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A COMPARISON OF TRADITIONAL INSTRUCTION, MENTAL PRACTICE, AND COMBINED PHYSICAL-MENTAL PRACTICE UPON THE LEARNING OF SELECTED MOTOR SKILLS

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A COMPARISON OF TRADITIONAL INSTRUCTION, MENTAL PRACTICE, AND COMBINED PHYSICAL-MENTAL PRACTICE UPON THE LEARNING OF SELECTED MOTOR SKILLS

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ABSTRACT

A COMPARISON OF TRADITIONAL INSTRUCTION, MENTAL PRACTICE, AND COMBINED PHYSICAL-MENTAL PRACTICE UPON THE LEARNING OF SELECTED MOTOR SKILLS

by Robert C. LaLance, Jr.

The purpose of this study was to compare the effects of traditional instruction, mental practice, and combined physical-mental practice upon the learning of the power and lob services in handball. Particular emphasis was given mental practice.

The subjects were sixty male students enrolled at Middle Tennessee State University. Of these, forty-six subjects were distributed among three handball classes offered by the University physical education department. The remaining fourteen subjects comprised a control group and were chosen from among male students not enrolled in physical education activity courses. Subjects in all groups were given a modified version of a handball service test developed by Pennington and others. In addition, the Iowa Brace Test of Motor Educability was administered to each subject.

Each of the three handball classes was assigned one of the instructional methods for learning the selected skills. The control group did not participate in any physical education activity during the experimental period. At the conclusion of the five and one-half week experimental period, all subjects were again tested on handball service skill as determined by the modified Pennington test.

The power and lob service scores were analyzed by a Groups by Pre/Post analysis of variance with repeated measures on the pre/post factor. In addition, the Iowa-Brace scores were correlated with the pre- to post-test difference scores of the Pennington test by means of a Pearson Product-Moment correlation analysis.

Major findings of this study were as follow:

(1) There were no significant effects of the instructional methods on the power service.

(2) The Traditional instructional method was significantly superior to the Control and Mental Practice methods for teaching the lob service.

(3) The Combined Physical-Mental instructional method was significantly superior to the Control "method" for teaching the lob service.

(4) There was no evidence to support the ability of the Iowa-Brace Test to predict improvement in either the power or lob handball service.

ACKNOWLEDGEMENTS

The writer wishes to express his appreciation to everyone whose assistance, guidance and directions made the completion of this study possible. Primary among those who gave their time and talents is Dr. Stanley H. Hall, the director of this project and chairman of the doctoral committee. In addition, the writer is grateful to Dr. Hall for making available the handball classes and facilities of the Physical Education Department, without which this study would have been impossible. Special tribute must also be paid to the other members of the writer's doctoral committee who include Dean Robert C. Aden, Dr. Herschel Aseltine, Dr. Wallace R. Maples and Dr. Fran Riel.

The writer is indeed indebted to Dr. Robert E. Prytula, who unselfishly donated his time and expertise to the statistical aspects of this investigation. Special acknowledgement is also given to Dr. Powell D. McClellan and Dr. A. H. Solomon for their assistance during the conceptual and planning stages of this study. For her technical assistance in the development of selected visual aids and in the preparation of photographs for inclusion in this

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Finally, had it not been for the gentle prodding and understanding of my loving wife, Martha Lou, and the kind tolerance of Wendy, Chuck, and Amy, this project would never have been more than a dream.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF ILLUSTRATIONS

LIST OF APPENDIXES

Chapter 1

INTRODUCTION

Physical educators, athletic coaches, psychologists, and others concerned with the teaching of motor skills and the mastery of physical performance objectives have long labored over developing techniques and procedures which will beneficially affect both the rate and quality of learning motor skills. Physical educators, in particular, have been handicapped to a certain extent in this endeavor due to the relatively limited amount of available class time. It has been necessary, therefore, that physical education teachers make optimum use of the facilities, equipment, and time available to them. In addition, such factors as class size and individual differences among students must be given careful consideration during motor skill instruction.

In their early attempts at motor skill instruction, physical educators primarily utilized mass practice techniques. This method of instruction was used because there were simply too many students with too little equipment and space to do otherwise. Another reason for the prevalence of mass practice techniques was a lack of evidence

to indicate the need for different methods. Evidence slowly developed, however, which indicated a need for recognizing individual differences and motivational levels among students. Resultant changes in teaching methods accompanied this evidence; however, practice continued to be physical in nature.

As scholarly research and experimental investigation of motor skill learning continued, the literature began to indicate the possible value of cognitive processes in the acquisition of physical skills. The 1930's and 1940's saw the development of some of the earliest theories concerning the value of mental practice in learning physical skills.[1] Since that time, many researchers have investigated the relative value of mental practice (MP) and its effect on varied types of motor learning.[2] This investigation has led to the general conclusion that MP has definite value in the learning of certain motor skills under certain conditions.

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[1]R. S. Sackett, "The Influences of Symbolic Rehearsal Upon the Retention of a Maze Habit," The Journal of General Psychology, X (1934), 376-395; Horace M. Perry, "The Relative Efficiency of Actual and Imaginary Practice in Five Selected Motor Tasks," Archives of Psychology, XXXIV (1939), 5-75; and Roland A. Vandell, Robert A. Davis, and Herbert A. Clugston, "The Function of Mental Practice in the Acquisition of Motor Skills," The Journal of General Psychology, XXIX (October, 1943), 243-350.

[2]Alan Richardson, "Mental Practice: A Review and Discussion--Part I," The Research Quarterly, XXXVIII, No. 1 (March, 1967), 95-107.

Given the evidence showing the value of MP, it seems remarkable that teachers have not used the MP approach as a partial solution to the problem of best use of time. Teachers in classes with particularly large enrollments in limited-sized teaching stations could possibly make valuable use of class time by alternating MP with actual physical practice (PP) among various groups within the class. It also seems reasonable to assume that MP could be put to good use on inclement days when activities normally practiced out of doors are impractical due to the weather and/or lack of suitable indoor space.

The factor of student motivation must be carefully considered during any goal-oriented learning process such as the acquisition of a certain motor skill. The utilization of MP as a partial or complete substitute for traditional PP methods could well raise motivational problems among the students. If handled carefully, however, these problems should be no more serious than those normally encountered in other practice situations. Regardless of the practice method, the objectives must be clearly identified and understood and the atmosphere of the teaching station must be conducive to learning. The teacher who shows concern for these factors will go a long way toward eliminating problems typically associated with low motivation.

In light of all the evidence and possible uses regarding MP, it seems noteworthy to report that little consideration has been given to MP by practicing physical educators. It appears to this writer that MP indeed merits additional investigation and should be given careful consideration as a potential teaching method in physical education activity instruction. This study was concerned with further assessing the value of MP as a teaching method for motor skill learning.

STATEMENT OF THE PROBLEM

The purpose of this study was to ascertain the relative effects of four methods of instruction upon the learning of two variations of a selected motor skill. The four methods of instruction were: (1) traditional, (2) mental practice, (3) combined mental-physical practice, and (4) no-practice. The criterion established for use in this study was the ability to execute the lob and power handball services as measured by a variation of the test developed by Pennington, et al.[3]

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[3]G. Gary Pennington, James A. P. Day, John N. Drowatzky, and John F. Hansan, "A Measure of Handball Ability," The Research Quarterly, XXXVIII, No. 2 (May, 1967), 247-253.

PURPOSE OF THE STUDY

All physical educators, as well as everyone else interested in human performance, are generally aware of the necessity of improving techniques by which motor learning occurs. The very process of "education through the physical"[4] has been characterized, however, by too little concern for experimentation with "non-physical" techniques during the learning period. A concept long accepted by physical educators is the "unity of man," or "organic unity" theory. This theory holds that there is a highly sophisticated integration of the human mind and body. These two entities can not function as mutually exclusive agents.[5]

It is strange, then, when considering the high level of general acceptance of the unity theory, that physical educators have not done more to involve cognitive processes when teaching motor skills. Theoretically, it seems there should be some systematic procedure for integrating MP techniques with PP techniques whereby the end result would be so favorable that physical educators could not possibly exclude this "method" from their teaching patterns.

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[4]George W. Hartmann, Educational Psychology (New York: American Book Company, 1941), p. 46.

[5]Ibid., p. 62.

While it goes without saying that one study seldom has a profound effect on a body of knowledge, it was hoped that this study would eliminate some of the uncertainty concerning the use of MP in the teaching of physical activities and perhaps uncover something that would stimulate subsequent investigation of the subject by future inquiries.

LIMITATIONS OF THE STUDY

Any investigation relying on statistical analyses for determining the significance of results is characterized by a certain element of chance. In dealing with groups consisting of no more than sixteen (16) subjects each, the writer acknowledges a certain limitation of the design based on the relatively small group sizes utilized.

There were indeed certain variables existing that could have biased the results of this study. One such variable was the motivational levels of the subjects. Every attempt was made by the writer to maintain a high level of motivation among the subjects during the course of the study. No assurance could be made, however, that guaranteed the elimination of this potential limitation. Another factor which may have had an undesirable effect on the criterion was the amount of carryover learning available from previous experiences. The design of this study provided for the

utilization of groups of subjects substantially predetermined by registration patterns and, therefore, offered little possibility for compensating for natural discrepancies among groups. Matching subjects, for example, or applying similar techniques for equating groups at the onset was not feasible in this design. It is acknowledged, therefore, that intangible factors such as those mentioned had a potential for tainting the results of this investigation.

An even greater limitation, however, existed due to the very nature of MP. Of necessity, MP was conducted on an internal basis and, therefore, presented a condition over which this investigator had little control. The writer had no means of being assured that the MP subjects did in fact engage in MP. It would have been an easy matter for a subject not endeared with the MP method to simply have sat with closed eyes and thought of anything but the criterion. The writer constantly stressed the importance of intensive involvement and concentration by the subjects.

DEFINITIONS OF TERMS

Traditional Instruction

For the purposes of this study, traditional instruction consisted of an oral description of the skill, supplemented by various visual and verbal aids and followed

by a practical demonstration by the instructor. The primary emphasis of traditional instruction was physical practice of the skills by students practicing individually or in small groups.

Mental Practice (MP)

For the purposes of this study, MP consisted exclusively of cognitive processes devoted to understanding and learning the motor skill. MP may be defined in various ways due to its abstract nature. The following examples of instruction are offered: "close your eyes and see yourself performing the skill; use your imagination; feel yourself perform the skill without overtly moving; rehearse the skill mentally." In addition, MP included audio-visual techniques, written drills, and problem solving in small groups.

Combined Mental-Physical Practice (MP-PP)

For the purposes of this study, MP-PP consisted of a combination of the methods employed in traditional instruction and MP. Each practice period (class meeting) consisted of 75 per cent (thirty minutes) of the time devoted to PP and 25 per cent (ten minutes) to MP.

Serving Skill

For the purposes of this study, serving skill was defined as the ability to strike the handball with the hand in such a way as to cause the ball to rebound off the front wall of the handball court and land in prescribed areas of the court. The lob serve and the power serve were the only type services utilized in this study.

Motor Educability

For the purposes of this study, motor educability was defined as the inherent aptitude (motor and mental) for learning new skills quickly and effectively.[6]

HYPOTHESES

For the purposes of this study, the following null hypotheses were tested:

HO_1: There will be no statistically significant differences among the four groups based on the initial test data.

HO_2: There will be no statistically significant increases in mean serving skill performance as a result of the experimental treatments.

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[6] M. Gladys Scott and Ester French, Measurement and Evaluation in Physical Education (Dubuque, Iowa: Wm. C. Brown Company, Inc., 1959), p. 342.

HO_3: There will be no statistically significant differences among experimental methods for increasing mean performances of serving skill.

HO_4: There will be no statistically significant positive relationships between motor educability and mean improvement in serving skill.

Chapter 2

REVIEW OF THE LITERATURE

The purpose of this chapter is to survey the literature regarding MP from the time of its conceptual emergence until the present. That this review may be more meaningful, the chapter has been organized into three major categories--early foundations and related studies, studies of MP as a method for developing or improving "physical education type" skills, and authoritative statements concerning the value of MP. The foundations and related studies section has been further divided into three sub-categories which seemingly represent the major areas of thrust during that developmental era.

EARLY FOUNDATIONS AND RELATED STUDIES

Although the concept of MP, per se, did not emerge until the early 1940's, a significant amount of research related to the early modern studies occurred between 1890 and 1940. A review of these initial studies indicates that most of the experimentation and reporting was done by psychologists and other behavioral scientists. The primary

areas of concern as revealed in the research were mental imagery, neuromuscular action during mental activity, and the effects of mental processes on the acquisition and accomplishment of selected fine-motor skills.

Mental Imagery

According to Shaw,[7] a study conducted by Dr. Joseph Jastrow[8] in 1892 actually marked the beginning of scientific interest between muscular activity and mental processes. Jastrow utilized a piece of apparatus similar to a Ouija board which measured the movement of the subjects' hands. He found that his subjects involuntarily moved their hands in a direction or fashion which was closely associated with the mental process of counting the beats of a metronome and other similar simple mental tasks. Jastrow later had the subjects concentrate on a nearby prominent landmark or hide an object somewhere in the vicinity and then asked them to think intently about the landmark or object without looking at it. It was found that the subjects' hands tended to move in the direction of the object of their thought.

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[7]William A. Shaw, "The Relation of Muscular Action Potentials to Imaginal Weight Lifting," Archives of Psychology, XXXV (February, 1940), 5-48.

[8]Joseph Jastrow, "A Study of Involuntary Movements," The American Journal of Psychology, IV (April, 1892), 398-407.

In an early study to investigate the behavior of mental images, Slaughter[9] found a trend which indicated: (1) the factors which keep visual images in clear consciousness are their own internal organization combined closely with motor elements; (2) that auditory images appear only in connection with an organized associative situation, in which motor elements usually play a predominant part; and (3) that images from other sense departments also require such a situation which is, in most cases, all that appears so that the real existence of these images is doubtful.

