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I am submitting herewith a thesis written by Michael R. Griffin entitled "Effects of Mental Practice Alone or in Combination with Kinesthetic Patterning on the Subsequent Motor Performance of Elementary Age Subjects." I recommend that it be accepted in partial fulfillment of the requirements for the degree of Master of Science, with a major in Physical Education.

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EFFECTS OF MENTAL PRACTICE ALONE OR IN COMBINATION WITH KINESTHETIC PATTERNING ON THE SUBSEQUENT MOTOR PERFORMANCE OF ELEMENTARY AGE SUBJECTS

A Thesis

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ABSTRACT

The present study addressed the extent to which mental practice alone or in combination with kinesthetic patterning influenced the performance of a motor skill executed by elementary age subjects.

Subjects were 54 sixth-grade students, 33 males and 21 females. Each subject participated in five 30 minute sessions of basketball instruction and activity as part of his/her physical education requirements and as a portion of the present study in order to gain experience and knowledge in basketball skills, specifically shooting technique. Following this period of instruction, all subjects who returned signed parental consent to participate in the study engaged in a pretest involving 10 nonconsecutive free throws from a distance less than 15 feet (10 feet) and at a rim height less than 10 feet (approximately 9 feet) in order to determine free throw shooting ability among subjects. From the pretest results, subjects were randomly matched into three experimental groups according to gender and performance.

Once distributed into three equal groups, each containing 11 males and 7 females, all subjects were given 10 trials according to the protocol used in the pretest. Prior to each free throw attempt, Group I performed three

kinesthetic patterning movements similar to that of the free throw shot (KP), Group II participated in mental practice (MP) for approximately eight seconds, and Group III recited a portion of the Stroop Color Word Test involving naming colors. The color naming was used to eliminate any cognitive activity (i.e. MP) relative to free throw performance. All subjects in all three groups performed under similar environmental conditions.

The measure obtained for each subject was the total number of free throws made in 10 attempts. Results were analyzed using a two-way analysis of variance with treatment (KP, MP, C) and gender (male, female) as the independent variables, and mean number of shots made out of a possible 10 attempts, the dependent variable. Results indicated no significant main effect of treatment nor a treatment x gender interaction. However, there was a significant main effect of gender ($p < .01$) with males displaying higher free throw accuracy than females.

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CHAPTER I

INTRODUCTION

The effect of mental practice on the performance of motor skills has received considerable attention in the research literature over the past fifty years. Therefore, the concept of "thinking through a movement" is not new. Scientists who have investigated the influence of covert rehearsal (Corbin, 1967), conceptualization (Egstrom, 1964) or simply mental practice on motor performance primarily with adult subjects have reported positive results relative to three primary areas of skill learning: (1) initial acquisition (Corbin, 1967; Egstrom, 1964; Smith and Harrison, 1962; Twinning, 1949), (2) intermediate stages of practice (Steel, 1952; Vandell, 1943; Waterland, 1972), (3) retention (Sackett, 1934).

Mental practice as it relates to improvement of motor skills has been used by practitioners as a supplement to motor practice in a wide variety of sports skills. Participants in various sports have been known to practice mentally before, during, and after a skill in order to enhance performance in that sport or skill (Singer, 1975).

Some attention has been given to possible reasons for using mental practice in motor learning situations. The total capabilities of the human brain have not yet been

recognized fully, and the use of mental practice, according to certain investigators, has been considered to be one area where skill performance or learning could be enhanced either alone or in combination with physical practice (Corbin, 1967; Stebbins, 1968; Steel, 1952). Jacobson, 1932, attempted to uncover the notion of why mental practice was effective in motor learning. In his investigation, Jacobson revealed that minute innervations of the muscle fibers occurred and registered on EMG records as subjects mentally practiced a task. This study appeared to link together the thought processes and actual muscular contraction through the concept of mental practice.

Several investigators have looked at mental practice alone or preceding physical practice, but few have attempted a combination of mental/physical practice in which a person actually patterns a skill (both physically and mentally) using no equipment, referred to as kinesthetic patterning. For example, the bowler who proceeds through the approach, backswing, stride and release without the bowling ball in order to better appreciate his technique is participating in this concept of kinesthetic patterning.

Limited studies have investigated the extent to which mental practice and/or kinesthetic patterning have affected the performance of younger subjects when compared with that of older subjects. Future research needs to investigate

whether differences in performance using mental practice and/or kinesthetic patterning will occur due to the differing ages of the subjects.

Although the mental practice literature has included a wide variety of skills, some appeared more practical than others. The basketball free-throw being a closed skill and having certain physical constraints (e.g. no practice shots, designated distance) appeared very sound for investigation. In the basketball free-throw situation, no physical practice is allowed prior to the actual shot, but mental practice and/or kinesthetic patterning are certainly in the realm of the rules.

I. STATEMENT OF PROBLEM

Does mental practice accompanied by kinesthetic patterning enhance subsequent free-throw shooting performance more effectively than traditional mental practice (i.e. with no overt movements) for sixth-grade boys and girls?

II. IMPORTANCE OF PROBLEM

The free-throw in basketball occurs following some unpredictable foul by an opposing player. Once the shooter is at the foul line, he/she has ten seconds in which to attempt the shot. Since actual practice shots are not allowed prior to the free throw attempt, players generally

stand at the foul line, concentrate on the basketball goal, perhaps perform extra movements (e.g. knee flexion, bouncing the ball several times, etc.), and then shoot within a period of a few seconds. However, it remains to be determined whether the allotted ten seconds could contain additional activities which would improve the subsequent free-throw attempt. Since ample time exists, the performer could actually physically and mentally pattern the motion desirable for the free throw prior to the actual shot. Moreover, it might be predicted that the faithful execution of a combination of internalized and externalized actions pertaining to the free-throw, would facilitate the accuracy of the subsequent shot.

III. DEFINITION OF TERMS

Mental Practice. Thinking about the requirements of a motor act, yet without overt movement.

