105	8
Total	31.579	36.842	31.579	100.000	
N	6	7	6		19

Appendix F. MIQ-R Percent & Frequencies

Frequencies

Q7 (rows) by ID (columns)

	1	2	3	Total
2	1	0	0	1
3	0	1	0	1
4	0	0	2	2
5	0	1	0	1
6	4	2	3	9
7	1	3	1	5
Total	6	7	6	19

Percents of total count

Q7 (rows) by ID (columns)

	1	2	3	Total	N
2	5.263	0.0	0.0	5.263	1
3	0.0	5.263	0.0	5.263	1
4	0.0	0.0	10.526	10.526	2
5	0.0	5.263	0.0	5.263	1
6	21.053	10.526	15.789	47.368	9
7	5.263	15.789	5.263	26.316	5
Total	31.579	36.842	31.579	100.000	
N	6	7	6		19

Frequencies

Q8 (rows) by ID (columns)

	1	2	3	Total
5	1	1	0	2
6	4	0	2	6
7	1	6	4	11
Total	6	7	6	19

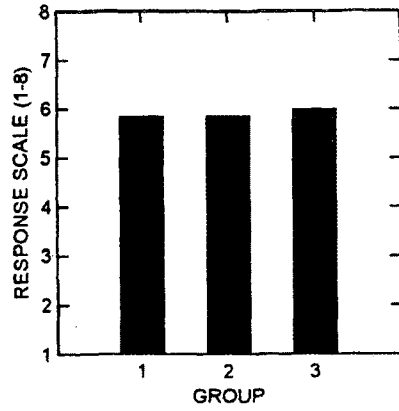
Percents of total count

Q8 (rows) by ID (columns)

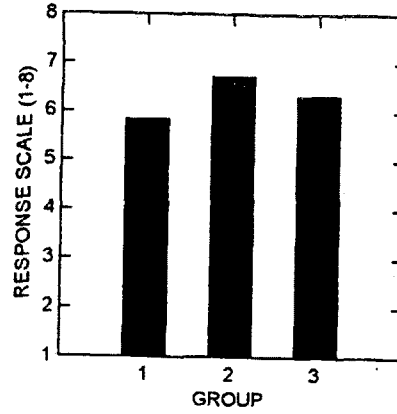
	1	2	3	Total	N
5	5.263	5.263	0.0	10.526	2
6	21.053	0.0	10.526	31.579	6
7	5.263	31.579	21.053	57.895	11
Total	31.579	36.842	31.579	100.000	
N	6	7	6		19