Meakin[10] conducted a study exploring the nature of memory images in early 1903. He felt that, if the mental image was to be continuous, a certain degree of complexity needed to be involved. In order for an image to occur after perception of an object, Meakin suggested that specific conditions were necessary:

> The tendency of an object to recur and persist in idea depends . . . upon the extent of its surface, the complexity of its form, the diversity of its contents, the length and recency of the time during which it occupies the attention, the definiteness of the direction which it imparts to the attention (as in the case of angles and lines), its state of motion or of rest, and finally, its brightness and its colors.[11]

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[9]J. W. Slaughter, "A Preliminary Study of the Behavior of Mental Images," The American Journal of Psychology, XIII (October, 1902), 526-549.

[10]Frederick Meakin, "Mutual Inhibition of Memory Images," The Psychological Review, Monograph Supplements, IV (January, 1903), 235-279.

[11]Ibid., p. 275.

The purpose of a study conducted by Perky[12] was to define and delimit the concept of imagination similar to what has been done to a related psychological concept, memory. In her summary, Perky held that the memory images of sight, sound, and smell involve gross movements of the eyes, larnyx, and nostrils, while the corresponding imaginations involve no such movement. She concluded that the materials of imagination are closely akin to those of perception and that imagination is more stable and vivid than memory, probably due to its kinaesthetic support.

An early book by Washburn on the subject of mental imagery appeared in 1916.[13] She stated that:

> Whenever a motor pathway is at the same time excited by a sensory pathway and partially inhibited by an antagonistic motor excitation, a process occurs in all sensory pathways connected with the motor pathway by low synaptic resistances, including the sensory pathway that is exciting the motor pathway in question. This process is accompanied by consciousness. When it occurs in a sensory pathway that has no outside excitation, it gives rise to the type of consciousness that we call a centrally excited sensation, or mental image.[14]

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[12]Cheves West Perky, "An Experimental Study of Imagination," The American Journal of Psychology, XXI (July, 1910), 422-452.

[13]Margaret Floy Washburn, Movement and Mental Imagery (Boston: Houghton-Mifflin Co., 1916).

[14]Ibid., p. 30.

A study by Clark[15] investigated the relationship between visual imagery and attention. One of her conclusions was that characteristic ocular movements, and possibly general motor attitudes, seemed to be transferred from visual perceptions to visual imagery. Thus, another close link was identified between motor activity and mental imagery.

Neuromuscular Action During Mental Activity

A significant amount of research concerning neuromuscular action during mental activities was conducted between 1925-1932 by Jacobson.[16] In a study to determine

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[15]Helen Clark, "Visual Imagery and Attention: An Analytical Study," The American Journal of Psychology, XXVII (October, 1916), 461-492.

[16]Edmund Jacobson, "Progressive Relaxation," The American Journal of Psychology, XXXVI (January, 1925), 73-87; "Electrical Measurements of Neuromuscular States During Mental Activities. (I) Imagination of Movement Involving Skeletal Muscle," The American Journal of Physiology, XCI (January, 1930), 567-607; "Electrical Measurements of Neuromuscular States During Mental Activities. (II) Imagination and Recollection of Various Muscular Acts," The American Journal of Physiology, XCIV (July, 1930), 26; "Electrical Measurements of Neuromuscular States During Mental Activities. (III) Visual Imagination and Recollection," The American Journal of Physiology, XCV (December, 1930), 694-702; "Electrical Measurements of Neuromuscular States During Mental Activities. (IV) Evidence of Convariation of Specific Muscles Contracting During Imagination; (V) Variation of Specific Muscles Contracting During Imagination," The American Journal of Physiology, XCVI (January, 1931), 115-121; "Electrical

whether thinking may take place where there is extreme muscular relaxation, Jacobson[17] found that, as relaxation progresses, ocular and other forms of motor, or kinaesthetic, imagery diminished until such time that "complete" relaxation occurs whereby imagery seems altogether absent.

In his first study concerning electrical measurements during mental activities, Jacobson[18] measured the actual potential of the right biceps both flexing the arm and imagining or recollecting a similar movement. During action flexion, he found that measurable electrical changes did occur in the neuromuscular regions which were involved in the performance. During imagination of the same action, Jacobson found that electrical phenomena simultaneously occurred in the biceps region of the arm. The action

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Measurements of Neuromuscular States During Mental Activities. (VI) A Note on Mental Activities Concerning the Amputated Limb," The American Journal of Physiology, XCVI (January, 1931), 122-125; "Electrical Measurements of Neuromuscular States During Mental Activities. (VII) Imagination, Recollection, and Abstract Thinking Involving the Speed Musculature," The American Journal of Physiology, XCVII (April, 1931), 200-209; and "Electrophysiology of Mental Activities," The American Journal of Psychology, XLIV (October, 1932), 677-694.

[17]Jacobson, "Progressive Relaxation," loc. cit.

[18]Jacobson, "(I) Imagination of Movement Involving Skeletal Muscle," loc. cit.

potential associated with imagery was perceptibly different from the psycho-galvanic reflex due to differences in other factors.

Continuing his studies in 1932, Jacobson[19] investigated phenomena occurring in the organism simultaneously with and indispensable to mental activities. Conclusions arrived at by the author were: (1) physiology of mental activity is not confined to closed circuits of the brain, but that muscular regions participate; (2) specifically, muscular action occurs in the muscle groups that are normally involved in specific imagined motor acts, such as lip and tongue movement during imagined speaking; and (3) as relaxation occurs in the muscles (body in general), mental imagery diminishes.

A review of the literature by Freeman[20] up until 1930 on the role of muscular tension in cortically integrated behavior led to the observation that most research had been conducted along two basic lines: (1) to vary some phase of higher behavior and observe its effects upon tonus accompaniments; and (2) to observe the effects of variations in muscular tension upon behavior. Freeman's own

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[19]Jacobson, "Electrophysiology of Mental Activities," loc. cit.

[20]G. L. Freeman, "Mental Activity and the Muscular Processes," The Psychological Review, XXXVIII (September, 1931), 428-449.

observations led him to conclude that mental activity (cerebration) is dominated by "excitation thresholds" which may be lowered by stimulation from lower neural centers, such as those involved in muscular contraction. To economize, the central nervous system utilizes a continuous flow of proprioceptive impulses from muscular contractions to sustain cortical processes in general. In effect, he concluded that muscular action results in increased and sustained cortical activity.

In a later study by Freeman,[21] it was found that the amount of spread of neuromuscular activity during mental work is a function of the set. Under conditions of habituation, general neuromuscular activity is lessened as the pattern becomes more specifically localized.

Clites[22] introduced a new slant to the study of neuromuscular activity during mental work by observing the effects of successful and unsuccessful problem solving on selected somatic activities. He found action potentials more prominent, and decreases in muscular movements and grip tension during successful, as compared with

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[21] G. L. Freeman, "The Spread of Neuromuscular Activity During Mental Work," The Journal of General Psychology, V (October, 1932), 479-494.

[22] Myron S. Clites, "Certain Somatic Activities in Relation to Successful and Unsuccessful Problem Solving," The Journal of Experimental Psychology, XIX (April, 1936), 172-192.

unsuccessful, problem solving. Clites concluded that muscular activity is increased during problem solving, or problem solving is identical with the increase in activity.

In another study concerning action potentials during imagination, Shaw[23] attempted to determine if muscular activity were generalized or localized during specific activities. It was found that the action potentials increased during imagining of the activities in nearly all muscle groups tested.

In a study investigating patterns of muscular activity as they related to psychological processes, action potentials were measured in the limbs of the subjects while they worked under normal working conditions and under conditions calling for relaxation of the right arm during work.[24] Muscular activity was found to increase progressively during work periods. The subjects exhibited more muscular activity in all parts of the body during mental work than during rest. It was found, however, that instructions to relax the right arm during mental work

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[23]William A. Shaw, "The Distribution of Muscular Action Potentials During Imaging," The Psychological Record, II (May, 1938), 195-216.

[24]R. C. Davis, "Patterns of Muscular Activity During 'Mental Work' and Their Constancy," The Journal of Experimental Psychology, XXIV (May, 1939), 451-465.

produced a decrease of activity there with smaller decreases in the other limbs, with no discoverable compensation.

All of the research cited in this section of the paper has substantiated one of the earliest theories on motor activity, i.e., that there are subconscious connections between the mental and physical attributes of the person. However, apparently no attempts were made to link the two in a conscious relationship in the teaching-learning processes. In developing her theory, Washburn[25] discussed associations that occur with a series of nonsense syllables or when a man is about to write a check that there are probably "going on in the muscles, light actual contractions."

Effects of Mental Processes on Fine-Motor Skills

The middle to late 1930's saw the emergence of research linking imaginary practice to selected motor skills. One of the earliest studies in this area investigated the influences of symbolic rehearsal upon the retention of a maze habit.[26] Sackett's study compared two forms of mental rehearsal (thinking or endeavoring to recall

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[25]Washburn, op. cit., p. 32.

[26]R. S. Sackett, "The Influences of Symbolic Rehearsal Upon the Retention of a Maze Habit," loc. cit.

the pattern of the maze in ideational or verbal terms, and attempting to draw the maze from memory) as a function of retaining the maze pattern and concluded that drawing the maze from memory was the more effective form of rehearsal. Both forms of practice proved to be significant, however, for later recalling the pattern.

A subsequent study by Sackett[27] continued his efforts in identifying the relationship between symbolic rehearsal and retention of a maze habit. The purpose of the study was to determine the relative effects of varying numbers of mental rehearsals upon the retention of a maze habit. The subjects were divided into groups and were to imagine going through a high-relief maze one, three or five times each practice period, depending on their group assignment. All of the experimental groups had better retention of the maze than the control group, and those practicing a greater number of repetitions had more retention than those with fewer practices per session. Sackett concluded that the relationship between symbolic rehearsal and retention was one of "negative acceleration."

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[27]R. S. Sackett, "The Relationship Between Amount of Symbolic Rehearsal and Retention of a Maze Habit," The Journal of General Psychology, XIII (1935), 113-128.

Siipola[28] was interested in the effects of watching mirror drawing on the actual performance of that skill. Subjects were grouped into pairs and instructed to watch the reflection in the mirror of their partner's hand movements. No overt practice was allowed before the actual trial. The author concluded that perceptual factors in mirror drawing were important to success in that task.

A determination of the relative efficiency of actual practice and imaginary practice in five selected motor tasks was the purpose of a study by Perry[29] reported in 1939. The tasks ranged from simple voluntary movements to highly coordinated motor skills which demanded ideational and symbolic activities. Results obtained from fourth-, fifth-, and sixth-grade boys indicated statistically significant improvement from pre- to post-test scores in all tasks. Perry concluded that MP was effective in improving skills in a variety of tasks.

An interesting experiment by Buegel[30] investigated the learning of a patterned motor performance with and

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[28]Elsa M. Siipola, "Studies in Mirror-Drawing," Psychological Monographs, XLVI, No. 210 (1935), 66-77.

[29]Horace M. Perry, "The Relative Efficiency of Actual and Imaginary Practice in Five Selected Motor Tasks," loc. cit.

[30]Herman D. Buegel, "The Effects of Introducing Ideational Elements in Perceptual Motor Learning," The Journal of Experimental Psychology, XXVII (1940), 111-124.

without the aid of ideational elements. Four groups of subjects were given the task of lighting lamps under four sets of circumstances which provided them something to associate with the proper order for lighting the lamps. These conditions included digits, related series of letters, unrelated series of letters, and no perceptual elements. Data were collected by recording the trials, time, and errors during the learning process.

Buegel concluded that the ideational contexts introduced during the learning of the motor performance proved to be a distinct advantage during initial learning. The order of ideational contexts from most to least advantage was digits, unrelated letters, related letters, and non-ideational material.

A study which introduced MP at two different points during piano keyboard learning was conducted to evaluate the effects of MP when some keyboard learning had already been accomplished.[31] The author compared three procedures, all of which incorporated a five-minute period of analysis before any keyboard trials. The first introduced a four-minute period of MP midway in the learning and then continued the keyboard trials until the criterion of perfect

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[31]G. A. Rubin-Rabson, "A Comparison of Two Forms of Mental Rehearsal and Keyboard Overlearning," The Journal of Educational Psychology, XXXII (1941), 593-602.

learning was accomplished. The second procedure carried keyboard trials to the criterion and then added four minutes of MP. The third reached the criterion and then added extra keyboard trials for four minutes. The pattern of learning using MP at the mid-point proved reliably superior to the other techniques. It not only reduced the number of keyboard trials, but achieved retention as well as any other method used.

A relatively recent study compared various forms of practice upon speed and accuracy of performing a simple eye-hand coordination task.[32] Six different groups of ten male university students were each given a one-minute speed test and re-test on a three-hole stylus punch board. To compare the effects of visual, motor, mental, and guided practice upon speed and accuracy of the performance, five groups received different types of practice between the tests. One group acted as a control and read between tests.

The control, motor practice, and reversed visual practice groups significantly improved performance in terms of correct hits and the total number of trials; they did not, however, reduce their number of errors. The visual and

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[32]L. E. Smith and J. S. Harrison, "Comparison of the Effects of Visual, Motor, Mental and Guided Practice Upon Speed and Accuracy of Performing a Simple Eye-Hand Coordination Task," The Research Quarterly, XXXIII, No. 2 (May, 1962), 299-307.

MP groups reduced their total number of errors and also increased their performance significantly in terms of correct hits and total number of trials. It was concluded that visual practice and MP improved accuracy on a punch board learning task, whereas motor practice and guided practice did not.

MENTAL PRACTICE AS A METHOD FOR DEVELOPING OR IMPROVING PHYSICAL EDUCATION TYPE SKILLS

Shaw[33] compared muscular action potentials during actual and imaginal weight lifting. Three subjects lifted weights varying from 100-500 grams which were hidden from their view behind a screen. After returning the weight to its resting place, the subjects imagined lifting the weight they had just lifted. The results indicated that action potentials varied according to the magnitude of the weight during imagined as well as actual lifting. The more vivid the imagined lifting resulted in the greater amount of muscular activity.