Kinesthetic Patterning. Physically replicating a desired movement sequence. When patterning tasks involving the projection of an object, the object is not actually projected.

Closed Skills. Skills that are performed in an environment in which the critical cues for the performance of that skill are stable or fixed in one position (Marteniuk, 1976).

Open Skills. Skills that are performed in an environment in which the critical cues for the performance of that skill are constantly changing (Marteniuk, 1976).

Performance. A temporary occurrence representing the amount of learning that has occurred in relation to the motor task in question.

CHAPTER II

REVIEW OF LITERATURE

Mental practice has been a concern of researchers for years, and findings in this area have shown consistently that mental practice can provide contributions to both acquisition and performance of motor skills (Corbin, 1962; Rawlings, 1962; Richardson, 1967; Waterland, 1972). While studies related to mental practice support its importance, none suggest that mental practice alone is superior to physical practice.

Two conflicting theories exist in the realm of mental practice research. The psychoneuromuscular theory (Jacobson, 1932) suggests that minute innervations of the muscle fibers occur as a person cognitively thinks about a particular movement. In his experiment, Jacobson found that as subjects thought about the movements involved in arm curls, EMG records displayed very small contractions in the related muscles. He reasoned that such contractions presumably transferred to actual physical performance of the task.

The symbolic learning explanation of mental practice (Sackett, 1934) suggests that mental practice is only effective in motor performance when cognitive factors are involved. According to Sackett, these types of activities should benefit more from mental practice than tasks with

low cognitive demand. Recent support for this theory was seen in a study by Wrisberg and Ragsdale (1979) using the McCloy Block test as the motor task, which relies heavily on cognitive demand. Results from this investigation indicated that mental practice facilitated motor activity as the cognitive demand of the task increased.

I. PRIOR KNOWLEDGE AND MENTAL PRACTICE

Research related to mental practice reveals that at least some knowledge of the motor task or skill must be obtained in order for cognitive rehearsal to be effective. The extent of the knowledge or experience obtained prior to implementing mental practice is not concrete in the literature, but the results of the following studies suggest that at least some prior knowledge/experience is necessary before mental practice can be effective.

Corbin (1967) reported that giving a group of adult subjects a training period of overt practice prior to mental practice in order to familiarize themselves with the technique of the task did enhance mental practice effectiveness. Using wand juggling as the task, three groups of subjects participated in physical practice for five days. The control group did nothing for the thirteen days following the overt practice, while the mental practice group mentally practiced during the thirteen day period. The physical

practice group physically practiced the entire time period. Results of the investigation revealed that the physically practicing group proved to be superior in their performance from the pretest until the criterion test following the practice, while the mental practice improved significantly following the five day practice session and the thirteen days of mental practice. The mental practice group displayed much higher scores than the control group which had no mental or physical practice during the thirteen day period.

Schmidt (1975) reported that mental practice can be effective when previous experience pertaining to a skill has been obtained in order for "visual pictures" to be constructed while mentally practicing a task. Others (Smyth, 1975; Stebbins, 1968) concerning this issue of previous experience relative to mental practice, suggested that the novice does not profit as much from mental practice as an individual with prior experience in the task.

II. TYPES OF TASKS AND MENTAL PRACTICE

There have been various types of skills or tasks used in mental practice studies, and these can be categorized into two general classes: (a) gross motor skills and (b) cognitive motor skills. Gross motor skills (involving large muscle movements) can be separated into closed and open skills. Closed skills (fixed environment) are represented often in

the literature. Several investigators (Clark, 1960; Start, 1960) used the basketball free-throw (in one form or another), but either lack of control or insufficient subject numbers prevented a great deal of merit from being associated with these studies.

Twinning (1949) required subjects to toss rings at a target (closed skill). Three groups were used in the study. Group I tossed the rings on the first day (70 trials) and did nothing until the second criterion test on the twenty-second day. Group II tossed the rings on the first day (70 trials) and also on each day following the first day until the second criterion test on the twenty-second day. Group III participated in the same two criterion tests (70 trials) on the first and twenty-second day except this group mentally practiced for 15 minutes on each of the days in between. Compared with control performance practice, the mental practice facilitated learning of this simple motor task. While the physical practice group displayed the most improvement ($t = 6.44$), the mental practice group showed improvement of $t = 3.8$, both clearly significant.

Others (Corbin, 1967; Egstrom, 1964) have employed closed skills in mental practice studies. Using a task in which a wooden paddle was held in the nonpreferred hand and used to hit a small rubber ball at a target on the wall, Egstrom (1964) found that both mental and manual practice

contributed to learning, but no control group was used in this study. Corbin (1967) using juggling, another closed skill, in his investigation reported similar results when compared with a control group.

Motor tasks relying more heavily on cognitive demand are represented in studies by Sackett (1934) using a maze drawing task and Wrisberg and Ragsdale (1979) using the McCloy Block test on the task. These studies indicated that as the cognitive demand of the task increased, mental rehearsal enhanced learning in the task.

Betts (1949) suggested that the simplicity of the task is a very important element to consider in mental practice studies and concluded that mental practice is more effective with motor tasks involving projection of an object at a stationary target, rather than with skills similar to gymnastics. Two gymnastics studies pertaining to mental practice (Jones, 1965; Start, 1964) revealed no significant benefit when compared with a control condition having no mental practice during skill acquisition. Although, Marteniuk (1976) has suggested that the type of skill is an extremely important factor to consider when assessing the potential effectiveness of mental practice, the literature indicates that gains have been made in terms of acquisition and performance in all types of skills. However, mental practice has been shown to be most effective when the skill is closed and relies heavily on high cognitive demand.

III. DURATION OF MENTAL PRACTICE

Concerning the duration of mental practice, research findings have been very inconsistent in this area. Harby (1962) suggested that an optimal amount of mental practice does exist, but studies are limited in dealing specifically with this issue. Along these lines, Morgan (1972) added that as the length of the mental practice sessions become excessive, performance may decrease.