Appendix G. MIQ-R Graphs

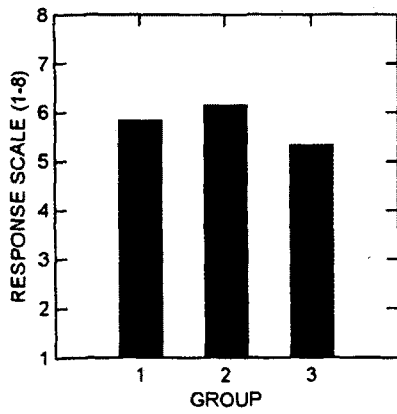
MIQ-R QUESTION 1



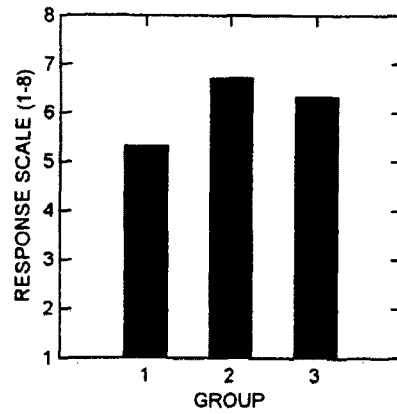
MIQ-R QUESTION 2



MIQ-R QUESTION 3

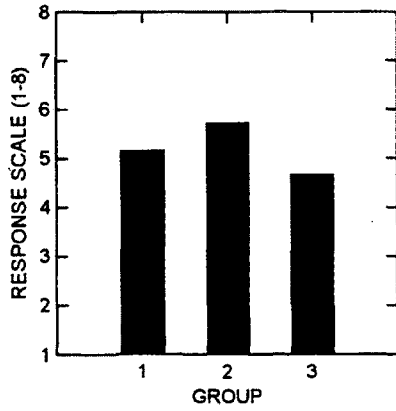


MIQ-R QUESTION 4

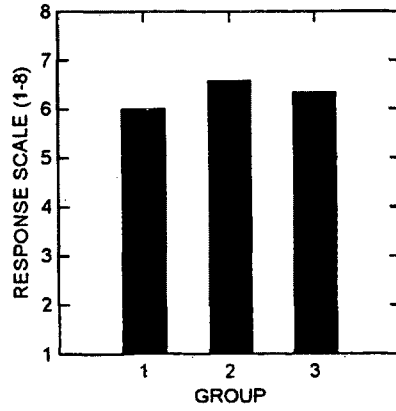


Appendix G. MIQ-R Graphs

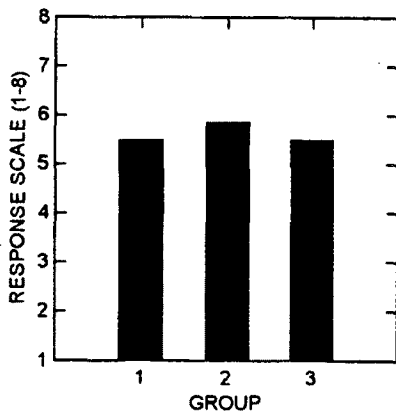
MIQ-R QUESTION 5



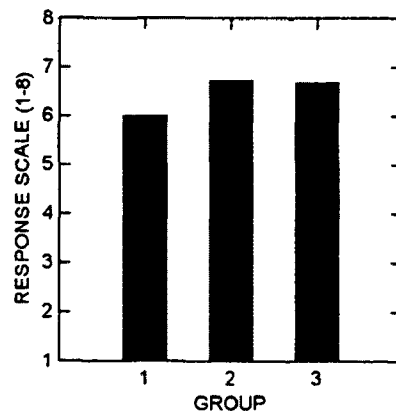
MIQ-R QUESTION 6



MIQ-R QUESTION 7



MIQ-R QUESTION 8



Appendix H. General Questionnaire Percent & Frequencies

NO EXERCISE COMPLIANCE

	Frequency	Percent	Valid Percent	Cumulative Percent
Valid 4.00	1	16.7	16.7	16.7
5.00	5	83.3	83.3	100.0
Total	6	100.0	100.0	
Total	6	100.0		

Control

DAILY INTERVENTION COMPLIANCE

	Frequency	Percent	Valid Percent	Cumulative Percent
Valid 2.00	2	33.3	33.3	33.3
4.00	3	50.0	50.0	83.3
5.00	1	16.7	16.7	100.0
Total	6	100.0	100.0	
Total	6	100.0		

Control

NO EXERCISE COMPLIANCE

	Frequency	Percent	Valid Percent	Cumulative Percent
Valid 4.00	1	14.3	14.3	14.3
5.00	6	85.7	85.7	100.0
Total	7	100.0	100.0	
Total	7	100.0		

Imagery

DAILY INTERVENTION COMPLIANCE

	Frequency	Percent	Valid Percent	Cumulative Percent
Valid 3.00	1	14.3	14.3	14.3
4.00	5	71.4	71.4	85.7
5.00	1	14.3	14.3	100.0
Total	7	100.0	100.0	
Total	7	100.0		

Imagery

NO EXERCISE COMPLIANCE

	Frequency	Percent	Valid Percent	Cumulative Percent
Valid 5.00	6	100.0	100.0	100.0
Total	6	100.0	100.0	
Total	6	100.0		

Belief

DAILY INTERVENTION COMPLIANCE

	Frequency	Percent	Valid Percent	Cumulative Percent
Valid 2.00	1	16.7	16.7	16.7
4.00	3	50.0	50.0	66.7
5.00	2	33.3	33.3	100.0
Total	6	100.0	100.0	
Total	6	100.0		

Belief

Appendix H. General Questionnaire Percent & Frequencies

AVERAGE IMAGERY TIME PER DAY

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	2.00	1	14.3	14.3	14.3
	2.50	1	14.3	14.3	28.6
	3.00	2	28.6	28.6	57.1
	3.50	1	14.3	14.3	71.4
	4.00	1	14.3	14.3	85.7
	5.50	1	14.3	14.3	100.0
	Total	7	100.0	100.0	
Total		7	100.0		

Imagery

ABILITY TO PERFORM IMAGERY DAILY

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	4.00	2	28.6	28.6	28.6
	5.00	5	71.4	71.4	100.0
	Total	7	100.0	100.0	
Total		7	100.0		