A most interesting and unique study by Kelsey[34] studied the effects of MP upon muscular endurance. The

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[33] W. A. Shaw, "The Relation of Muscular Action Potentials to Imaginal Weight Lifting," loc. cit.

[34] I. B. Kelsey, "Effects of Mental Practice and Physical Practice Upon Muscular Endurance," The Research Quarterly, XXXII, No. 1 (January, 1961), 47-54.

results indicated that muscular endurance of the abdominal and thigh flexor muscles is increased significantly over a twenty-day period by a daily five-minute MP session of sit-ups. The increase, however, was significantly smaller than that achieved by a daily five-minute PP session of sit-ups. Kelsey concluded that, whenever PP is at all possible, it is recommended over MP to increase abdominal muscular endurance.

The effects of periods of guided MP upon the performance of the standing broad jump and manual strength were determined in a two-part study which utilized identical conditions in terms of performance tasks, age, and sex of the subjects.[35] The variables were the length of the training period and different combinations of MP and PP. The test-retest method of evaluation led to the following conclusions: (1) MP alone or in combination with PP did not have a significant effect upon the performance of manual strength or the standing broad jump in the one-day study; (2) the combination of three MP and three PP sessions was significantly more effective in improving jumping performance than other combinations or MP alone, although it was not significantly better than PP alone in the extended study; (3) MP alone or in combination with PP did

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[35]Betty Jane Wills, "Mental Practice as a Factor in the Performance of Two Motor Tasks" (unpublished Ph.D. thesis, University of Wisconsin, 1966).

not have a significant effect upon the overt performance of manual strength in the extended study; and (4) variation of the proportions of MP and PP did not have different effects by sex and age in either the one-day or extended study.

Twining[36] concluded that both MP and PP are effective in facilitating "ring-tossing" for accuracy as determined under the conditions of the study. The results showed that a twenty-two day experimental period rendered 137 per cent improvement by PP and 36 per cent improvement by the MP method in this simple motor skill.

The effects of varying types of practice on the development of dart-throwing skill were studied by Burns.[37] Two hundred and fifty adolescent girls were divided into control, PP, MP, and combined MP-PP groups to determine the relative values of the different methods over a fifteen-day experimental period. The control group had no practice between testing; the PP group threw every day; the MP group imagined throwing every day; and the combined group alternated methods throughout each day of the experiment. An analysis of the data shows significant improvement for

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[36]W. E. Twining, "Mental Practice and Physical Practice in Learning a Motor Skill," The Research Quarterly, XX, No. 4 (December, 1949), 432-435.

[37]Patricia L. Burns, "The Effect of Physical Practice, Mental Practice and Mental-Physical Practice on the Development of a Motor Skill" (unpublished Master's thesis, Pennsylvania State University, 1962).

the PP and combined MP-PP groups. The MP group's improvement was substantial, but not quite significant. No significant differences existed among the three experimental groups.

Stebbins[38] divided his subjects into MP, PP, MP then PP, PP then MP, and control groups to study the relative effects of each method on learning to accurately throw rubber balls. Neither the PP nor the MP group was significantly more effective in learning the skill than the control group. Stebbins suggested that possible experimental design errors were responsible for these unexpected results. He concluded that the combined methods (either) were the most effective techniques for learning the ball throwing skill and should be utilized when learning a simple hand-eye coordination task.

Six randomly selected groups of twenty male college students with a right hand preference were studied to determine the effects of varying emphasis on conceptualizing and manual practice during the early learning of a novel ballistic gross-motor skill.[39] It was found that

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[38]Richard J. Stebbins, "A Comparison of the Effects of Physical and Mental Practice in Learning a Motor Skill," The Research Quarterly, XXXIX, No. 3 (October, 1968), 714-720.

[39]G. H. Egstrom, "Effects of an Emphasis on Conceptualizing Techniques During Early Learning of a Gross Motor Skill," The Research Quarterly, XXXV, No. 4 (December, 1964), 472-481.

alternating periods of emphasis on conceptualizing and manual practice was as effective as successive periods emphasizing manual practice during learning to hit a target after striking a propelled ball with a paddle.

Corbin[40] studied the effects of MP, PP, and combined MP-PP on learning a simple juggling task. The subjects were classified into skill levels before being assigned to the control or one of the experimental groups. The results indicated that the combined MP-PP and PP groups were significantly better than the MP and control groups. However, there was no difference between the two superior methods. The skill level of the subjects was not a factor in their ability to benefit from any of the learning methods.

A study by Vandell, et al.[41] in 1943 marked the beginning of an era characterized by a thorough and exhaustive investigation of the value of MP to learning and/or improving free throw shooting in basketball. The authors divided thirty-six male subjects into three age groups and then sub-divided each age group into a PP, MP, and control sub-group. The youngest and oldest age groups

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[40] C. Corbin, "The Effects of Mental Practice on the Development of a Unique Motor Skill," The Journal of General Psychology (April, 1967), 143-150.

[41] Vandell, Davis, and Clugston, "The Function of Mental Practice in the Acquisition of Motor Skills," loc. cit.

practiced dart throwing and the middle-aged group practiced free throw shooting. It was concluded that both the MP and PP techniques had value in learning the selected motor skills at all three age levels.

Halverson[42] continued the investigation of the effects of MP on free throw shooting. She established demonstration, kinesiological, MP, and control groups and conducted a five-week study to compare the relative value of the three experimental methods on teaching free throw shooting. In her conclusions, Halverson stated:

> All three methods of the study proved effective in the development of motor skill. The mental practice method was not as effective in the development of motor skill as the actual practice groups. However, mental practice is effective in the development of a concept of skill and results in improvement in actual performance.[43]

Two hundred and fifty subjects were divided into MP and PP groups to compare the value of the two methods in learning to shoot free throws.[44] The MP group viewed motion film of the skill while the PP group actually practiced foul shots. It was found that MP as used in this study was a

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[42] L. E. Halverson, "A Comparison of Three Methods of Teaching Motor Skills" (unpublished Master's thesis, University of Wisconsin, 1949).

[43] Ibid.

[44] S. F. Harby, "Comparison of Mental and Physical Practice in the Learning of a Physical Skill," U.S.N. Special Development Center Technical Report, S.D.C. 269-7-25, 1952.

significantly effective method for learning free throw shooting, but the relative effectiveness varied with the subject and length of time spent in practice. Harby suggested that combined MP-PP was probably more effective than MP alone.

Three methods, including overt practice, overt practice-implicit learning, and a kinesiological method were found to produce significant improvement in free throw shooting when a special "scoring-technique" was utilized.[45] However, when the actual number of baskets made was considered, no significant improvements were evident.

A similar study by Clark[46] found that MP was nearly as effective as PP when comparing groups equated on arm strength, intelligence, and basketball experience. The subjects in the MP group read a comprehensive description of the skill each day before mentally rehearsing their shots.

A series of studies by Start[47] investigated the effects of various factors on the ability of the subjects to

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[45]Gilman W. Hertz, "The Effectiveness of Three Methods of Instructions in One-Hand Foul Shooting" (unpublished Doctoral dissertation, Indiana University, 1956).

[46]L. Verdelle Clark, "Effect of Mental Practice on the Development of a Certain Motor Skill," The Research Quarterly, XXXI, No. 4 (December, 1960), 560-569.

[47]K. B. Start, "Relationship Between Intelligence and the Effect of Mental Practice on the Performance of a Motor Skill," The Research Quarterly, XXXI, No. 4 (December, 1960), 644-649; E. Riley and K. B. Start, "The Effect

utilize MP for effectively learning to shoot free throws. In comparing the relationship between intelligence and the effect of MP, it was found that significant improvement occurred in the skill, but that IQ had no effect on the performance of the skill after MP.[48] An investigation of the effects of various patterns of spacing MP and PP on the acquisition of free throw shooting skill showed that a week of PP followed by a week using MP was not quite as effective as daily alternating between MP and PP over the two-week period.[49] Both methods were statistically significant techniques for the acquisition of the skill. A subsequent study showed that subjectively assessed "games ability" had no significant effect on free throw shooting after MP, although Start stated factors such as games ability and motivation must be considered in MP.[50]

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of the Spacing of Mental and Physical Practices on the Acquisition of a Physical Skill," The Australian Journal of Physical Education, XX (1960), 13-16; and K. B. Start, "The Influence of Subjectively Assessed 'Games Ability' on Gain in Motor Performance After Mental Practice," The Journal of General Psychology, LXVII (1962), 159-173.

[48]Start, "Relationship Between Intelligence and the Effect of Mental Practice on the Performance of a Motor Skill," loc. cit.

[49]Riley and Start, "The Effect of the Spacing of Mental and Physical Practices on the Acquisition of a Physical Skill," loc. cit.

[50]Start, "The Influence of Subjectively Assessed 'Games Ability' on Gain in Motor Performance After Mental Practice," loc. cit.

Webb[51] investigated the effects of varying amounts of "implicit rehearsal" and the effects of the spacing of these rehearsals on the amount of learning that can be accomplished in certain archery skills when the implicit rehearsal is combined with overt practice. The study combined eight, twelve, and sixteen implicit rehearsals with overt practice. Although unable to base her conclusions on statistically significant results, Webb observed a trend indicating the best number of mental rehearsals was somewhere between eight and twelve spread over a two-week period.

In one of the few studies investigating the effects of MP on swimming, Shelden[52] concluded that MP was nearly as effective as PP in improving the breast stroke; however, improvement in the efficiency of the stroke by both methods was significant.

Start[53] shifted his interest in MP from its effects on free throw shooting to the effects on mastery of a

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[51]Florence Webb, "An Exploratory Study to Determine the Effects of the Number of Implicit Rehearsals and the Spacing of These Rehearsals on the Learning of a Motor Skill" (unpublished Doctoral dissertation, University of Oregon, 1961).

[52]M. F. Shelden, "An Investigation of the Relative Effects of Mental Practice in Improving the Efficiency of the Breast Stroke" (unpublished Master's thesis, University of Oregon, 1963).

[53] K. B. Start, "Kinaesthesis and Mental Practice," The Research Quarterly, XXXV, No. 3, Pt. 1 (October, 1964),

gymnastic stunt on the Olympic horizontal bar. In attempting to determine the relationship between kinaesthesis and the ability to successfully perform the single-leg upstart after MP, Start concluded that kinaesthesis was unrelated to the physical performance of the skill which had been mentally practiced.[54] In a similar design, Start[55] concluded that there was a high positive correlation between IQ and skill scores on the single-leg upstart among the highly skilled subjects.

Jones[56] partially replicated Start's gymnastic studies when he studied the effects of MP without benefit of a demonstration or physical rehearsal on learning the horizontal bar upstart. The results indicated that subjects without previous experience may learn gross-motor skills without PP and that MP without direction is superior to MP with direction in learning gymnastic skills.

316-320; and K. B. Start, "Intelligence and the Improvement in a Gross Motor Skill After Mental Practice," The British Journal of Educational Psychology, XXXIV (1964), 85-90.

[54]Start, "Kinaesthesis and Mental Practice," loc. cit.

[55]Start, "Intelligence and the Improvement in a Gross Motor Skill After Mental Practice," loc. cit.

[56]J. G. Jones, "Motor Learning Without Demonstration or Physical Rehearsal Under Two Conditions of Mental Practice," The Research Quarterly, XXXVI, No. 3 (October, 1965), 270-276.

The purpose of a study by Wills[57] was to determine the relative effect of MP and PP on learning to pass a football for accuracy. Sixty seventh-grade boys were equated by a motor ability test and were divided into PP, MP, and control groups. The author concluded that MP and PP were significant methods for improving football passing for accuracy; however, there was no significant difference between MP and PP and PP and no-practice for improving accuracy. MP was significantly better than no-practice of the skill.

The effect of MP on the learning of three motor skills of varied difficulty was the object of investigation by Phipps and Morehouse.[58] It was concluded that the effectiveness of MP without prior PP is specific to the skill and is more pronounced for simpler skills.

Among the purposes of a study by Wilson[59] was listed the investigation of the relative effects of three

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[57]Keith Clark Wills, "The Effect of Mental Practice and Physical Practice on Learning a Motor Skill" (unpublished Master's thesis, Arkansas State College, 1965).

[58]Stephen J. Phipps and Chauncey A. Morehouse, "Effects of Mental Practice on the Acquisition of Motor Skills of Varied Difficulty," The Research Quarterly, XL, No. 4 (December, 1969), 773-778.

[59]M. E. Wilson, "The Relative Effect of Mental Practice and Physical Practice in Learning the Tennis Forehand and Backhand Drives" (unpublished Master's thesis, University of Oregon, 1964).

combinations of MP and PP in learning the forehand and backhand drives in tennis. The results indicated that all the combinations of MP and PP proved significant for improving proficiency, but that no method was superior to the others.

Whitehill[60] studied four variations of MP for learning the one-wall handball serve by boys aged ten to twelve. The author found that three of the MP methods (demonstration and MP, pure MP, and diagrams and MP) were statistically significant for making improvement in the skill. The control group and kinaesthetic MP group did not realize significant improvement. A comparison among methods showed no significant differences; however, there was a tendency toward superiority of methods by the "diagram and MP" approach.

A later study by Whitehill[61] developed further the design used earlier to include three skills being learned under a variety of MP conditions by both boys and girls in grades one through six. In addition, Whitehill was concerned with the amount of retention up to twelve weeks

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[60]M. Patrick Whitehill, "A Comparison of Different Variations of Mental Practice on the Ability of Boys to Learn a Motor Skill" (unpublished Master's thesis, University of Oregon, 1964).