Twinning (1949) in his investigation, used 15 minutes of mental practice. From his investigation and suggestions from the subjects in his study, he suggested that five minutes is the maximal amount of time which should be provided for mental practice sessions.

A study by Shick (1970) looking at the effects of mental practice on selected volleyball skills used different intervals of mental practice to determine which was the most effective. The task in this investigation was a volleyball serving test. In substudy I, one group participated in no physical or mental practice for two weeks, while the second group had daily mental practice at home for six minutes, also for two weeks. In this substudy, a significant difference ($p < .05$) was found between the two groups with the mental practice group being shown to be clearly more effective relative to serving skill.

In substudy II, one group participated in mental practice for one minute at home following physical practice in class on serving skill, while the second group participated in three minutes of mental practice at home following the physical practice in class. Results from this substudy displayed significantly higher benefits ($p < .05$) on the three minute mental practice group when compared with the one minute mental practice group. Although few investigations have specifically looked at the duration of mental practice as a primary factor, evidence does indicate that mental practice is probably most effective when it does not exceed more than five minutes in duration.

IV. PHYSICAL PRACTICE AND MENTAL PRACTICE

A great deal of literature has been published which reports the effects of mental practice by itself. Several recent studies indicate that mental practice accompanied by physical practice produces equally beneficial results when compared with simply physically practicing, but few if any indicate that a combination of mental practice and physical practice is more beneficial than physical practice alone.

Egstrom (1964) found that college men who mentally practiced for five minutes and then physically practiced for the same length of time learned as effectively as a physical practice group on a task involving striking a ball at a target.

Corbin (1967) used wand juggling as the skill and found that a combined mental practice-physical practice group displayed significantly better performance when compared with a control group that had no practice. Corbin suggested that mental practice in combination with physical practice could facilitate skill acquisition, but the data did not reveal that mental practice should take the place of physical practice.

V. MENTAL PRACTICE IMMEDIATELY PRIOR TO THE TASK

Limited research in mental practice has investigated the effects of practice occurring immediately prior to physical performance, especially in sports skills. One study (Wrisberg and Ragsdale, 1979) employed two laboratory tasks which differed in cognitive demand; the stabilometer task (low cognitive demand) and McCloy Block tests (high cognitive demand). In Experiment I a bout of mental practice was interpolated early in acquisition prior to performance on the tasks. In Experiment II mental practice was injected after three days of practice and prior to criterion trials on Day 4. The results indicated that mental practice was as effective as physical practice only during early performance (Experiment I) on the task having high cognitive demand.

Rawlings (1972) investigated the effects of mental practice on rotary pursuit tracking acquisition. The control

group counted colors for 14 seconds prior to physical performance while the experimental group mentally practiced during the 14 second period. The results revealed significantly higher performance in rotary pursuit tracking by the mental practice group relative to the control group ($p < .05$). While a great number of studies have not employed mental practice immediately prior to the task, several investigations have revealed significant improvement in skill performance using this procedure.

VI. MENTAL PRACTICE AND AGE OF SUBJECTS

Most investigations in the area of mental practice have used adults as subjects. However, a study by Vandell (1943) utilized three different age groups (e.g. junior high students, senior high students, college students) in order to determine whether mental practice affected one age group differently in comparison to the others. Findings revealed that mental practice occurring 15 minutes daily increased performance in dart throwing and foul shooting later in practice, almost identically for all three groups. Although significant results appeared evident, limited statistical measures were performed on the data.

Research in other areas including information processing has looked at age as a factor for investigation. Wickens (1979) concluded from his findings that performance can be

affected partially by maturational differences including age, relative to processing information.

VII. SUMMARY

Mental practice has been an area of interest for many years. Research primarily using adults as subjects indicates that mental practice has a positive influence on the acquisition and performance of some motor skills. Mental practice has also been shown to be better than no practice, but generally to be less effective than physical practice. Studies also have suggested that in most instances at least some level of previous experience is necessary in order for mental practice to be effective. While mental practice has been shown to be effective in many types of skills, those which are "closed" and/or require a high cognitive demand appear to benefit more from mental rehearsal.

Research relative to the duration of mental practice periods generally suggests the use of shorter intervals not exceeding five minutes. Exactly when mental practice should take place is another area of inconsistency in the literature. Various studies, however, have shown substantial skill improvement using mental practice directly prior to the skill or performance.

Findings also indicate that physical practice combined with mental practice is equivalent in effect to mere physical

practicing. The extent to which kinesthetic patterning in combination with mental practice can enhance performance of motor skills is an area which has received little research attention.

Pertaining to the issue of kinesthetic patterning occurring immediately prior to motor performance, this concept might be viewed as an extension of Jacobson's notion which was formulated as a psychoneuromuscular theory. This theory, as discussed previously, suggests that minute innervations, which occur as subjects mentally practice a skill, transfer to actual physical performance. If this theory is correct, it would seem reasonable to assume that actual physical patterning of the movement would further reinforce muscular innervation, thus increasing the possibility of enhancing performance on a subsequent motor task.

CHAPTER III

PROCEDURE

This study was conducted in order to determine the effect of mental practice alone or in combination with kinesthetic patterning on the motor performance of a subsequent skill. Discussion of the procedures used in this study is presented in the following sections: (a) selection of subjects, (b) selection of performance task and testing area, (c) pilot study, (d) training and testing procedures, (e) data collection.

I. SELECTION OF SUBJECTS

The subjects for this experiment were 56 sixth-grade students from a local elementary school. Subjects participating in this study ranged in age from 11-13 years. The subjects originated from the entire pool of sixth-graders, but either failure to return the permission form (Appendix A) or illness prevented the entire population of sixth-graders from participating in the investigation. Each subject met with the experimenter and was given a letter explaining, (a) purpose of the study, (b) amount of time expected, and (c) request to participate accompanied by a consent form to be signed by the child's parent or guardian. Permission to conduct this study was granted by the Knoxville City Schools

after approval of the letter of request (Appendix B). The Human Subjects Committee at The University of Tennessee, Knoxville, also granted permission to conduct the study after receiving the appropriate Human Subjects Form (Appendix C).