Imagery

AVERAGE IMAGERY TIME PER DAY

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	2.00	3	50.0	50.0	50.0
	2.50	1	16.7	16.7	66.7
	3.00	1	16.7	16.7	83.3
	5.00	1	16.7	16.7	100.0
	Total	6	100.0	100.0	
Total		6	100.0		

Belief

ABILITY TO PERFORM IMAGERY DAILY

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	4.00	6	100.0	100.0	100.0
	Total	6	100.0	100.0	
Total		6	100.0		

Belief

Appendix H. General Questionnaire Percent & Frequencies

IMAGERY ABILITY DURING REST PERIODS

	Frequency	Percent	Valid Percent	Cumulative Percent
Valid 4.00	1	14.3	14.3	14.3
5.00	6	85.7	85.7	100.0
Total	7	100.0	100.0	
Total	7	100.0		

Imagery

BELIEF THAT IMAGERY IMPROVED PERFORMANCE

	Frequency	Percent	Valid Percent	Cumulative Percent
Valid 4.00	5	71.4	71.4	71.4
5.00	2	28.6	28.6	100.0
Total	7	100.0	100.0	
Total	7	100.0		

Imagery

IMAGERY ABILITY DURING REST PERIODS

	Frequency	Percent	Valid Percent	Cumulative Percent
Valid 5.00	6	100.0	100.0	100.0
Total	6	100.0	100.0	
Total	6	100.0		

Belief

BELIEF THAT IMAGERY IMPROVED PERFORMANCE

	Frequency	Percent	Valid Percent	Cumulative Percent
Valid 3.00	1	16.7	16.7	16.7
4.00	4	66.7	66.7	83.3
5.00	1	16.7	16.7	100.0
Total	6	100.0	100.0	
Total	6	100.0		

Belief

Appendix H. General Questionnaire Percent & Frequencies

BELIEF IN IMAGERY EDUCATION

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	4.00	2	33.3	33.3	33.3
	5.00	4	66.7	66.7	100.0
	Total	6	100.0	100.0	
Total		6	100.0		

Belief

BELIEF THAT EDUCATION IMPROVED PERFORMANCE

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	3.00	1	16.7	16.7	16.7
	4.00	4	66.7	66.7	83.3
	5.00	1	16.7	16.7	100.0
	Total	6	100.0	100.0	
Total		6	100.0		

Belief

Appendix H. General Questionnaire Percent & Frequencies

**PERFORMED SPONTANEOUS IMAGERY
DURING WEEKS BETWEEN TESTING (Q9)**

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1.00	1	16.7	16.7	16.7
	2.00	1	16.7	16.7	33.3
	3.00	2	33.3	33.3	66.7
	4.00	2	33.3	33.3	100.0
	Total	6	100.0	100.0	
Total		6	100.0		

Control
**PERFORMED SPONTANEOUS IMAGERY
DURING REST PERIODS (Q10)**

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	2.00	2	33.3	33.3	33.3
	3.00	1	16.7	16.7	50.0
	4.00	2	33.3	33.3	83.3
	5.00	1	16.7	16.7	100.0
	Total	6	100.0	100.0	
Total		6	100.0		

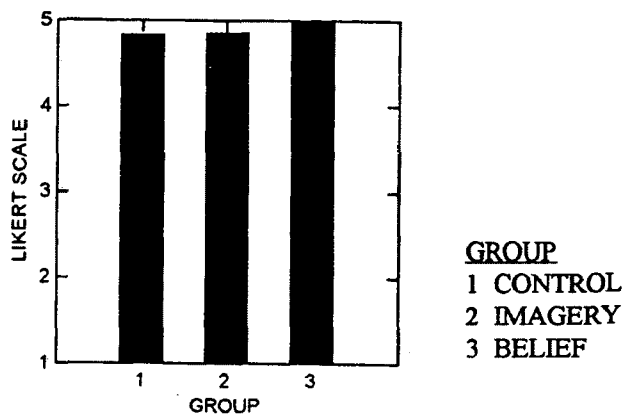
Control
PERFORMED SPONTANEOUS GOAL SETTING (Q11)

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1.00	1	16.7	16.7	16.7
	2.00	1	16.7	16.7	33.3
	3.00	2	33.3	33.3	66.7
	4.00	1	16.7	16.7	83.3
	5.00	1	16.7	16.7	100.0
	Total	6	100.0	100.0	
Total		6	100.0		