[61]M. Patrick Whitehill, "The Effects of Mental Practice on Children's Learning and Retention of Gross Motor Skills" (unpublished Ed.D. dissertation, University of Oregon, 1965).

after the experimental period. The conclusions held that PP of a gross motor skill was no more effective in improving the performance or learning of first- to fourth-grade children than MP or no-practice. It appeared, however, that PP of a gross motor skill may be more effective than no-practice in improving the performance or learning of fifth- and sixth-grade students.

A comparison of the effectiveness of MP by viewing loop films on the learning of the long and short serves in badminton was characterized by an interesting sidelight with the subjects in the control group.[62] In order to motivate these subjects, Beckhow had them practice the golf putt through MP. Beckhow concluded that the use of loop film as a MP technique was effective in improving both skills. However, motor skills requiring fine control and precise movements, such as in the short serve, were influenced by MP to a larger extent than those skills which are explosive or dynamic, such as the long serve.

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[62]Paul Beckhow, "A Comparison of the Effectiveness of Mental Practice Upon the Learning of Two Gross-Motor Skills" (unpublished Master's thesis, University of Oregon, 1967).

Somewhat similar studies by Kelly[63] and Shick[64] investigated the effectiveness of selected MP techniques on the acquisition of volleyball skills. Kelly[65] found that verbal MP, PP-MP, and PP were more effective in developing ability to perform the overhand serve than was imagery MP. She also found no significant difference in the effectiveness of verbal MP, PP-MP, and PP in learning the skill. In three sub-studies, Shick[66] found that a MP group had learned to serve significantly better than the no-practice group, a combined MP-PP group was significantly superior to a no-practice group over a five-week period, and when reduced to three weeks of practice there was no difference between a combined MP-PP group and no-practice group.

A two-pronged approach characterized a study on MP effectiveness by Johnson.[67] One purpose was to study the

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[63]Darlene Alice Kelly, "The Relative Effectiveness of Selected Mental Practice Techniques in High School Girl's Acquisition of a Gross Motor Skill" (unpublished Master's thesis, University of Washington, 1965).

[64]Jacquelin Shick, "Effects of Mental Practice on Selected Volleyball Skills for College Women," The Research Quarterly, XLI, No. 1 (March, 1970), 88-94.

[65]Kelly, "The Relative Effectiveness of Selected Mental Practice Techniques in High School Girl's Acquisition of a Gross Motor Skill," loc. cit.

[66]Shick, "Effects of Mental Practice on Selected Volleyball Skills for College Women," loc. cit.

[67]Bonnie L. Johnson, "An Examination of Some Factors Which Might be Related to Effective Utilization of Mental Practice in Learning a Gross-Motor Skill" (unpublished Master's thesis, University of Oregon, 1967).

effect of MP on learning the one-wall handball service. She also investigated the effects of IQ, logical reasoning, spacial ability, numerical reasoning, verbal concepts, memory, language ability, non-language ability, motor ability, and self-concept on the ability to effectively utilize MP techniques on learning a gross motor skill. The subjects were 171 sixth-grade students who were tested in the various areas of concern and given a test, re-test to determine the amount of learning on the handball serve. Results showed that MP is somewhat effective in learning the handball serve by sixth grades, but that the physical and mental characteristics examined were not related to ability to profit by MP. It was also found that boys could more effectively use MP for improvement in motor skills than girls.

The effectiveness of MP as a function of audio, visual, and audio-visual instruction for learning the forehand drive in tennis was the object of a recent study by Surburg.[68] One hundred and eighty-three subjects were divided into one control and six experimental groups. The experimental groups included hearing, viewing, and hearing

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[68]Paul R. Surburg, "Audio, Visual, and Audio-Visual Instruction with Mental Practice in Developing the Forehand Tennis Drive," The Research Quarterly, XXXIX, No. 3 (October, 1968), 728-734.

and viewing a sound filmstrip describing the forehand drive in tennis. Three similar groups received parallel instruction but also engaged in ten minutes of MP. The experiment lasted eight weeks with three sessions per week. The three experimental groups which engaged in MP showed significant improvement in the performance of the skill. The group using audio in conjunction with MP had the most significant improvement on the forehand drive.

Oxendine[69] conducted three separate experiments involving (a) the pursuit rotor, (b) a soccer kick for accuracy, and (c) a modified jump shot involving 212 seventh-grade boys to investigate the effects of different schedules of MP and PP on the learning and retention of the motor tasks. In each experiment, four groups practiced for seven successive school days. Three of the groups were involved with schedules which included different proportions of MP and PP, while the fourth group engaged in PP only. The results led Oxendine to make the following conclusions: (1) up to 50 per cent of the MP time can be as effective as 100 per cent of the time in PP; (2) for subjects within normal intelligence range, IQ scores are not indicative of

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[69]Joseph B. Oxendine, "Effect of Mental and Physical Practice on the Learning of Three Motor Skills," The Research Quarterly, XL, No. 4 (December, 1969), 755-763.

one's ability to benefit from MP; and (3) seventh-grade boys respond favorably and conscientiously to the suggestion of MP.

The purpose of a study by Hamerslough[70] was to determine the effectiveness of three methods of instruction, followed by MP, on the learning of the softball windmill pitch, golf chip shot, and soccer dribble. The three methods of learning were reading a description of the performance techniques of the motor skill, observing a filmed sequence of the task, or listening to a tape recording describing the motor task. A two-week experimental period was begun and concluded with skills tests for each task, followed by another re-test four weeks after the conclusion of the experimental period. The results led the author to conclude that the presentation of instruction followed by MP, as used in the study, was relatively ineffective in increasing performance in a complex gross-motor task. Skill level achieved by MP in the tasks used in this study appeared to be retained with no loss up to four weeks after the cessation of practice. Males exhibited no difference in the ability to use verbal

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[70]Walter Scott Hamerslough, "The Effectiveness of Three Methods of Instruction Followed by Mental Rehearsal, in Learning Three Complex Gross-Motor Tasks" (unpublished Ed.D. thesis, University of Oregon, 1971).

and visual stimuli in learning gross-motor skills. However, females were more effective in utilizing information presented in an auditory fashion than that which was presented by a filmed demonstration.

In 1967, Richardson[71] reported a comprehensive review of literature completed through 1965 on the relation of MP to performance and to individual differences in the amount of gain obtained. Regarding the relation of MP to performance, Richardson found that primary interest has focused on the general value of MP in facilitating the initial acquisition of a perceptual motor skill, aiding the continued retention of such a skill, or in improving the immediate performance of a skill. The author concluded that the trend of most studies indicates that MP procedures are associated with improved performance of the task. He further concluded that: (1) there is evidence that MP can lead to bilateral transfer effects; (2) the degree of familiarity with the physical performance of the task is related to the efficiency of MP relative to PP; (3) there is a trend which suggests when MP and PP trials are alternated during learning that the improvement in performance will be as good or better than PP trials only; and (4) there is an

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[71]Richardson, "Mental Practice: A Review and Discussion--Part I," loc. cit.

indication that MP sessions should not exceed five minutes if concentration is to be maintained.

In summarizing the individual difference studies, Richardson[72] concluded that only games ability and one of the two studies on motor ability, imaging ability, and the capacity for selective attention showed a significant relationship to amount of gain from MP.

AUTHORITATIVE STATEMENTS CONCERNING THE VALUE OF MENTAL PRACTICE

In a survey of research in the teaching of sports, Kretchmar made the following comment on mental practice:

> Tied into general considerations of learning from the observation of others and from various sorts of visual aids is the problem of learning through "mental practice," which is a process of trying to visualize a desired motor action without actually performing it at the moment.[73]

In introducing his study, Egstrom made the following observation:

> Perhaps the traditional methodology used in learning motor skills has resulted from the achievements which individuals have made as a result of learning based primarily on trial and error methods in which the response to external stimuli was paramount. No one would dispute the fact that the purposeful practice of a gross motor skill can result in improved performance.

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[72] Ibid.

[73] Robert T. Kretchman, "A Survey of Research in the Teaching of Sports," The Research Quarterly, XX, No. 3 (October, 1949), 243.

> One could, however, question the efficiency of any method which did not take full advantage of any abilities that an individual possessed which could conceivably contribute to the learning process in a positive manner. Perhaps skills are learned as they have been taught, when prior experience has proven the effectiveness of the previous method. Nevertheless, it seems conceivable that individuals could learn to focus their concentrative powers and respond to internal as well as external stimuli. Improved performances might result from this more sensitive reliance upon the central mechanisms through which learning is regulated.[74]

Addressing the value of mental practice, Kingsley stated:

> In the absence of an instructor, it would seem that an individual might in some cases be able to think out the proper procedure from developing a new type of skill. To think out the best method of performing a skill requires a certain amount of knowledge or experience relevant to the skill and an acquaintance with the principles involved. It is probably more often the expert or person who has already acquired more proficiency than the novice who actually thinks out a way to perform a skill. When reflective thinking is helpful, its contribution is of the same sort as that made by the instruction of a teacher. It provides suggestions on how to proceed. Of itself it can never yield a motor skill, however, it may foreshorten trial and error and thereby contribute to the efficiency of learning. The development of skill requires physical practice on the part of the learner, although mental practice can assist the process.[75]

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[74] Egstrom, op. cit., p. 472.

[75] Howard L. Kingsley, The Nature and Conditions of Learning (Englewood Cliffs, N.J.: Prentice-Hall, Inc., 1957), pp. 307-308.

One of the strongest advocates of the value of mental practice to learning golf was Morrison,[76] who felt that mental rehearsal between physical practice is desirable and helpful. In addition, mental practice tends to increase learning, decrease forgetting and rearrange activity into more successful trials at the next practice. Finally, Morrison stated that creative imagination may bring new insights into better form.

In their textbook, Physiology of Exercise, Morehouse and Miller stated:

> Thinking about muscular performance has been shown to produce an increase in the tension of the muscles which would participate in actual performance. This phenomenon suggests that learning and perfection of skill can proceed through reading and thinking about the technique or event. Thus, a golfer during the winter season may improve his swing by studying texts written on the subject.[77]

SUMMARY

The literature reviewed in this chapter leads to the general conclusion that MP has proven to be a statistically significant method for effecting motor learning in selected sports and physical education activities as well as many

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[76]Alex J. Morrison, Better Golf Without Practice (New York: Simon and Schuster, 1960), p. 89.

[77]Laurence E. Morehouse and Augustus T. Miller, Physiology of Exercise (St. Louis: The C. V. Mosby Company, 1959), p. 69.

other unrelated motor skills. In a few rare cases, MP has been more effective than PP when determined by physical performance testing. Combination of both MP and PP occasionally renders better results than either method utilized singularly. More often than not, PP was the single most effective approach when considered in studies including MP, PP, and MP-PP.

Chapter 3

PROCEDURE

This chapter is devoted to the general procedure used during this study. It includes the procedure used for the selection of subjects, a description of the instruments used in determining serving skill and capacity for learning new motor skills, and the teaching approach followed during the actual experimental period.

SUBJECTS

The subjects were sixty male students enrolled at Middle Tennessee State University during the spring semester, 1973. Of these, forty-six subjects were distributed among three handball classes in which all were enrolled for academic credit. These classes served as the experimental groups used for this study. The remaining fourteen subjects comprised a control group and were chosen from among male students not enrolled in physical education activity courses. This group was selected to parallel as closely as possible the other three groups based on age, varsity athletic

experience, previous handball experience and number of physical education activity courses completed.

To accommodate the selection of the subjects for the control groups, a personal data form was completed by each subject in the experimental groups (handball sections) which provided the following information: name; age; height; weight; academic classification; QPR; day and time of class meeting; section number; number of physical education activity courses completed; high school and college varsity athletic experience; and amount of previous handball experience.

After collecting these data, the writer developed a profile representing the typical subject in the experimental groups. Fifteen students who closely paralled the profile of the experimental subjects were chosen as members of the control group. One of these subjects was unable to complete the required testing, thereby reducing the size of the control group to fourteen subjects.

INSTRUMENTS

The literature reveals a real scarcity of skill tests that may be used with handball instruction. A number of suggested skill testing methods for handball appear in textbooks and other teaching guides; however, few have been statistically evaluated. This writer has been able to

identify only a few handball skill tests which have been subjected to statistical analysis. Cornish developed a handball skill test which had a multiple correlation coefficient of .694 for five items and the total number of plus points on games won in a handball tournament.[78] The highest zero-order correlations on the Cornish test were .67 between the criterion and the 30-second wall volley and .67 between the criterion and the service placement item.

In a more recent study, Pennington, et al., reported the development of an instrument to measure handball ability.[79] These investigators reported a multiple correlation coefficient of .802 for three experimental variables and the criterion of the average score per game obtained in a partial round-robin tournament among thirty-seven male undergraduate students. The highest zero-order correlation obtained was .711 between the service placement test and the criterion.

The service placement test developed by Pennington, et al., was selected for use in this experiment due to its relatively high validity coefficient and ease in

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[78]Clayton Cornish, "A Study of Measurement of Ability in Handball," The Research Quarterly, XX, No. 2 (May, 1949), 215-222.

[79]Pennington, et al., loc. cit.

administering. It was necessary, however, to slightly modify this test in two ways for use in this study. The court markings were slightly adjusted for use on the regulation Middle Tennessee State University courts since the Pennington study was conducted on a court slightly smaller than regulation size. While the Pennington study used a black rubber ball with a diameter of 2.5", this study utilized a handball meeting regulation specifications.

Pennington Service Placement Test

The court was divided into areas that were assigned numerical values as shown in Figure 1. Serving in a regulation manner, the subject attempted to place the served ball into the court area having the highest numerical value. Each subject was given ten trials on each type service (power and lob) and his score was computed by adding the results of each trial. Thus, a total score for each of the two serves was recorded for each subject. The test was administered to the subjects on the second and eleventh class periods, or their equivalents, depending on the group tested. The administration of the test was under the supervision of the writer.