II. SELECTION OF PERFORMANCE TASK AND TESTING AREA

The task used in this study was the standard basketball free throw shot. The rim was set at a height lower than regulation (approximately 9 feet), and the distance from the subject to the rim was less than regulation (10 feet). All testing and training took place in the school gymnasium, and all subjects were trained and tested under the same environmental and instructional conditions. The selection of the basketball free throw as the performance task was primarily used because the majority of the subjects had at least some previous experience with this skill. According to Corbin (1967), Schmidt (1975), Smyth (1975), and Stebbins (1968), some previous experience in a task is beneficial in using mental practice in order to facilitate the learning of a motor act.

III. PILOT STUDY

Prior to any testing a pilot study was conducted in order to determine whether the pretest, which would include

10 consecutive free throw attempts, would create undue fatigue which in turn might impair results to some degree. The distance of 10 feet, used for both the pretest and posttest, along with the lowered rim was defined in the pilot study in order to determine the suitability of these modifications for elementary school subjects. Henry (1979) found no conclusive evidence relative to basketball modifications of this nature, but his observations of poor shooting technique at elementary and junior high age levels, he emphasized had been extensive.

Ten subjects who were judged to have relatively low strength levels when compared with their sixth-grade peers were selected for the pilot study. The experimenter felt that selecting these subjects as opposed to some of the stronger subjects would better expose the limitations of the physical constraints (10 consecutive trials, 10 feet distance) associated with the pilot study, if indeed such were possible.

Each subject in the pilot study individually attempted 10 consecutive free throws from the designated 10 feet distance. No time constraints were placed on the students relative to the 10 attempts unless excessive time was taken. Subjects were instructed to attempt the shots in a manner closely associated with what they felt was a good technique in foul shooting. Underhand shooting was not permitted.

Results from the pilot study revealed adequate success in attempting the 10 consecutive free throws (Appendix D).

Only one of the subjects failed to hit any of the attempted trials. Results also indicated that later trials did not show a marked decrease in the number of shots made when compared to the initial trials. Data revealed that across subjects the total shots made for the first five trials were 12, while for the last five trials, 15 shots were made.

IV. TRAINING AND TESTING PROCEDURES

All students in the sixth-grade at the school participated in five 30 minute periods of instruction and training in the techniques of basketball over a five week time period (one meeting per week) as part of their requirement for physical education. This basketball instruction also served as the training for the 56 subjects who would eventually be participating in the study. All students were treated equally during the training period. Relative to the study, the basketball training served to further increase the amount of experience that the subjects would encounter in basketball shooting (including free throws) which has been considered desirable in mental practice studies (e.g. Corbin, 1967). Each of the 30 minute training periods involved several minutes specifically devoted to actual basketball shooting.

Following the five periods of basketball instruction and training, all sixth-grade students were given a consent form and letter describing the purpose, amount of time and

details involved in the study. Consent forms were collected the entire week, and only those students who returned the consent form signed by a parent or guardian were allowed to participate in the study. Of the 80 sixth-graders at the school, 56 returned the signed permission form and were used in the investigation.

The 56 subjects participated in a pretest involving 10 basketball free throw attempts in order to determine the skill level of each of the subjects. All other students in the sixth-grade physical education classes were allowed to attempt the 10 free throws also, but their scores were not used in this study. Subjects in the investigation attempted the 10 pretest free throws during their regular physical education time. Although the 56 subjects were not all in the same physical education class, an attempt to provide the same (or similar) environment during the pretest was made. During the pretest the subjects were not allowed to shoot the free throws consecutively. Each sixth-grade physical education class was divided into two groups with one group of students at one end of the gymnasium at one basketball goal and the other group at the other basketball goal. Each student in each group lined up behind one another behind each of the free throw lines at either end of the gym floor so that two straight uncrowded lines were formed behind the two foul lines. One student at each end of the floor would

attempt one free throw followed by returning to the back of his/her line. After all persons in each line had attempted their first shot, the second shot was taken and so on until 10 shots had been attempted by all of the subjects. Through this procedure, every subject in the study attempted 10 free throws under very similar circumstances, and a general skill level for every subject was obtained relative to basketball free throw shooting accuracy. All subjects were instructed to attempt their shots using the techniques employed during the previous five periods of basketball instruction and training.

Based on the number of shots made during the pretest, the 56 subjects (22 females and 34 males) were randomly matched into three groups; in this way both gender and skill level were balanced across groups. Two subjects were not included in the remainder of the study due to extreme scores made on the pretest. After the randomized matching process, each group included 18 subjects (7 female and 11 male). Pretest scores of the three groups indicated that they were not significantly different in skill level (Appendix E).

On the posttest each subject attempted 10 free throws according to the protocol used in the pretest. All subjects attempted each shot with only the experimenter visible in the gym. Those subjects who were not attempting the free throw were seated behind the stage curtain supervised by an aide

to the experimenter until it was their time to shoot the foul shot. Following each attempt, the subject would walk behind the stage curtain while the next subject in order would walk to the foul line to make his/her attempt. In this procedure, each of the 18 subjects attempted the first foul shot before any subject attempted the second shot and so on. This technique was employed (in similar fashion) in both the pretest and posttest in order to provide consistent preparatory sets.

Prior to each attempt subjects in the various conditions engaged in a different type of activity. Group I participated in the kinesthetic patterning (KP) technique three times prior to each free throw attempt for all of the ten trials. Prior to any trials, each subject was instructed in the concept and purpose of kinesthetic patterning and was encouraged to remain serious through the entire testing situation. The potential value of kinesthetic patterning was also emphasized. As discussed previously, the kinesthetic patterning concept was designed to supplement the mental rehearsal and concentration which normally precedes foul shot performance. The KP technique consisted of physically patterning the free throw motions three consecutive times while thinking about the upcoming shot.