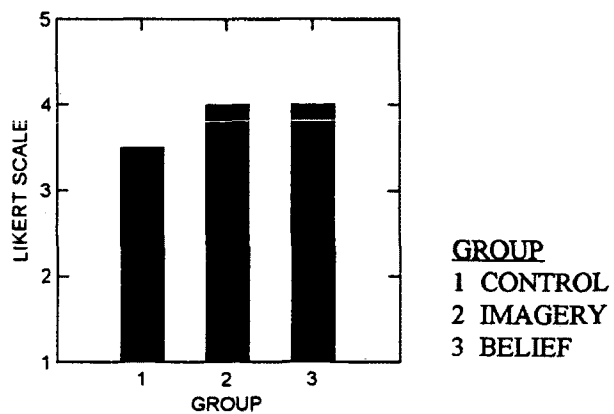
Control

Appendix I. General Questionnaire Graphs

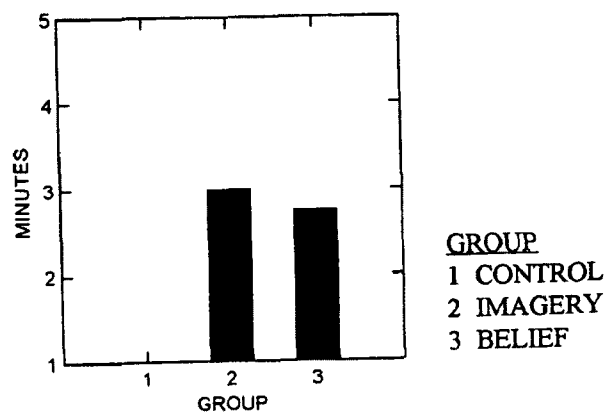
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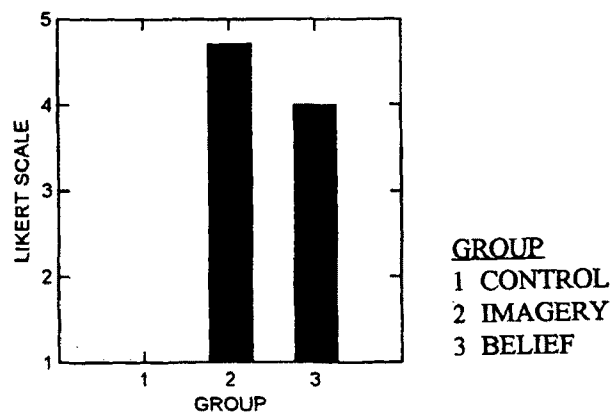
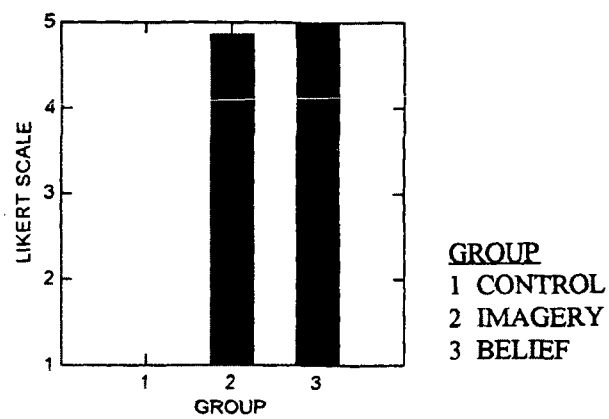
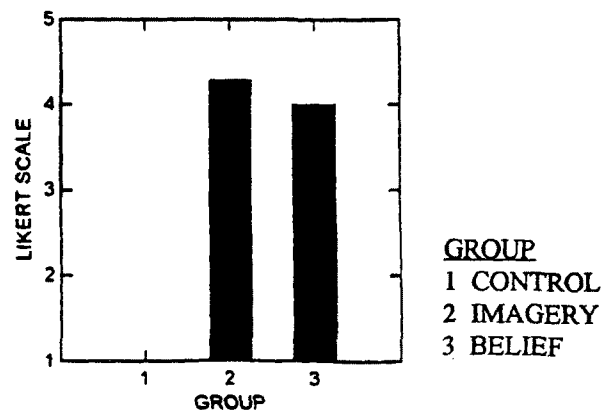