In order to determine the reliability level of this test, it was administered a second time during the initial

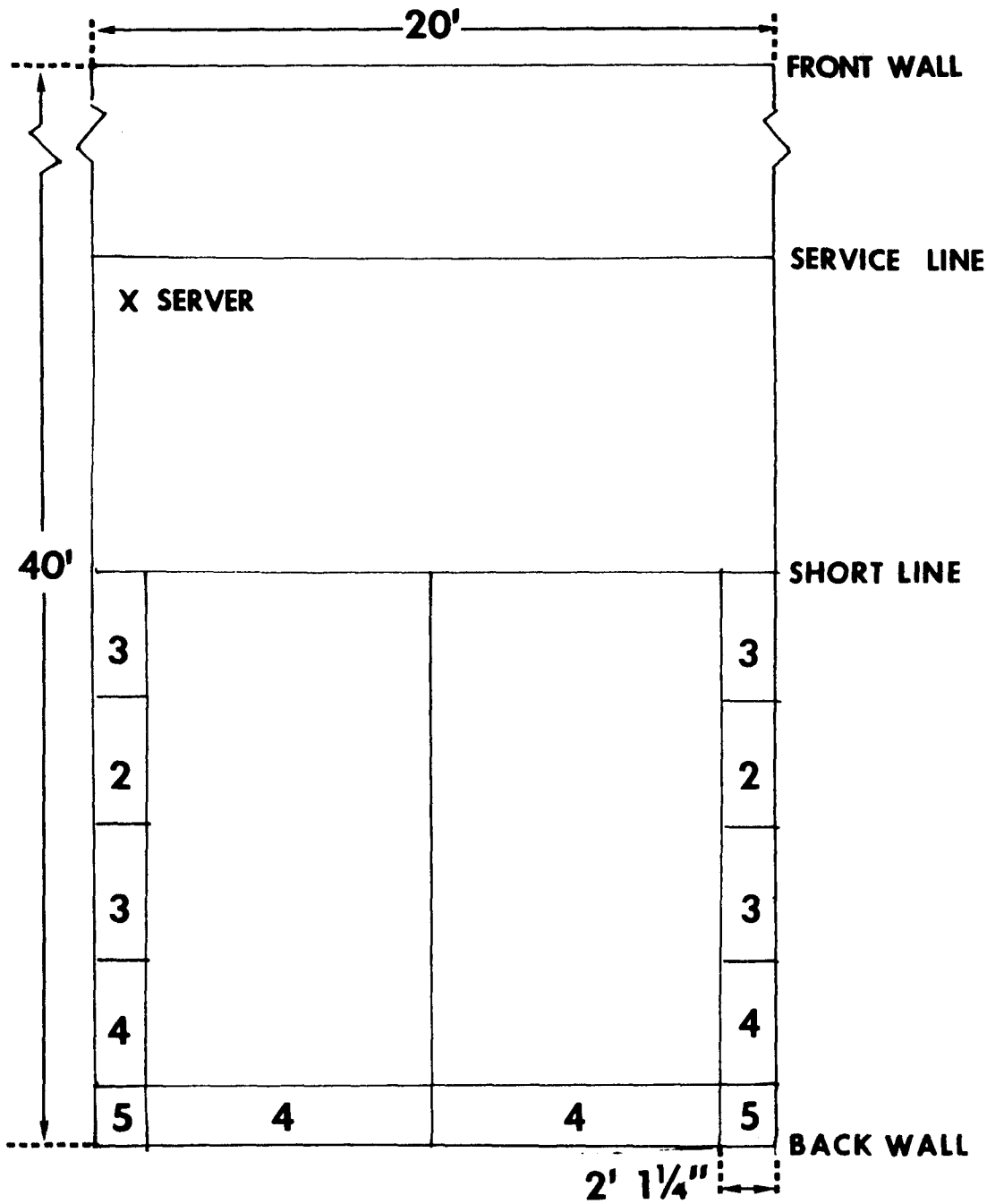

Figure 1

Court Markings for Modified
Pennington Service Test

testing period. A reliability coefficient was computed by using the Pearson Product-Moment Correlation method.[80]

Iowa-Brace Test of Motor Educability

The Iowa-Brace Test of Motor Educability[81] includes, among others, a battery of ten stunts designed for high school boys which purportedly measures the ease with which persons learn new motor skills. This test was used to provide information relative to overall capacity of the four groups to learn new skills. In addition, the results of the Iowa-Brace Test were correlated with the net difference between pre- and post-test results on the Pennington test. These correlations provided information concerning the amount of agreement between capacity for learning new motor skills and the actual change in performance on the service test.

The Iowa-Brace Test was chosen because it is generally acknowledged to be one of the best tests of its kind and is very easily and quickly administered. Although this test does not provide a battery for college men, it was assumed that the battery used was equally reliable in ascertaining motor educability levels of college men. The

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[80]N. M. Downie and R. W. Heath, Basic Statistical Methods (New York: Harper and Row, 1965), p. 83.

[81]Donald K. Mathews, Measurement in Physical Education (Philadelphia: W. B. Saunders Co., 1963), pp. 150-154.

test was administered at the beginning of the experimental period (second class meeting) under the supervision of the writer. It consisted of the following items which were conducted on a pass-fail basis: one foot-touch head; grapevine; stork stand; forward hand kick; three dips; side kick; kneel-jump to feet; Russian dance; single squat balance; and jump foot.

Each subject's score was determined by recording a "2," "1," or "0" for each of the ten test items, depending on whether the item was properly performed on the first or second trial, respectively, or not at all. The sum of scores on the ten items was recorded as the Iowa-Brace Test score.

EXPERIMENTAL PERIOD

The experiment was conducted in conjunction with the regular class meetings held in the Murphy Athletic Center and lasted a total of eleven consecutive class meetings, or approximately five and one-half weeks. The experimental period was distributed as follows:

1st Meeting--Orientation to course; explanation of experiment and what expectations were made of subjects; question and answer period; completion of personal data forms.

2nd Meeting--Administered motor educability test at beginning of period; administered handball service test for

score; followed up with second administration of service test for reliability purposes.

3rd-10th Meetings--Subjects in experimental groups practiced the handball service in accordance with the methodological approach used in their respective sections.

11th Meeting--Readministered the service test as per its initial administration at the second class meeting.

EXPERIMENTAL GROUPS

The experimental groups were three handball classes which were part of the normal physical education activity course offerings at the University. Each group (class section) was randomly assigned one of the three instructional techniques to teaching the handball service.

Instructional Techniques

Traditional. The traditional method consisted primarily of an oral description of the skill presented by the writer, followed by a demonstration. The subjects worked individually and in small groups practicing the skill while the instructor roamed among them offering hints for improvement and providing other forms of feedback.

To better illustrate the traditional instructional method, the following account of the initial instructional

period during which the lob service was introduced, is offered:

1) The subjects were gathered in one court and seated in a small group on one side of the court. The instructor introduced the skill by naming it and briefly describing the objectives of the service.

2) The instructor demonstrated the skill several times and advised the subjects to familiarize themselves with the "whole" skill.

3) The partially cupped position of the striking hand was demonstrated. The ball was held on the palm of the striking hand to demonstrate the ideal point of contact between the ball and hand.

4) The holding of the ball by the "dropping hand" was demonstrated.

5) The starting position was described and demonstrated. Points for emphasis included the server's position within the service zone, the weight-bearing leg, the partially flexed hips and knees resulting in a slightly crouched body position, and the position of the striking arm.

6) The actual service motion was described and demonstrated. Emphasis was given the step motion, point at which the ball is dropped and the "scissor-like" action of the arms.

7) The actual dropping of the handball was demonstrated and tips were given for success. Emphasis was placed on dropping, rather than tossing, the ball and on the importance of striking the ball at its zenith, or "dead point" of the bounce.

8) The motion of the striking hand immediately before, during, and after the striking of the ball was demonstrated.

9) The instructor stressed the importance of concentrating on watching the ball throughout the entire service sequence from the starting position through the follow-through.

10) The importance of the follow-through was stressed, and the points to be conscious of were noted as the follow-through was demonstrated.

11) The instructor demonstrated several more executions of the service with the intention of "tying together the components" into the "whole" skill.

12) The subjects were then asked to pair off with a partner and go with another pair to one of the four available courts. Each subject was asked to practice the service motion without the ball while his partner observed and provided constructive criticism relative to the instructor's "model" performance.

13) Each subject was instructed to become familiar with the handball, how it bounced and how to control the height of the bounce.

14) The subjects were asked to get the feel of the service, using the ball, while the partners again observed. The instructor suggested that at the outset emphasis be placed on developing a smooth, natural motion rather than accuracy of service placement.

15) The instructor circulated among the subjects and courts, observing service attempts, offering hints for improvement, demonstrating the service or a particular segment of it, and occasionally gathering all four subjects on a given court to reemphasize some aspect of the skill.

At the outset of each subsequent practice period a brief review of past lessons was presented to the group en masse, followed by directions, demonstrations, and objectives for the lesson at hand. The primary emphasis of the traditional instruction method was physical practice of the motor skill on a trial and error basis. This instructional method did include, however, an assignment to read descriptions of the skills as well as viewing motion film and other aids showing "model type" performances.

Mental Practice. The MP method consisted exclusively of cognitive processes devoted to understanding and learning the skill. No physical practice was permitted

at any time during the experimental period. This method included directed MP whereby the writer offered very precise directions for imagining the performance of the skill. The following statements are characteristic of the instruction given during directed MP of the lob service:

1) Close your eyes and concentrate on what you hear. As you listen, visualize yourself as the subject in the description of activities you are about to hear. Attempt to feel your body move as you see a mental image of yourself executing the skill.

2) Position yourself in the service zone relatively close to the left side wall and facing the front wall.

3) You should be standing with your weight over your right foot which is just inside the service zone in front of the short line. The left foot should be slightly ahead of the right foot and ready to step forward toward the front wall. Both knees should be flexed comfortably and your body should be leaning slightly forward. Can you feel the tension in the muscles of your rear leg as it is partially bent and supporting your body weight?

4) Your right arm, that is the striking arm, should be fully extended at the elbow and drawn back well behind your body so that it is approximately parallel to the floor, with the palm facing down.

5) The hand itself should be in a "cocked" or hyper-extended position at the wrist, such that the back surface of the hand approaches your forearm. The fingers and thumb should be close together forming a slightly cupped hand position.

6) The ball should be held loosely between the thumb and fingers of the left hand with the palm up.

7) The left arm should be extended at the elbow and slightly forward away from the body so that your left hand, that is the one with the ball, is positioned above and slightly ahead of your front foot.

8) Your head should be down with your eyes focused intently on the ball. You are now ready to initiate the lob service motion.

9) Now try to feel your body move as you imagine yourself executing the following service motion: step forward toward the service line with your left foot. As your weight transfers from the rear foot to the left foot the ball should be dropped so that it strikes the floor slightly beyond and to the right of the left foot.

10) Focus your eyes on the ball and try to follow it as it falls and rises after bouncing off the floor.

11) As the ball is released from the left hand, the right arm should be swung downward and forward so that the right hand strikes the ball at its peak after it has bounced about a foot or foot and one-half above the floor.

12) At contact, the ball should meet the hand at the juncture of the fingers with the palm. As the right arm proceeds through its downward and forward path, the left arm swings in the opposite direction, moving backward and upward. The action of the arms could be described as scissor-like.

13) As the ball leaves the right hand on its flight toward the front wall, your right arm continues in an upward motion completing an arc of about 225 degrees, or two-thirds of a circle from start to finish.

14) The left arm continues to move backwards and upwards until it is about parallel with the floor and extended backwards. Your body weight has continued to shift forward until at the completion of the arm action it is almost entirely on the left or front foot.

15) Your eyes continue to follow the path of the ball as it strikes high and soft on the front wall and rebounds down the side wall, striking the floor just behind the short service line.

16) It is important to remember that the lob service is a finesse shot and, consequently, does not depend on power or speed of movement to be executed properly. Ideally, the ball should strike the front wall gently and high so that on the return flight the ball descends acutely in an arcing path. When the ball strikes the floor beyond

the short line, it should bounce high and carry towards the left rear corner where it should die or lose all its momentum as it strikes the rear wall resulting in the ball dropping nearly vertically after wall contact. The closer the ball stays to the side wall, the more effective the service. A lob service may also be executed on the other side of the court.

The instructor also encouraged the use of non-directed imagination of the skill by the subjects. This technique provided that each subject establish his own sequence of imagined movements. The only instruction given regarding non-directed MP was to mentally rehearse the motor skill from the very beginning completely throughout a successful execution of the skill. Thus, the primary emphasis of the MP instructional method was to "close the eyes and see and feel yourself performing the skill without actually moving."

In addition to the primary MP teaching approach, techniques congruous with a broader connotation of the term "mental practice" were employed for learning the skill. These included viewing motion films, studying photographs, observing practical (live) demonstrations, hearing precise verbal descriptions, and reading descriptive accounts of the proper skill sequence.

While involved in these aspects of MP, the following comments typified the instruction to the subjects:

1) Watch the film very closely, particularly the segment just before the power phase of the service, and imagine your own arm moving as you prepare to strike the ball.

2) As you study this photograph, you will notice that the shoulders are well ahead of the hips and the knees are flexed substantially. Try to imagine the feeling within your body as the shoulders revolve forward and your weight shifts accordingly as illustrated in this photograph.

3) While you are watching repeated performances of me dropping this ball, I especially want you to visualize yourself executing the same movement and pay particular attention to what my left arm does after releasing the ball.

4) As I read this description to you, I would like you to keep your eyes closed and concentrate very hard on what I say. As you listen, visualize your body in the exact motion or position and imagine what your joints and muscles feel like during the sequence.

5) First, I want you to read this entire statement with the idea of gaining a basic understanding of a complete execution of this service. Then, I want you to re-read the statement with the idea of seeing and feeling the movement of your body as you execute an imagined repetition of the skill.

Yet another "secondary" MP approach was to have the subjects write their own description of the proper skill sequence. This approach was characterized by using a problem solving technique within small sub-groups in class. Basic points for consideration by the sub-groups were identified by the writer, after which each group developed its own narrative description of the "solution" or proper sequence of events in consideration of the guiding points.