Group II participated in mental practice (MP) for approximately eight seconds prior to each free throw attempt.

Before any free throw trials, each subject was instructed on this issue of mental practice. As previously defined, MP involves thinking about the requirements of a motor act in the absence of overt movement. As in the KP group, subjects were encouraged to keep in mind the seriousness of what they were doing.

Group III participated in a portion of the Stroop Color Word Test (Thurstone, 1944) (Appendix H) prior to each free throw attempt. This technique involved naming verbally the color of printed words while ignoring the word itself. The written words were the names of various colors. For example, if the word "red" was printed in green ink the subject was to say "green." Each subject was asked to name eight of these colors prior to each free throw trial in order to eliminate cognitive activity (MP) relative to free throw shooting. Before any trials were attempted, the subjects were asked to concentrate on the eight colors and were instructed that the experimenter would notice whether they were correct in the naming of the colors. As mentioned previously, all subjects in all three groups were given equal attention and participated under very similar environmental conditions (e.g. placement of experimenter, absence of other students, etc.).

V. DATA COLLECTION

Following each trial, the experimenter recorded the result of the subject's attempt as a hit or a miss. An example of the score sheet used for each subject may be found in Appendix F. The posttest data are presented in Appendix G.

CHAPTER IV

RESULTS

Data for the 54 sixth-grade boys and girls were collected and analyzed in order to determine the effect of the three experimental conditions (KP, MP, C) on the performance of 10 basketball free throw shots. This chapter includes a description of the data analysis and a discussion of the results.

I. ANALYSIS OF DATA

Descriptive statistics on the dependent measure (i.e., the number of successful free throws out of 10 attempts) are given in Table 1. Inspection of Table 1 reveals only small mean differences among groups but a somewhat larger difference between the performance of males and females. Relative to the three experimental groups, the mean number of successful free throws in each was less than 4.5 but greater than 4.0 out of the possible 10 free throw attempts (Table 1). A mean difference between male and female performance, however, was evident in all three groups. At least one more free throw was made by the males on the average when compared with females in each group (Table 1).

A 3(treatments) × 2(gender) factorial analysis of variance was performed on the dependent variable. Statistical

TABLE 1

DESCRIPTIVE STATISTICS—NUMBER OF TRIALS CORRECT ON POSTTEST

Gender	KP		MP		C		Across Treatment	
	$\bar{X}$	SD	$\bar{X}$	SD	$\bar{X}$	SD	$\bar{X}$	SD
Female	3.43	1.27	3.14	1.57	2.86	1.68	3.14	1.46
Male	4.45	2.46	5.27	1.68	5.09	1.58	4.94	1.92
Across Gender	4.05	2.10	4.44	1.91	4.22	1.93	4.24	1.95

Analysis System (1979) procedure GLM was used to calculate the ANOVA because of the unequal number of males and females on the gender factor (Table 2). The ANOVA revealed no significant differences among treatments, F (2, 48) = 0.21, p = .81 (Table 2). However, there was a significant gender difference, F (1, 48) = 12.81, $p < .01$. Males had significantly higher performance scores when compared with female scores. Table 2 further indicates that the treatment × gender interaction was not significant, F (2, 48) = 0.59, p = .56.

II. DISCUSSION OF THE RESULTS

Results of the analysis of variance revealed no significant differences between the three experimental groups on accuracy of posttest free throw performance. Thus, the present study suggests that the kinesthetic patterning technique has little potential as a supplement to mental practice for enhancing free throw shooting performance. However, no monitoring of EMG records took place during the experiment leaving some doubt as to whether muscular innervation was taking place during the interpolated pretrial activity. Whether or not the kinesthetic patterning technique can be linked to Jacobson's theory of mental practice (1932) through future investigation remains to be determined.

Findings in this study are inconsistent with the results of several previous studies which investigated the effects

TABLE 2

SOURCE OF VARIANCE FOR PERFORMANCE ERROR

Source	d.f.	SS	MS	F	P
Treatment	2	1.37	.07	0.21	.81
Gender (G)	1	41.42	41.42	12.81	.01
T × G	2	3.83	1.96	.59	.56
Error	48	155.24	3.23		
Total	53	201.87			

of mental practice on the performance of closed skills (Corbin, 1967; Egstrom, 1964; Twinning, 1949). While such studies have shown mental practice to be effective using closed skills, few employed skills which required a fairly powerful thrusting motion as was evident in this investigation. Previous evidence has also indicated that employing some period of training in order to allow experience to be gained on the task is necessary for mental practice to be effective (Corbin, 1967; Shick, 1970; Stebbins, 1968). However, this did not appear to be the case in the present investigation which included a training period but did not produce significant between-group results. In this study the possibility of having only five 30 minute sessions of training rather than several weeks of training on a task, which was used in many mental practice studies, could be a possible explanation for the conflicing results.

The use of eight seconds of mental practice immediately prior to criterion trials was slightly different than the 14 seconds employed by Rawlings (1972) for a rotary pursuit tracking task. In this study mental practice produced higher performance than that of a control group given no mental rehearsal instruction. It is also possible that the difference in the type of task used in the two studies might have been a contributing factor to the different findings obtained in the two investigations.

Using children as subjects in mental practice studies was not evident to a great extent in the literature. Wickens (1974) reviewed the research on child-adult differences in information processing. His findings revealed that performance seems to depend both on maturational differences in processing rates and nonprocessing factors such as incentive, motivation, attentiveness, and practice. The possibility of the results being affected by the use of sixth-graders in this investigation is entirely possible, but only future research which includes age as an independent factor could answer this question effectively.