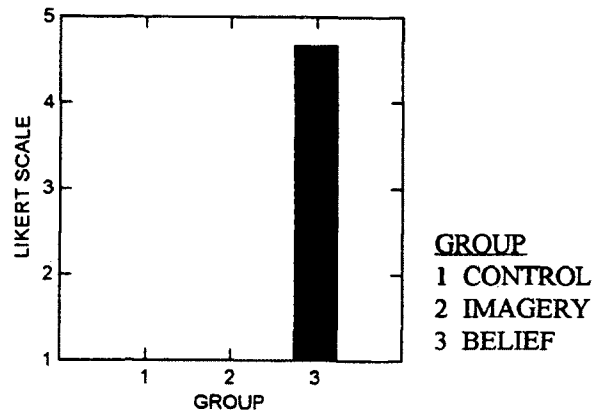
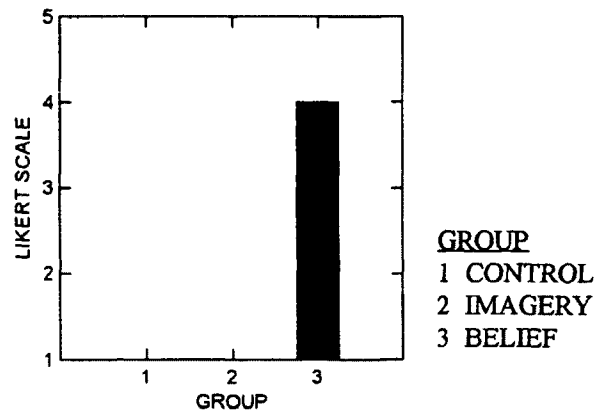
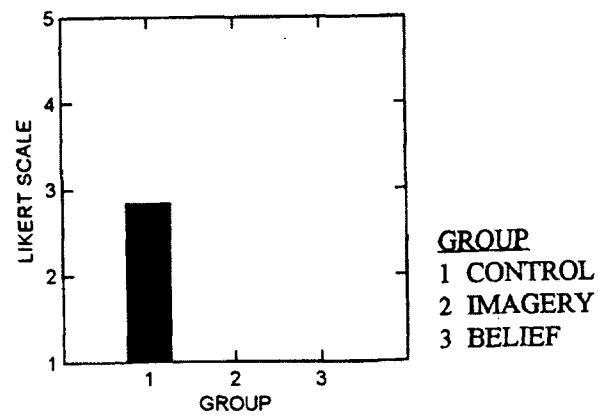
DAILY INTERVENTION COMPLIANCE



AVERAGE IMAGERY TIME PER DAY

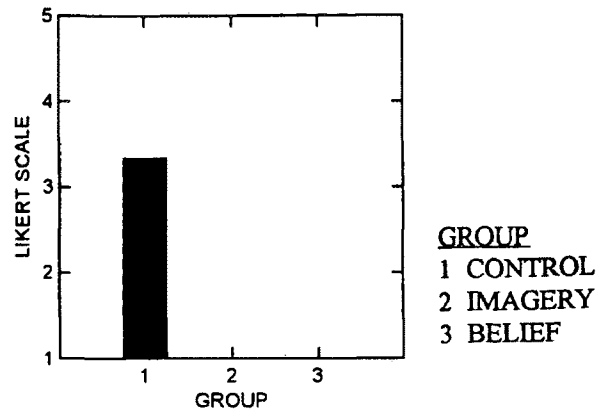


Appendix I. General Questionnaire Graphs**IMAGERY ABILITY DAILY****IMAGERY ABILITY DURING REST PERIODS****BELIEF IMAGERY IMPROVED PERFORMANCE**

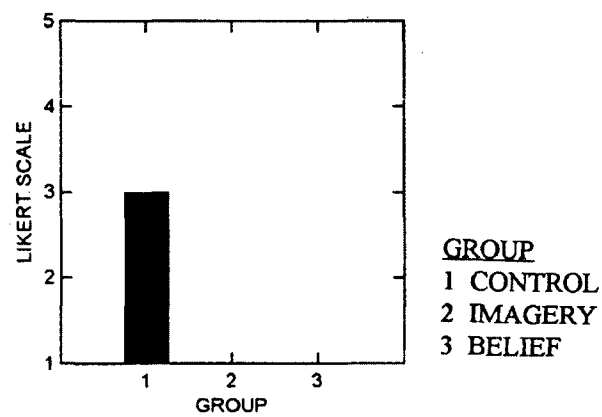
Appendix I. General Questionnaire Graphs**BELIEF IN IMAGERY EDUCATION****BELIEF EDUCATION IMPROVED PERFORMANCE****PERFORMED SPONTANEOUS IMAGERY WEEKLY**