Combined Mental-Physical Practice. The MP-PP method employed parts of both the traditional (PP) and MP instructional methods. The group using this method heard oral descriptions of the skill and saw practical demonstrations. Before engaging in PP as described in the traditional approach, the subjects in this group devoted a unit of time (approximately ten minutes) each period to MP, using both directed and non-directed approaches. The MP-PP method also included outside reading and exposure to various visual aids as per the other experimental methods.

In the final analysis, the MP-PP group devoted 75 per cent of instructional time to PP and 25 per cent to MP.

CONTROL GROUP

The control group met with the writer at the beginning of the experimental period to discuss the

requirements and responsibilities of the subjects during the study and to take the pre-tests (motor educability and handball service). This group did not participate in any physical education activity and was not subjected to any experimental treatment over the course of the experiment. The members of this group were never told they were "control" subjects. They were simply told that theirs was one of the groups necessary for the study. The subjects in the control group were re-tested on service skill at the conclusion of the experimental period. These two meetings for testing purposes constituted the only involvement for the control group during this experiment.

As one of the conditions of the experiment, all subjects were required to refrain from participation in other physical activities except those which were associated with other academic requirements. There was no attempt to interfere in any way with requirements the subjects might have had in other courses. The intention of the writer was to control the subjects by limiting their physical activities only to those conducted under his supervision in conjunction with this study. It was not entirely possible to accomplish this objective, however, since several of the subjects were enrolled in other courses which also required participation in physical activities. In addition, the writer acknowledges

that there was very little opportunity to enforce this requirement unless the subjects chose to comply based upon their personal convictions and concerns for the welfare of this study.

All subjects were constantly reminded, however, of the importance of their compliance with this objective.

Chapter 4

ANALYSIS OF THE DATA

The purpose of this chapter is to describe the procedures used in the analysis of the data. The results of these analyses are also presented.

The power and lob service scores were analyzed by means of a Groups by Pre/Post analysis of variance[82] with repeated measures on the pre/post factor. The groups' effect were the four methods of instruction (Traditional, Combined Mental-Physical Practice, Mental Practice and Control).

Pearson Product-Moment Correlation analyses[83] were run on the results of the first and second administerings of the modified Pennington Service Placement Test for the purpose of determining its reliability. In addition, the Iowa-Brace scores were correlated with the pre- to post-test difference scores of the Pennington test.

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[82]E. F. Lindquist, Design and Analysis of Experiments in Psychology and Education (Boston: Houghton-Mifflin Company, 1953), p. 267.

[83]Downie and Heath, loc. cit.

TEST RESULTS

Power Service

Analysis of the power service indicated that there were no significant effects of the various instructional methods. Neither was there interaction among the methods of instruction as indicated by the absence of significant improvements over the experimental period. This information is presented in Table 1.

Table 1

Analysis of Variance of the Power Service

Source	SS	df	MS	F
Between--Ss	1425.29	59		
Instructional Methods	180.27	3	60.08	2.70
error (b)	1245.03	56	22.23	
Within--Ss	1769.50	60		
Pre/Post	75.21	1	75.21	2.72
Instructional Methods x Pre/Post	146.29	3	48.76	1.76
error (w)	1548.00	56	27.64	
Total	3194.79	119		

Pre/Post power service scores were converted to a "difference score" and analyzed by means of a Randomized Group Analysis of Variance.[84] The result of that analysis, shown in Table 2, concurred with the initial analysis which indicated there were no significant instructional effects for the power service.

Table 2

Randomized Groups Analysis of Variance of the Power Service

Source	SS	df	MS	F
Instructional Methods	292.58	3	97.53	1.76
Ss/Instructional Methods	3096.00	56	55.29	
Total	3388.58	59		

Lob Service

Analysis of the lob service showed that there was a significant overall instructional effect ($F = 8.65$, $df = 3/56$, $p < .001$); the pre/post factor was also significant ($F = 35.46$, $df = 1/56$, $p < .001$); and the instruction by pre/post interaction was significant ($F = 5.92$, $df = 3/56$, $p < .005$). These results are presented in Table 3.

[84] Allen L. Edwards, Experimental Design in Psychological Research (New York: Rinehart and Winston, Inc., 4th ed., 1972), p. 386.

Table 3

Analysis of Variance of the Lob Service

Source	SS	df	MS	F
Between--Ss	2654.37	59		
Instructional Methods	841.14	3	280.38	8.66**
error (b)	1813.22	56	32.28	
Within--Ss	1656.00	60		
Pre/Post	537.63	1	537.63	35.46**
Instructional Methods x Pre/Post	269.39	3	89.80	5.92*
error (w)	848.97	56	15.16	
Total	4310.37	119		

**p < .001
*p < .005

Subsequent comparisons of the overall main effect and interaction by Tukey's[85] procedure showed that, for the main effect of instruction, the Traditional group scored significantly higher in terms of the lob service than the Control group ($q = 5.17$, $df = 4/56$, $p < .01$), the Combined Mental-Physical Practice group scored significantly higher

[85]Roger E. Kirk, Experimental Design: Procedures for the Behavioral Sciences (Belmont, Calif.: Brooks/Cole Publishing Co., 1968), p. 88.

than the Control group ($q = 4.30$, $df = 4/56$, $p < .05$), and the Traditional group scored significantly higher than the Mental Practice group ($q = 3.86$, $df = 4/56$, $p < .05$). These data are shown graphically in Figure 2.

Analysis of the instruction methods by pre/post interaction showed that the Traditional and Control groups differed significantly from each other ($p < .01$) in that the former scored significantly higher than the latter on the lob service at the time of pre-testing. It was also found that the Mental Practice group was significantly higher on the lob service than the Control group based on the pre-test data ($p < .05$).

Analysis of the lob service post-test data indicated that the scores of the Traditional, Combined Mental-Physical Practice, and Mental Practice groups were all significantly higher than those of the Control group ($p < .01$). Additional post-test comparisons of the lob service showed that the Traditional group was significantly higher than both the Combined Mental-Physical Practice and Mental Practice groups ($p < .01$).

Subsequent analysis of the instructional methods by pre/post interaction showed that the Traditional group's rate of change (improvement) on the lob service over the course of the experimental period was significant ($p < .01$). It was

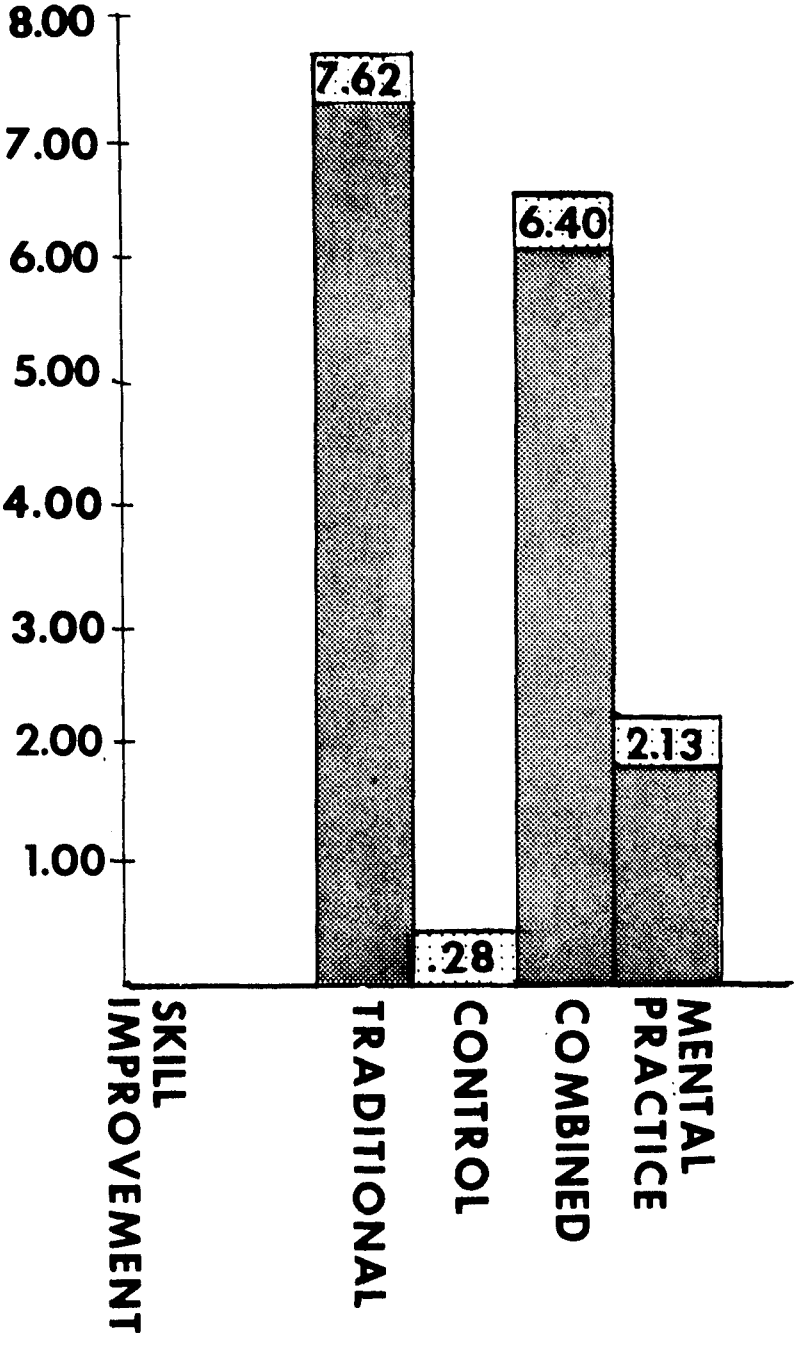

Figure 2

Lob Service Improvement

also found that the Combined Mental-Physical Practice group improved significantly on this skill from the time of pre- to post-testing ($p < .01$).

Due to the fact that there were significant initial group differences on the lob service, adjustment for these group differences was made by utilizing a "difference score" method of analysis.[86] These difference scores were analyzed by means of a Randomized Groups analysis of variance design. This analysis provided evidence that there was a significant overall instructional effect on the lob serve ($F = 5.92$, $df = 3/56$, $p < .005$). These data are shown in Table 4.

Table 4

Randomized Groups Analysis of Variance of the Lob Service

Source	SS	df	MS	F
Instructional Methods	538.78	3	179.59	5.92*
Ss Instructional Methods	1697.95	56	30.32	
Total	2236.73	59		

*$p < .005$

[86] Edwards, op. cit.

Multiple mean comparisons by Tukey's procedure[87] showed, as in the prior analysis, that the Traditional group performed significantly higher than both the Control group ($p < .01$) and the Mental Practice group ($p < .05$) on the lob service. It was also found, as before, that the Combined Mental-Physical Practice group was significantly higher in terms of the lob service than the Control group ($p < .05$). All other comparisons between groups by this method rendered non-significant results (see Figure 2).

Pennington Test Reliability

Pearson Product-Moment Correlations were performed on the power and lob service scores in order to determine the reliability of the Pennington test as used in this study. There was a significant positive ($r_{xy} = +.32$, $p < .01$) correlation between the power service test/re-test. Test/re-test results of the lob service also rendered a significant reliability coefficient ($r_{xy} = +.483$, $p < .001$).

Iowa-Brace vs. Service Improvement

Correlations by means of the Pearson Product-Moment technique were performed between the Iowa-Brace test scores

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[87] Kirk, op. cit.

and a difference score between the pre/post-test scores for both the power and lob services. The results indicated no statistically significant relationship between these measures.

Chapter 5

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

The purpose of this study was to evaluate the relative effectiveness of different instructional methods on learning two selected gross-motor skills. Particular emphasis was given a technique commonly referred to as mental practice (MP).

SUMMARY

Procedure

Each of three handball classes from the Middle Tennessee State University physical education program was randomly assigned an instructional method which was applied toward the learning of two handball services. A fourth group was established to serve as a control group and, consequently, subjects in this group did not participate in any handball activity during the experimental period. The forty-six subjects in the experimental groups were tested on their handball service ability and motor educability at the beginning of the experimental period. The fourteen subjects in the control group were also administered the same tests at the beginning of the experimental period.

The experiment was conducted in conjunction with the regular class schedule of the University and spanned a total of eleven consecutive class meetings, or approximately five and one-half weeks. The first two class meetings were devoted to orientation to the study, pre-testing, and other administrative requirements. During the next four weeks (eight class meetings), the subjects in the three experimental groups followed their respective routines as determined by the group to which they had been assigned.

The instructional methods assigned to the experimental groups were as follow:

Traditional Instruction. The Traditional method consisted primarily of an oral description of the skills followed by a demonstration of the same. The subjects worked individually and in groups of four or less practicing the skills while the instructor roamed among them offering hints for improvement and providing other forms of feedback. A review of past material was presented at the beginning of each class session after which new information was introduced and practiced. The Traditional instructional method was characterized by physical practice (PP) of the selected skills by primarily using a trial and error technique for mastery. Included, however, in this method were assignments to read descriptions of the skills and viewing motion film and other aids showing "model type" performances.

Mental Practice. The MP method consisted exclusively of cognitive processes devoted to understanding and learning the skills. At no time was there permitted any physical practice of the skills. Participation in handball or related games was prohibited during the experimental period. The subjects in this group participated in "directed MP" which was characterized by precise oral instructions provided by the instructor and designed to be followed while imagining the performance of the skill. Non-directed MP was also utilized by the subjects in this group. This technique required each subject to establish his own routine for practicing the skills. The only direction given regarding non-directed MP was to mentally rehearse the motor skill from the very beginning completely through a successful execution of the skill. There was no movement of the body permitted during "rehearsal," nor was physical practice of the simulated skill permitted at any time during the experimental period.

Other learning techniques used within the MP method included viewing motion film, photographs, and practical demonstrations of the skills, hearing precise verbal descriptions of the skills, reading descriptive accounts of the skills, and writing one's own description of the proper skill sequence.