The results did reveal a significant difference between the performance of males and females used in this investigation, with males displaying a higher level of free throw accuracy. Factors including strength, greater experience, and cultural characteristics could have contributed to the difference. Noble, Baker, Jones (1964) followed the strength development of boys and girls over a period of time. Differences in strength were evident at age eleven and became even more noticeable at age thirteen and succeeding ages. In a reaction time investigation in which males displayed superior reaction time performance to that of females, Hodgkins (1963) speculated that the cultural expectation of male superiority in physical performance or a more strongly developed sense of competition could have

contributed to stronger motivation and thus better scores by the males. The present investigation employed a task (basketball free throw shooting) having a strong male orientation. Such an artifact has been observed by others to influence performance differences in males and females. Roberts (1975) has reported that in certain situations, the use of sexually neutral tasks lessens the performance differences of males and females. All of the above studies suggest the importance of considering gender differences in physical performance investigations.

The basketball free throw task used in this study is consistent with some of the mental practice literature involving the use of closed skills. However, it is not consistent with literature implying that tasks relying heavily on cognitive demand enhance the effectiveness of mental practice (Sackett, 1934; Wrisberg and Ragsdale, 1979). The extent to which this task could have affected the results using mental practice and kinesthetic patterning should be considered, since the basketball free throw may not rely heavily on the cognitive aspect of skill performance.

CHAPTER V

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

I. SUMMARY

The purpose of this study was to determine if there was an effect of kinesthetic patterning and mental practice or simply mental practice alone on subsequent free throw performance of sixth-grade elementary school subjects.

Fifty-six sixth-grade male and female students enrolled at a local elementary school in Knoxville, Tennessee were used as subjects in this study. These 34 males and 22 females participated in five 30 minute basketball instruction and training sessions which occurred in the scheduled physical education classes. These sessions also served as part of the physical education requirements for both the subjects in this study and other sixth-graders in the physical education classes. Following the five training sessions, the subjects participated in a pretest consisting of 10 free throws from a distance less than the regulation distance (10 feet) in order to obtain general basketball performance skill levels for all subjects. Results from the pretest were used to randomly match the subjects into three experimental groups according to gender and skill level. Two subjects, one male and one female were eliminated due to extreme pretest scores

so that 18 subjects (11 males, 7 females) were included in each group.

Once the subjects were randomly matched into three groups, each of these groups participated in a posttest involving one of three experimental conditions. Group I performed three repetitions of kinesthetic patterning prior to each of the 10 free throw attempts. Group II participated in eight seconds of mental practice prior to each trial, and Group III engaged in a version of the Stroop Color Word Test involving naming eight colors prior to each free throw attempt. Several minutes separated any two trials on the posttest. Following each trial, each subject would move behind a stage curtain until all subjects in his/her group had completed that trial. This procedure controlled for any repetitious pattern that could have occurred while shooting the ten shots consecutively.

A two-way analysis of variance was used to analyze the results of the posttest performance with gender (female, male) and treatment (KP, MP, C) as the independent variables.

II. CONCLUSIONS

Based on this study the following conclusions were drawn:

1. For sixth-grade males and females, free throw shooting accuracy is not enhanced by kinesthetic patterning

and/or mental practice given immediately prior to the performance.

2. Sixth-grade males are significantly more accurate than sixth-grade females on the basketball free throw shot.

III. RECOMMENDATIONS

The conduct of this investigation prompted the following recommendations:

1. Age should be added as an independent factor in order to determine the effect of mental practice and/or kinesthetic patterning on the performance of younger and older subjects.

2. Studies using different tasks or skills should be used in order to determine whether the kinesthetic patterning technique is effective under other conditions.

3. Future investigations should employ sexually neutral tasks.

4. Future studies should use EMG records to monitor muscular activity in order to determine whether more muscular innervation occurs while mentally practicing or kinesthetically patterning as opposed to control situations.

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APPENDICES

APPENDIX A

LETTER TO PARENT OR GUARDIAN

AND

INFORMED CONSENT

THE UNIVERSITY OF TENNESSEE, KNOXVILLE
DIVISION OF PHYSICAL EDUCATION

January 12, 1980

Dear Parent or Guardian:

As a Graduate Assistant at the University, I am teaching Physical Education at Rocky Hill Elementary School. As part of the requirements for my Master's degree, I plan to conduct a study dealing with motor skill performance, specifically the basketball free throw.

This investigation deals directly with necessary physical education activities and will only require approximately ten minutes of the student's time outside of the recess period. The majority of the experimental time will come from your child's recess period. Should you allow your child to participate in the study, he/she will participate in a period of instruction involving basketball skills accompanied by two short tests of free throw accuracy. It should be noted that this experiment will not be used to replace the activities in the usual recess period, but will be a part of each of the student's instruction in physical education pertaining to basketball skills.

No names will be used in discussing the results of the study and the data will be strictly confidential.

Since the results of this experiment will suggest the possibility of better teaching and coaching techniques pertaining to motor skills, specifically basketball shooting, I would greatly appreciate your son/daughter's participation. The teachers of the three sixth grade classes and the principal have all granted permission for me to conduct this investigation.

If you decide to allow your child to participate in the study, please sign the attached consent form and return it to your child's teacher as soon as possible.

Thank you very much for your consideration in this matter. If you have any questions, feel free to contact me (693-9206) or my faculty advisor, Dr. Craig Wrisberg (974-5111).

Sincerely,

Mike Griffin

Mike Griffin

Consent Form

I understand that the purpose of this study is to determine the possibility of better teaching and coaching techniques pertaining to motor skills, specifically the basketball free throw.

I conform that my child's participation as a subject is entirely voluntary. No coercion of any kind has been used to obtain my permission.

I understand that I may withdraw my consent and terminate my child's participation, without penalty, during the investigation.

I have read the letter explaining the procedures that will be used in the study and understand what will be required of my child as a subject. I also realize that my child's grade will not be affected by results from this study.

I understand that all of my child's responses and scores will remain completely anonymous.

I wish to give my permission for my child to participate as a subject.