Appendix I. General Questionnaire Graphs

SPONTANEOUS IMAGERY DURING REST PERIODS



SPONTANEOUS GOAL SETTING



Appendix J

THE UNIVERSITY OF MONTANA
 INSTITUTIONAL REVIEW BOARD (IRB)
 CHECKLIST

Submit one completed copy of this Checklist, including any required attachments, for each project involving human subjects. The IRB meets monthly to evaluate proposals, and approval is granted for one academic year. See *IRB Guidelines and Procedures* for details.

Project Director: Patsy Mangan Dept.: HHP Phone: 243-4006

Signature: *Patsy Mangan* Date: 11/24/97

Co-Director(s): Alicia Kuhl and Brian Miller Dept.: Phys. Therapy Phone: 243-6070

Project Title: 1. Quadriceps muscle performance: comparison of a hand-held dynamometer and an isokinetic dynamometer. 2. The effects of imagery & belief on motor performance.

Project Description: 1. This project will measure quadriceps muscle strength using two instruments. 2. Using one of the instruments, the effects of imagery and belief interventions on quadriceps strength will be assessed.

Please provide the dates requested below:

Date Submitted to IRB	Projected Start Date	Ending Date
11/25/97	2/7/98	9/23/98

Students only: 1. Beth Ikeda Phys. Therapy 243-5190
 Faculty Supervisor: 2. Lew Curry Dept.: HHP Phone: 243-5242

Signature: *Lew Curry* Date: 11/24/97
 (My signature confirms that I have read the IRB Checklist and attachments and agree that it accurately and adequately represents the planned research and that I will supervise this research project.)

Project Director: Please complete page 2 of IRB Checklist, on back.

For IRB Use Only

IRB Review and Determination:

Exempt from Review Expedited/Administrative Review Approved

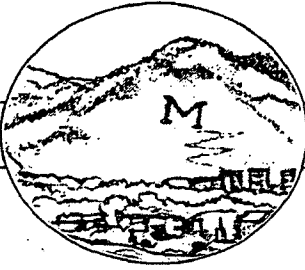
Conditional approval: _____

Resubmit proposal: _____

Disapproved: _____

Signature/IRB Chair: *Barrie Haidmick* Date: Dec 5, 1997

Appendix K



ST. PATRICK HOSPITAL / COMMUNITY MEDICAL CENTER INC.

JOINT INVESTIGATIONAL REVIEW BOARD

500 W. Broadway • Missoula, MT 59802 • (406) 329-5669 • Fax: (406) 329-5677

APPROVED: November 4, 1997

PERIODIC REVIEW DUE: August 1998

November 4, 1997

Alicia Kuhl
 Patsey Mangan
 Brian Miller
 620 Whittaker #4B
 Missoula, MT 59803

Dear Ms. Kuhl, Ms. Mangan, and Mr. Miller:

Research Entitled: Comparison of hand-held dynamometer and the Kin-Com, an isokinetic machine to measure quadriceps muscle strength and an investigation of the effects of cognitive strategies on physical performance:

Your research project and consent form were reviewed and approved by the Joint Investigational Review Board on November 4, 1997. The study population will consist of 18 female students. This approval is effective for nine months, at which time the IRB will request follow up information.

The following is a list of IRB expectations which apply to this project:

1. You must promptly report any procedural changes or amendments to the IRB for review and approval. No changes may be implemented without IRB approval except to eliminate apparent immediate hazards.
2. You must report to the IRB within five (5) working days ALL unanticipated adverse events whether significant or insignificant and whether or not study related. Any unanticipated problems involving risks to subjects must be promptly reported to the IRB as well.
3. All patients being entered on this project must sign the current Approved Consent Form. You are responsible for maintaining all consent forms in appropriate medical charts and/or in your personal records as investigator.
4. This project will be subject to continuing review. A report will be required prior to the next periodic review date as noted in the upper right hand corner or upon completion of the study.
5. Periodic site visits may be made by the IRB. You are therefore, requested to provide the information required should your project be reviewed.
6. If your project has been significantly altered as a result of the IRB review and recommendations, it is your responsibility to notify the study sponsor of the changes.

Sincerely,

J.E. Gouaux, M.D., Chairman
 Joint Investigational Review Board

JEG/lg