Combined Mental-Physical Practice. The MP-PP method employed parts of both the Traditional and MP instructional methods. Before engaging in practice as described earlier under the Traditional method, the subjects in this group devoted approximately ten minutes each class meeting to MP, using both directed and non-directed approaches. Also included were outside reading and exposure to various visual aids. The subjects in this group devoted 75 per cent of instructional time to PP and 25 per cent to MP.

The last class meeting of the experimental period was used for re-administering the handball service skills test. Since the subjects in the control group had not been attending any given handball class, a special testing period was established in order to re-test these subjects at the conclusion of the five and one-half week experimental period.

Results

The data, when treated statistically, indicated the following results:

1) There were no statistically significant effects of the various instructional methods on the power service.

2) The Traditional instructional method was significantly superior to the Control and MP methods for teaching the lob service both before and after adjusting for initial group differences.

3) The MP-PP method was also significantly superior to the Control "method" for teaching the lob service both before and after adjusting for initial group differences.

4) The rate of skill improvement on the lob service was statistically significant by both the Traditional and MP-PP instructional methods.

5) There was no statistical significance evidenced in the ability of the Iowa-Brace Test to predict improvement in either the power or the lob handball service.

Based on the results obtained in this investigation, the following actions were taken on the hypotheses which were tested:

HO_1: Rejected, based on the relatively high initial test scores of the Traditional and MP groups.

HO_2: Rejected, based on the significant improvement in lob service skill by two of the three experimental groups.

HO_3: Rejected, based on the clear superiority of the Traditional and MP-PP groups over the MP and Control groups on the lob service skill.

HO_4: Accepted, there was absolutely no indication that motor educability indices could predict improvement in handball service skills.

Discussion of Results

Educators continue to create and devise new methods or gimmicks that will aid the learning process. The

literature has revealed that physical educators and psychologists have shown particular interest in various cognitive approaches, referred to generally in this study as MP, to learning motor skills. Research indeed confirms that MP has proven to be valuable in learning motor skills under certain conditions.

The exclusive use of MP as conceived in this study, however, was not a statistically significant method for teaching either the power or the lob handball service. There could be numerous reasons for this fact, including too short an experimental period, the complexity of the motor skill objectives, a lack of concerted effort by the subjects during MP, and myriad other factors too numerous to mention. This writer was somewhat distressed to find that the results of this study concerning MP were not generally consistent with those found in related experiments. There is a rather obvious implication, however, that perhaps overshadows the ineffectiveness of the MP instructional method.

Far too often we in education abandon methods proven again and again by ageless success for a "new approach" that is supposed to revolutionize the teaching profession. Physical educators have not been unlike the educational profession at large in this respect. The results found in this experiment, however, should serve as a mandate for sustained and/or renewed interest among physical educators in

the traditional, learn by doing, approach to handball service instruction. It is conceded by this writer that it is not likely many physical educators have resorted to MP as a teaching method in handball instruction. In the absence of substantial empirical support, there appears to be no good reason to utilize MP for acquiring handball service skills.

Another interesting observation predicated on the results of this investigation is the pronounced difference between the amount of learning on the lob and power services. No instructional method used in this experiment resulted in a significant increase in skill on the power service. The lob service, on the other hand, was readily learned by subjects in the Traditional and MP-PP groups; and while not significant, there was, nevertheless, a tendency which indicated that MP could be effectively used for teaching the lob service. The difference between results concerning these two skills seems to indicate that the power service is significantly more difficult to master than the lob service. This is probably true based primarily on the factors of speed and force which are necessary for a successful execution of the power service. The factors of speed and force, when added to the wide range of motion through which the arm travels during the power service, make hand-eye coordination considerably more difficult when compared to that of the lob service. A decrease in hand-eye coordination quite

obviously affects accuracy, which, of course, was the critical factor in measuring serving skill as determined by a modification of Pennington's test.

It is interesting to note that the greatest amount of research reporting effective use of MP in learning motor skills utilized activities which did not require striking a missile. This writer argues that activities including ballistical skills, particularly that of striking a missile and propelling it accurately, are generally more difficult to gain proficiency in than similar activities not characterized by the need to strike and propel a missile. The same logic used to develop this argument, when taken a step further, seems to support the following theory: A ballistical activity relying on a great amount of speed for a successful execution is more difficult to learn than one in which little speed of movement is required to successfully complete the skill.

The fact that the MP-PP instructional method was significant for learning the lob service can be interpreted from at least two points of view. The reader will recall that the increase in lob service ability by the MP-PP group was significant but was, nevertheless, less significant than that of the Traditional group. The MP group did not evidence a significant amount of learning on this skill.

A hypothetical continuum comparing the relative effectiveness of the three experimental methods for learning serving skill finds the MP method at the low end and the Traditional method at the high end with the MP-PP method in between, but much closer to the upper end than the lower. Does this indicate that MP is a desirable learning technique when combined with PP, or does it imply that the Traditional approach is not as effective an instructional method when "limited" by the inclusion of MP with it? It would appear to this writer that the evidence is stronger in support of a theory which holds that time should not be devoted to MP when circumstances permit a totally traditional approach to teaching the handball lob service.

A comment or two seems indicated regarding the apparent ineffectiveness of the Iowa-Brace Test as an instrument for predicting serving skill ability. The Iowa-Brace Test is, of course, a test purporting to measure general motor educability. The results of this investigation would indicate that handball serving skill is quite specific and one's ability to learn it is basically unrelated to one's overall capacity for learning new motor skills in general. These findings seem to support the idea that motor skill learning is specific to the task. This writer speculates that the ability to learn a forward somersault or an upstart from the mat, for example, would be much easier to predict

from the Iowa-Brace index than any skill involving striking and/or other ballistical characteristics. One reason for this is likely due to the preponderance of self-testing components and absence of ballistical-type components within the Iowa-Brace Test battery.

CONCLUSIONS

The following conclusions are submitted, based on the results evidenced under the conditions imposed during this investigation:

1) The instructional methods employed in this study were substantially ineffective for learning the handball power service.

2) The Traditional method of teaching the handball lob service was found to be by far the most effective of the methods employed.

3) A method characterized by combining MP with PP at a ratio of 25 per cent to 75 per cent, respectively, proved to be an effective approach to teaching the handball lob service.

4) Motor educability as measured by the Iowa-Brace Test should not be relied upon to predict handball serving skill improvement.

RECOMMENDATIONS

No absolute or clear-cut pattern has yet been established concerning the value of MP as an approach to learning complex motor skills. There does seem to be a tendency in favor of using MP for certain types of motor skills, although the evidence could not yet be described as substantial. It would appear that this study could easily be interpreted as an indictment against the absolute use of MP for learning complex motor skills including certain ballistical characteristics. It would certainly be premature, however, to draw any generalized conclusions concerning the relative value of MP in this regard; therefore, this writer recommends that researchers continue to explore the many facets of MP and their application to motor skill learning.

Some suggestions for additional studies follow:

1) Replicate this study to determine its validity.

2) Conduct a study similar to this but replace the handball service with the tennis, badminton, or table tennis service.

3) Attempt to determine if there is an optimum combination of mental and physical practice for learning motor skills.

4) Investigate the value of MP as an approach to learning other ballistical activities involving the striking of an object.

5) An investigation to determine the categories of motor skills in which learning is most easily predicted from a test of motor educability.

APPENDIXES

APPENDIX A

RAW DATA USED IN STUDY

Table 5

Results of Modified Pennington Service Test
Traditional Group

Subject	Power Service		Lob Service		Reliability	
	Pre	Post	Pre	Post	Power	Lob
110	10	5	6	20	10	10
111	12	11	10	25	10	10
112	3	11	14	19	15	7
113	3	0	9	17	8	8
114	12	3	12	26	10	16
115	0	10	7	15	3	5
116	0	3	8	8	5	5
117	16	11	15	17	13	22
118	11	6	13	27	6	13
119	0	18	12	20	8	11
120	3	12	13	15	3	22
121	7	8	12	19	12	13
122	7	13	18	16	12	8
123	0	17	8	14	2	10
124	0	3	0	13	5	5
125	0	18	12	20	0	4

Table 6

Results of Modified Pennington Service Test
Combined MP-PP Group

Subject	Power Service		Lob Service		Reliability	
	Pre	Post	Pre	Post	Power	Lob
126	9	5	10	19	6	18
127	0	3	6	15	6	6
128	5	17	6	13	8	10
129	0	13	4	19	6	10
130	9	4	14	19	3	24
131	3	3	9	18	8	9
132	5	0	4	6	7	3
133	5	0	20	19	8	5
134	9	9	7	13	9	12
135	8	6	5	15	11	14
136	12	6	13	9	3	21
137	12	4	6	15	11	10
138	0	14	0	9	8	3
139	9	9	10	20	16	8
140	5	11	13	14	0	14

Table 7

Results of Modified Pennington Service Test
Mental Practice Group

Subject	Power Service		Lob Service		Reliability	
	Pre	Post	Pre	Post	Power	Lob
141	9	5	11	16	5	16
142	0	0	3	8	4	3
143	2	7	14	23	3	8
144	9	4	6	9	4	5
145	4	12	12	7	6	11
146	7	0	22	14	4	9
147	3	0	6	17	8	2
148	12	0	6	9	0	14
149	6	6	2	7	6	8
150	5	5	8	18	11	7
151	11	17	14	9	3	17
152	5	3	15	21	3	16
153	4	17	14	7	6	12
154	18	0	19	11	6	13
155	6	0	3	11	0	8

Table 8

Results of Pennington Service Test
Control Group

Subject	Power Service		Lob Service		Reliability	
	Pre	Post	Pre	Post	Power	Lob
156	0	3	9	8	2	5
157	0	6	8	7	3	7
158	3	0	0	0	0	2
159	6	4	8	12	4	6
160	0	0	5	7	2	5
161	4	19	8	8	6	7
162	0	3	13	9	2	9
163	0	2	5	0	3	5
164	0	7	11	17	5	7
165	0	3	6	0	3	13
166	0	5	0	7	2	3
167	3	10	5	13	2	3
168	8	11	8	6	0	8
169	10	3	9	5	4	9

Table 9

Results of Iowa-Brace Test

Traditional		MP-PP		MP		Control	
Subject	Score	Subject	Score	Subject	Score	Subject	Score
110	12	126	16	141	14	156	9
111	13	127	12	142	6	157	13
112	10	128	17	143	15	158	5
113	16	129	14	144	13	159	9
114	15	130	15	145	18	160	14
115	17	131	13	146	12	161	16
116	15	132	14	147	13	162	13
117	13	133	12	148	15	163	17
118	17	134	10	149	9	164	10
119	14	135	15	150	9	165	16
120	14	136	18	151	15	166	16
121	12	137	16	152	13	167	17
122	14	138	13	153	15	168	14
123	12	139	13	154	17	169	17
124	17	140	12	155	12		
125	15						

APPENDIX B

SAMPLES OF FORMS AND LETTER USED IN STUDY

LETTER FOR SCHEDULING POST-TEST APPOINTMENTS

February 6, 1973

Dear

I have scheduled a handball court on Sunday, February 11, 1973, from 4:00-6:00 P.M. for the purpose of administering the follow-up skills test for the experiment in which you are participating. It is important that you plan to meet me sometime during these hours for this purpose.

In addition, I will be meeting my regular handball classes on Monday, February 12, at 9:00-9:50, 10:00-10:50, and 1:00-1:50. You may join me at any one of these times if the Sunday date is not convenient for you.

If you will be unable to join me at any of the above mentioned times, please call me at my office (898-2454) or at home (896-0096) in order that we can arrange a mutually acceptable time.

Thank you kindly for your much appreciated assistance in this matter. Please do not hesitate to contact me if I may be of assistance.

Sincerely,

Robert C. LaLance, Jr.

RCL/jmg

P.S. One more time!

Sunday, February 11, 1973	4:00-6:00 P.M.
Monday, February 12, 1973	9-10, 10-11, and 1-2.