Signature of Parent or Guardian: _____

Date: _____

Child's name: _____
Last M.I. First

Home Address: _____

Home Phone: _____

Project Director: Michael R. Griffin
Home Address: 507 Buckeye Dr., Apt. 305
Knoxville, TN 37919
Home Phone: 693-9206
Work Phone: 691-0123

APPENDIX B

LETTER OF REQUEST TO THE KNOXVILLE CITY SCHOOLS

February 9, 1980

Mr. John E. McCook
Knoxville City Schools
101 East 5th
Knoxville, TN 37917

Dear Mr. McCook:

I am writing to ask your permission to conduct the research study described in the enclosed proposal. I am a Master's degree candidate at U.T. in the department of physical education, and this study is designed to partially fulfill the requirements for that degree. I would like to conduct the experiment at Rocky Hill Elementary School with students from the sixth grade. I am employed as the physical education teacher at that school as part of my graduate assistantship responsibilities at U.T. I have talked to the principal and the three sixth grade teachers involved, and they have expressed strong support for the study.

The enclosed proposal has been approved by the Human Subjects Committee at The University of Tennessee. If you have any questions about the experiment, please contact me. My phone number is 693-9206.

I believe that this investigation has the potential to make a solid contribution to our understanding of the factors contributing to successful motor performance in children. After completing the study, I hope to have something to say about the importance of mental practice and/or kinesthetic patterning on the performance of a motor skill.

I would greatly appreciate a decision on this matter as soon as possible. Thank you very much for your consideration.

Sincerely,

Mike Griffin

Michael R. Griffin

APPENDIX C

APPLICATION FOR REVIEW OF RESEARCH INVOLVING HUMAN SUBJECTS

The University of Tennessee, Knoxville
Application for Review of Research Involving Human Subjects
Form B

I. Identification of Project: Date: January 12, 1980
Project Director: Michael R. Griffin
Faculty Member Responsible for Research:
Craig A. Wrisberg, Ph.D.
Title of Project: "Effects of Mental Practice Alone or in Combination with Kinesthetic Patterning on the Subsequent Motor Performance of Elementary Age Subjects"
Department: Physical Education Division in the School of Health, Physical Education, and Recreation.
Estimated Starting Date and Completion Date:
January 1980-March 1980

II. Objectives of the Project:

A. Specific Aim: To investigate the effects of mental practice by itself or in combination with kinesthetic patterning on the subsequent performance of a modified basketball free throw shot.

B. Rationale for the Study: Previous research investigating motor performance preceded by mental practice is seen frequently in the motor skill literature. Vandell (1943), Steel (1952), and Waterland (1972) have all reported positive effects of mental practice on motor skill performance. Egstrom (1964), and Corbin (1967a) have reported similar findings in studies combining mental practice and physical practice.

Jacobson (1932) has reported that minute innervation of specific muscle fibers occurs as a person cognitively rehearses particular bouts of motor activity. If such muscular action is occurring as a person covertly rehearses a movement, it is reasonable to assume that additional physical patterning of the movements involved in a particular skill might further enhance subsequent performance on the task.

In a free throw situation in the sport of basketball, the performer is allowed limb movement prior to being handed the ball. Thus, the question exists as to the potential advantage of overt

kinesthetic patterning during this brief period of time in the performance of a subsequent free throw attempt. Therefore, the present study will attempt to determine the relative effectiveness of kinesthetic patterning in combination with mental practice, and mental practice alone, on the free throw shooting performance of young subjects.

III. Descriptions of Subjects:

The subjects will be 60 sixth grade students from Rocky Hill Elementary School in Knoxville, Tennessee. It should be noted that half the subjects will be male and half of the subjects female. The subjects will be assigned to one of three groups by a randomized mathcing procedure based on the results of a pretest. The only additional restriction in assignments is that half of the subjects in each group will be males and half females. Each subject will be asked to have a parent or guardian sign a consent form (see Appendix) before participating in the experiment.

IV. Procedures:

All of the subjects will initially participate in a four-week instruction period devoted to basketball shooting. Following this period of training, each subject will participate in the pretest which will involve shooting ten free throw basketball shots in order to determine the skill levels of the subjects. The subjects will be randomly matched into three groups according to their performance on the pretest (i.e., number of shots made in ten attempts), in order to determine that equal ability exists among the three groups. Following this period of training, the three groups will be post-tested. Prior to the post-test trials one of three types of activity will be given.

Group I: (10 males, 10 females) Five separate free throws preceded each time by a verbal task (The Stroop Color Word Test) (Thurstone, 1944) designed to prevent the subject from mentally practicing the movement prior to executing the free throw.

Group II: (10 males, 10 females) Five separate free throws preceded each time by mental practice only (i.e., thinking about the movement without overt physical practice).

Group III: (10 males, 10 females) Five separate free throws preceded each time by mental practice combined with kinesthetic patterning (i.e., thinking about the movement while making shooting motions with the preferred hand).

The testing will require the subjects to be present two days for approximately 15 minutes a day. All subjects will receive instructions and will be encouraged to do their very best.

The dependent measure in this study is the number of successful free throws made out of the five attempts. A two-way ANOVA (sex and treatments) will be performed on the dependent measure to determine whether significant differences exist. Any significant differences obtained ($p < .05$), will be further analyzed by the Newman-Keuls post-hoc procedure to determine the source of the significant differences.

V. Protection Measures:

(1) Subjects will be made aware of the requirements of the experiment prior to their participation.

(2) The subject's parent or guardian will sign a consent form prior to participation.

(3) Participation will be strictly voluntary. There will be no coercion.

(4) No portion of the subject's grade will be dependent upon participation in this experiment.

(5) The confidentiality of subjects will be protected and only group data will be discussed in the experimental manuscript.

VI. Responsibility of the Project Director:

By compliance with the policies established by the University Committee on Research Participation,

the Project Director subscribes to the broad principles stated in "The Declaration of Helsinki" and standards of professional ethics in all research, development, and related activities involving human subjects under the auspices of The University of Tennessee, Knoxville.

a. When appropriate, Form DHEW 596 will be completed and returned to the Office of the Vice Chancellor for Graduate Studies and Research, 404 Andy Holt Tower.

b. Approval will be obtained from the University Committee prior to instituting any change in project protocol.

c. Development of any unexpected risks will be reported to the University Committee.

d. Signed consent statements will be kept for the duration of the project and for at least 3 years thereafter.

e. A status report (Form D) will be submitted as requested, attesting to the current status of the project.

Signature: Mike Griffin

Project Director: Michael R. Griffin

Date: 1/24/80

Signature: _____

Faculty member in charge of research: Craig A. Wrisberg

Date: _____

VIII. Department Reviews:

Comments/Recommendations

The application described above has been subjected to department review and has been approved.

Signature
Department Head: _____

Date: _____

Chairperson,
Departmental Committee: _____

Date: _____

APPENDIX D

PILOT STUDY RESULTS

TABLE 3

PILOT STUDY RESULTS

Subjects	Trials 1	2	3	4	5	6	7	8	9	10	Total Hits Per Subject
Males											
1	H*	M**	M	M	M	H	M	H	H	M	4
2	H	M	M	M	M	H	M	M	M	H	3
3	M	M	M	M	M	M	H	M	H	M	2
4	M	H	M	H	H	M	M	M	M	H	4
5	M	M	H	H	M	H	M	M	M	M	3
Females											
6	M	M	M	M	M	M	M	H	M	M	1
7	M	M	M	M	H	M	M	M	M	H	2
8	M	H	H	M	H	M	M	M	M	M	3
9	M	M	M	M	M	M	M	M	M	M	0
10	H	M	M	M	M	H	M	M	H	H	4
Total Hits Per Trial	3	2	2	2	3	4	1	2	3	4	26

*Hits

**Misses

APPENDIX E

PRETEST RESULTS

(FOLLOWING RANDOMIZED MATCHING PROCEDURE)

TABLE 4

PRETEST RESULTS

(Following Randomized Matching Procedure)

	Group I		Group II	Group III
	Subjects	No. Hits	No. Hits	No. Hits
	1	2	2	2
	2	1	1	2
	3	3	2	2
Females	4	1	3	1
	5	1	3	2
	6	5	5	4
	7	4	1	4
	8	4	3	2
	9	3	3	1
	10	2	3	3
	11	1	2	3
	12	3	3	3
Males	13	5	5	5
	14	4	6	5
	15	6	5	6
	16	6	4	5
	17	4	4	5
	18	4	6	6
	Total	59	59	58
		$\bar{x}$ = 3.27	$\bar{x}$ = 3.27	$\bar{x}$ = 3.22

APPENDIX F

EXPERIMENTER'S SCORE SHEET

SCORE SHEET

Subject	Trials										Total No. Hits
	1	2	3	4	5	6	7	8	9	10	
1											
2											
3											
4											
5											
6											
7											
8											
9											
10											
11											
12											
13											
14											
15											
16											
17											
18											

APPENDIX G

POSTTEST RESULTS

TABLE 5

POSTTEST RESULTS

	Subjects	KP Group No. Hits	MP Group No. Hits	C Group No. Hits
	1	3	3	6
	2	3	4	3
	3	4	1	2
Females	4	2	3	2
	5	5	6	2
	6	5	2	4
	7	2	3	1
	8	2	6	3
	9	4	3	7
	10	4	5	5
	11	3	7	5
	12	7	6	7
Males	13	9	3	7
	14	5	8	3
	15	8	5	3
	16	2	7	5
	17	5	4	5
	18	1	4	6
	Total	74	80	76

APPENDIX H

STROOP COLOR WORD TEST

STROOP COLOR WORD TEST*

Blue (green)	Blue (black)	White (green)	Orange (brown)
Brown (black)	White (pink)	Brown (black)	Black (pink)
Red (blue)	Orange (brown)	Orange (green)	Blue (brown)
Green (blue)	Red (green)	Brown (blue)	Orange (blue)
Blue (pink)	Orange (blue)	Gray (brown)	Red (green)
Yellow (green)	Purple (brown)	Brown (green)	White (black)
Blue (black)	Black (pink)	Tan (black)	Black (brown)
Black (brown)	Green (blue)	Purple (blue)	Yellow (green)
Blue (pink)	Brown (green)	Red (brown)	Purple (black)
Orange (green)	Red (black)	Orange (pink)	Orange (blue)
Blue (black)	Purple (pink)	Purple (green)	Black (brown)
White (blue)	Blue (black)	Green (black)	Black (pink)
Blue (pink)	Green (black)	Black (pink)	Orange (pink)
Blue (brown)	Black (blue)	White (brown)	Green (green)
White (black)	Red (green)	Red (pink)	Orange (black)
Orange (blue)	Green (pink)	Tan (black)	Orange (blue)
Black (green)	Orange (brown)	Brown (blue)	Red (blue)
Gray (black)	Brown (black)	White (pink)	Blue (pink)
Black (green)	Green (brown)	Green (brown)	Black (black)
Black (black)	Blue (green)	Brown (green)	Black (green)
Brown (black)	Red (blue)	White (brown)	Red (black)
Purple (pink)	Blue (pink)	Yellow (pink)	White (blue)

*First word indicates written word.
Second word indicates the actual color each word was printed in.

VITA

Michael Robert Griffin was born in Atlanta, Georgia, on April 4, 1957, to Mr. and Mrs. William W. Griffin.

He attended elementary schools in that city and was graduated from Henderson High School in June 1975. The following September he entered Georgia Southern College, Statesboro, Georgia and in June 1979 he received a Bachelor of Science degree in Physical Education. In the summer of 1979 he accepted a physical education teaching assistantship in the Knoxville City Schools in Knoxville, Tennessee and began study toward a Master of Science degree in September, 1979. He expects to receive the Master of Science degree in August, 1980.