PERSONAL DATA CARD

Class Section #_____

Time and Days_____

NAME:_____AGE:_____
Last First Middle

HEIGHT:_____WEIGHT:_____
Feet Inches

ACADEMIC CLASSIFICATION: FR SOPH JR SR GRAD QPR:____
(circle one)

NUMBER OF COLLEGE PHYS. EDUC. ACTIVITY COURSES COMPLETED____

HIGH SCHOOL ATHLETIC EXPERIENCE

Number of Letters Won in Following:

Football____Basketball____Baseball____Track or CC___

Golf____Tennis____Swimming____Wrestling____

Gymnastics____Other____

COLLEGE ATHLETIC EXPERIENCE

Number of Letters Won (1, 2, etc.) or Member of Team (√)

Football____Basketball____Baseball____Track or CC___

Golf____Tennis____Swimming____Wrestling____

Gymnastics____Other____

HANDBALL EXPERIENCE

Never Played____1-2 Times____3-10 Times____

More than 10____
(Check one)

SERVICE TEST DATA CARD

NAME: _____
Last First Middle

POWER				LOB		
PRE	POST	RELIABILITY		PRE	POST	RELIABILITY
____	____	____	#1	____	____	____
____	____	____	2	____	____	____
____	____	____	3	____	____	____
____	____	____	4	____	____	____
____	____	____	5	____	____	____
____	____	____	6	____	____	____
____	____	____	7	____	____	____
____	____	____	8	____	____	____
____	____	____	9	____	____	____
____	____	____	10	____	____	____
TOTALS						

IOWA-BRACE SCORE CARD

NAME:_____
Last First Middle

	ITEM	SCORE
(1)	One foot-touch head	_____
(11)	Forward hand kick	_____
(16)	Kneel, jump to feet	_____
(5)	Stork stand	_____
(20)	Single squat balance	_____
(3)	Grapevine	_____
(14)	Three dips	_____
(15)	Side kick	_____
(17)	Russian dance	_____
(21)	Jump foot	_____

TOTAL

APPENDIX C

PHOTOGRAPHS USED FOR MP INSTRUCTION

SELECTED SHOTS

Contact Point of Ball and Hand

Front Wall Contact for Power Serve

Elbow Lead for Maximal Power

Hand Hyperextended Before Contact

POWER SERVE SEQUENCE

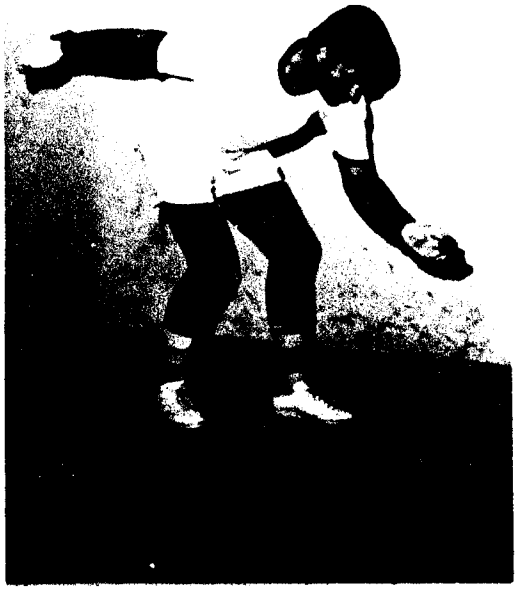
Starting Position

Before Contact

At Contact

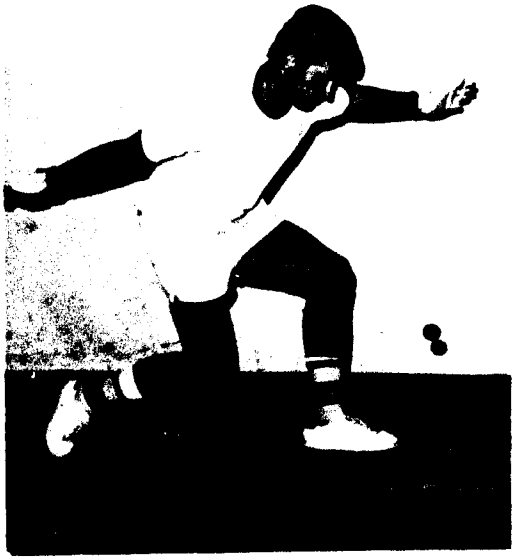
Follow Through

LOB SERVE SEQUENCE



Starting Position

Serve Movement Initiated



Before Contact

Follow Through

LEFT ARM EMPHASIS: POWER SERVE

Shortly After Dropping Ball

Power Phase Initiated

Just Before Contact

POWER SERVE ACTION SHOT

APPENDIX D

WRITTEN DESCRIPTIONS OF HANDBALL SKILLS USED FOR MP INSTRUCTION

POWER SERVICE
(Low Sidearm Stroke)

Objective: To strike the ball in a fashion that causes it to hit relatively low (2-4 feet above the floor) on the front wall and rebound off that wall hard enough to hit behind the short line close to the left side wall with a trajectory that will result in the ball heading into the left rear corner of the court. Ideally, the ball should not be hit so high or hard that it rebounds off the back wall; rather, it should bounce its second time on the floor at the juncture of the back wall and floor. This serve may also be hit to the opposite side of the court.

STARTING POSITION

Position yourself in the serving zone somewhere between five feet from the left wall and the middle of the court. Your back should be toward the left wall. Your weight should be on the right (rear) foot which is just inside the short line. The left foot should be ready to step laterally toward the front wall in the general direction you intend to hit the ball. Both knees should be flexed and you should be bent forward at the waist so that you are in a generally crouched and low position. Your arms should be hanging comfortably in front of you.

The ball should be held loosely between the thumb and fingers of the left hand. Your eyes should be fixed intently on the ball and should remain so throughout the entire service. Now, you are ready to initiate the power service.

SERVING MOTION

The serve is begun by dropping the ball to the left and in front of the left foot. Just as the ball is released from the hand, the left foot should step laterally toward the front wall in the direction you intend to hit the ball. As the left foot begins its step, the right arm is drawn backwards and upwards until it is approximately parallel to the floor and pointed toward the back wall. The fingers and thumb of the right hand should be close together forming a slightly "cupped" position. The hand itself should be in a

"cocked" (hyperextended) position at the wrist such that the back surface of the hand approaches the forearm. The left arm should simultaneously be drawn backwards and upwards across the front of your body so that it, too, is pointed towards the rear of the court.

Before your body weight has been shifted entirely to the left (front) foot, the left arm should be rather forcefully swung downward, forward, and upward toward the front wall. The swinging action of the left arm will initiate a desirable rotation of the shoulders and hips towards the front and will be closely followed by the forceful stroking action of the right arm.

The right arm should be pulled downward and forward across the front of your body in such a way that the elbow leads the forearm through the movement. The last phase of the service motion consists of the right forearm "whipping" forcefully forward so that the hand catches up and passes the elbow as it contacts the ball. The final movement of the right arm is the forceful "slapping" of the hand just as contact is made with the ball. The ball will have already bounced, reached its zenith, and started descending back towards the floor. Ideally, handball contact should occur no higher than 12-18 inches above the floor. At the time of contact, the body weight will have shifted entirely to the left (front) foot.

FOLLOW THROUGH

As the ball leaves the hand on its flight toward the front wall, the right arm continues in a forward motion until the normal range of movement at the shoulder is complete. The follow-through motion should be kept relatively low and close to the floor.

Comments: The effectiveness of the power serve is improved when the ball is hit extremely low and hard. It should be varied as to direction and speed during a match in order that the opponent can be kept guessing and somewhat off guard. The server should be careful not to hit the ball so high on the front wall that it carries strongly to the back wall on the first bounce. This will result in your opponent having a back-wall "kill" opportunity and should be avoided if at all possible.

LOB SERVICE
(Underhand Stroke)

Objective: To strike the ball in a fashion that causes it to hit high on the front wall and rebound off that wall hard enough to barely clear the short line on the bounce and to "die" just as the ball hits the back wall. The served ball should hug close to the side wall and ideally will "die" in the left rear corner of the court.

STARTING POSITION

Position yourself in the serving zone three to eight feet from the left side wall (depending on your preference) as you face the front wall. You should be standing with your weight back over your right foot which is just inside the short service line. The left foot should be slightly ahead of the right foot, ready to step forward toward the front wall. Both knees should be flexed comfortably and your upper body should be leaning slightly forward.

Your right arm (striking arm) should be fully extended at the elbow and drawn back well behind your body so that it is approximately parallel to the floor with the palm facing down. The fingers and thumb should be close together forming a slightly "cupped" hand position. The hand itself should be in a "cocked" (hyperextended) position at the wrist such that the back surface of the hand approaches your forearm.

The ball should be held loosely between the thumb and fingers of the left hand with the palm up. The left arm should be extended at the elbow and slightly forward away from the body so that your left hand (with ball) is positioned above and slightly ahead of your front foot. Your head should be down with your eyes focused intently on the ball. Now, you are ready to initiate the lob serve.

SERVING MOTION

The serve is begun by stepping forward towards the service line with the left foot. As the weight is transferring from the rear foot to the left foot, the ball should be dropped so that it strikes the floor slightly beyond and to the right of the left foot (in line with the

forward swinging right arm). The eyes stay fixed on the ball as it falls and rises after bouncing off the floor. As the ball is released from the left hand, the right arm should be swung downward and forward so that the right hand strikes the ball as it rises on the bounce at a height of about 12-18 inches above the floor. At contact, the ball should meet the hand at the juncture of the fingers with the palm. As the right arm proceeds through its downward and forward path, the left arm swings in the opposite direction, moving backward and upward. The action of the arms could be described as "scissor-like."

FOLLOW THROUGH

As the ball leaves the right hand on its flight toward the front wall, the right arm continues in an upward motion completing an arc of about 225°, or two-thirds of a circle, from start to finish. The left arm continues to move backwards and upwards until it is about parallel with the floor and extended backwards. The body weight has continued to shift forward until, at the completion of the arm action, it is almost entirely on the left (front) foot.

Comments: The lob service is a finesse shot and, consequently, does not depend on power or speed of movement to be executed properly. Ideally, the ball should strike the front wall gently and high so that on the return flight the ball descends acutely in an arcing path. When the ball strikes the floor beyond the short line, it should bounce high and carry towards the left-rear corner where it should "die," or lose all its momentum as it strikes the rear wall, resulting in the ball dropping nearly vertically after back wall contact. The closer the ball stays to the side wall, the more effective the serve. The lob serve may also be executed on the other side of the court.

APPENDIX E

GUIDELINES PROVIDED MP SUB-GROUPS FOR DEVELOPING SKILL NARRATIVES

1. What is the general objective of the service? Describe the "ideal" flight of the ball from the time of hand contact through its first bounce and up until the point of its second bounce.

2. What is the server's relative position in the service zone?

3. What is the general body position (all major segments) of the server just before the initiation of the service action?

4. Describe the wrist and hand positions.

5. From the starting position (see #3 above), how is the service initiated?

6. Where should the ball be dropped relative to the server's body?

7. How high should you allow the ball to rise from its bounce before striking it?

8. What is the ideal place on the hand for contacting the ball?

9. Give a general description of the actual service motion. Include the follow through.

APPENDIX F

IOWA-BRACE TEST ITEMS AND INSTRUCTIONS

TEST 1. ONE FOOT-TOUCH HEAD. Stand on left foot. Bend forward and place both hands on the floor. Raise the right leg and stretch it back. Touch the head to the floor and regain the standing position without losing balance. It is a failure:

1. Not to touch head to the floor.
2. Losing the balance and having to touch the right foot down or step about.

TEST 11. FORWARD HAND KICK. Jump upward, swinging the legs forward, bend forward and touch the toes with both hands before landing. Keep the knees as straight as possible. It is a failure:

1. Not to touch both feet while in the air.
2. To bend the knees more than 45 degrees.

TEST 16. KNEEL, JUMP TO FEET. Kneel on both knees. Extend the toes of both feet out flat behind. Swing the arms and jump to the feet without rocking back on the toes or losing the balance. It is a failure:

1. To have the toes curled under and rock back on them.
2. Not to execute the jump, and not to stand still on both feet.

TEST 5. STORK STAND. Stand on the left foot. Hold the bottom of the right foot against the inside of the left knee. Place the hands on the hips. Shut both eyes and hold the position for ten seconds without shifting the left foot about on the floor. It is a failure:

1. To lose the balance.
2. To take the right foot down.
3. To open the eyes or remove the hands from the hips.

TEST 20. SINGLE SQUAT BALANCE. Squat as far down as possible on either foot. Stretch the other leg forward off the floor, hands on hips. Hold this position for five counts. It is a failure:

1. To remove the hands from the hips.
2. To touch the floor with the extended foot.
3. To lose the balance.

TEST 3. GRAPEVINE. Stand with both heels tight together. Bend down, extend both arms down between the knees, around behind the ankles, and hold the fingers together in front of the ankles without losing the balance. Hold this position for five seconds. It is a failure:

1. To fall over.
2. Not to touch and hold the fingers of both hands together.
3. Not to hold the position for five seconds.

TEST 14. THREE DIPS. Take a front leaning-rest position, i.e., place the hands on the floor, with arms straight, extend the feet back along the floor until the body is straight (in an inclined position to the floor). Bend the arms, touching the chest to the floor, and push up again until the arms are straight. Do this three times in succession. Do not touch the floor with the legs or waist. It is a failure:

1. Not to push up three times.
2. Not to touch the chest to the floor each time.
3. To rest the knees, thighs, or waist on the floor at any time.

TEST 15. SIDE KICK. Throw the left foot sideways to the left, jumping upward from the right foot; strike the feet together in the air and land with the feet apart. The feet should strike outside the left shoulder line. It is a failure:

1. Not to swing the feet enough to the side.
2. Not to strike the feet together in the air.
3. Not to land with the feet apart.

TEST 17. RUSSIAN DANCE. Squat as far down as possible; stretch one leg forward; do a Russian dance step by hopping to this position with first one leg extended, then the other; do this twice with each leg. The heel of the forward foot may touch the floor. It is a failure:

1. To lose the balance.
2. Not to do the stunt twice with each leg.

TEST 21. JUMP FOOT. Hold the toes of either foot in the opposite hand. Jump up and jump the free foot over the foot that is held, without letting go. It is a failure:

1. To let go of the foot that is held.
2. Not to jump through the loop made by holding the foot.

APPENDIX G

PROFILES OF SUBJECTS

EXPERIMENTAL SUBJECTS

PROFILE

COLLEGE MALE

QPR

Mean = 2.545

AGE

Mean = 20.1 YRS.

ACADEMIC RANK

Mean = 3.06 YRS. COLLEGE (JUNIOR)

NUMBER PHYSICAL EDUCATION ACTIVITY COURSES COMPLETED

Mean = 1.86 COURSES

HIGH SCHOOL ATHLETIC EXPERIENCE

Mean = 3.4 LETTERS

COLLEGE ATHLETIC EXPERIENCE

Mean = .44 LETTERS AND/OR TEAM MEMBERSHIPS

HANDBALL EXPERIENCE

Mean = PLAYED ONE OR TWO TIMES

CONTROL SUBJECTS

PROFILE

COLLEGE MALE

QPR

Mean = 2.525

AGE

Mean = 20.0 YRS.

ACADEMIC RANK

Mean = 2.7 YRS. COLLEGE (SOPHOMORE)

NUMBER PHYSICAL EDUCATION ACTIVITY COURSES COMPLETED

Mean = 1.23 COURSES

HIGH SCHOOL ATHLETIC EXPERIENCE

Mean = 2.3 LETTERS

COLLEGE ATHLETIC EXPERIENCE

Mean = .30 LETTERS AND/OR TEAM MEMBERSHIPS

HANDBALL EXPERIENCE

Mean = NEVER PLAYED

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