# THE EFFECTS OF MENTAL PRACTICE AND PHYSICAL PRACTICE ON THE SCORES OF INTERMEDIATE BOWLERS



by

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# CHAPTER I

## INTRODUCTION

"Practice, by taking thought, might little by little hammer out divers arts." (5:298) That thought expressed by Virgil so many centuries ago and receiving attention today is exemplified by numerous studies performed by psychologists in the area of motor learning. Since psychology has called itself a science, much research has been done in the area of psychomotor learning to connect the facts concerning the mind with the facts of bodily movement. In 1916, Washburn (6) advanced such a theory in the book Movement and Mental Imagery in which she states:

> If, then, one persists in being curious about the "inner aspect" of behavior and in believing that a man's thoughts are as legitimate objects for scientific study as his movements; if on the other hand, one realizes that it is through his movements that man takes his place in the rest of the order of nature, then the proper outcome of this twofold interest is an attempt to show that the whole of the inner life is correlated with and dependent upon bodily movement. (6:xiii)

Whether in psychology or in physical education, the belief that mental imagery is related to motor learning is a concept of considerable importance in advancing present and future learning theories. Studies done within recent years show that the performance of a motor skill is no longer thought of as a purely physical achievement, but

psychological as well. Just how much of motor learning is physical and how much is psychological is still not known and the difficulty in determining these factors further substantiates the entity of man. Were man a dichotomous being, and the mental and physical separate, the problem of how learning takes place might have been solved long ago.

The effects of mental practice on learning have been the object of many investigations, whether it be learning a language, spelling, playing the piano, or performing a physical skill. Although other educational endeavors seem to have kept pace with modern learning theories, it appears that methods of teaching physical education skills have remained relatively unchanged, particularly in the application of mental practice. All too often the daily lesson plan is taught following the usual explanation, demonstration, participation, and evaluation method.

The inclusion of mental practice in the lesson plan of today is almost unheard of, even though the use of mental practice, implicit learning, mind rehearsal, or mental imagery has been the object of many investigations. Much research has been done in the area of psychomotor learning and the effects of mental practice on learning a motor skill. Mental practice involves the thought processes and exhibits no form of visible movement. Although many factors affect mental practice, the results of the research performed in this area were conclusive enough to

assume that there is a definite connection between mental practice and the ability to learn a motor skill. Formerly, most research was of a psychological nature involving mirror tracing, maze habits, and pursuit rotor tasks and little thought was given to the application of the results to learning skills requiring gross movement patterns.

Perhaps one of the reasons that physical educators have not used mental practice in teaching motor skills is the lack of investigation into its application. It is possible the techniques of mental practice best suited to learning motor skills have yet to be developed. Research in this area is limited by the number of variables which must be considered in doing such an investigation. One of the greatest problems is trying to determine if mental practice actually took place. If subjects improved their performance through the use of mental practice, it could be assumed that mental practice did actually take place, but if improvement did not occur, it could not be assumed that mental practice did not take place. The results of investigation into the effects of mental practice on a motor skill have been varied. Some studies have revealed significant differences between mental practice groups and control groups, while others have obtained results showing little change. This investigation was undertaken to compare differences that might occur between mental practice and physical practice on bowling performance. Through one

more investigation into the application of mental practice, it might be possible to learn more about this practice as well as to verify past conclusions that it is effective in learning a motor skill. It is also possible that this investigation might shed some light on the techniques which might be used for mental practice.

Further experimentation is necessary to find out more about the application of mental practice and the techniques which best enhance learning. It is not known whether motor skill improvement comes from increased coordination through mental practice or whether it improves from a better understanding of the skill and the movements necessary for performing that skill. Only through repeated investigation in various skill areas can this become more clearly understood. As the use of mental practice is increased, knowledge of how learning occurs will improve, and thus, improved teaching methods should result.

# CHAPTER II

## STATEMENT OF PROBLEM

The purpose of this study was to determine the effects of mental practice and physical practice on bowling scores of college women who have completed a semester course in beginning bowling.

Mental practice involved the use of thought processes only, with no overt movement.

Physical practice involved the actual performance of the skill.

The study compared the differences between the mental practice group and the physical practice group in bowling performance and accuracy before and after three weeks of practice. Performance scores and accuracy scores were compared both within and between the groups to find out differences between the two groups at the onset of the study and to find out if improvement occurred from the initial scores to the final scores.

# CHAPTER III

## REVIEW OF LITERATURE

Little research on mental practice has been done in physical education skill learning. This might have been because most physical educators assume that the only way to learn or improve on a skill is to get out and practice. It would be practically unheard of to expect anyone to say, "well sit down and think about it for a while," yet this might have been exactly what that individual needed. Perhaps in eagerness to be active, a very important part of motor learning has been ignored. Research has shown that mental practice is effective in learning a motor skill. It is a known fact that both mental practice and physical practice, and physiological factors might all be limiting factors in learning a motor skill. Major studies within these areas have been reviewed as background for this investigation.

Although nothing appears to have been done with bowling and just mental practice, studies of bowling were reviewed to get a complete picture of the best methods to obtain the best possible results.

The mental practice studies which were reviewed pertain mainly to skills involved in physical education. The

studies of motor skill achievement involving recall, verbal, and visual cues were primarily psychological in nature. After obtaining an overall picture of all these studies, it is believed that the gap between the physical and mental is closing and that physical educators and psychologists are approaching the same goal from opposite poles. The findings of each will lead to common understandings about how learning takes place and what factors most affect motor learning.

## PHYSICAL PRACTICE STUDIES

### Intelligence

Among the factors affecting physical practice, intelligence is often considered, but is most difficult to substantiate. Research which has been done to relate intelligence to motor learning has shown no relationship or a very low degree of relationship between the two.

The Kulcinski study showed a low degree of relationship between physical education skills and intelligence but correlations between intelligence and stunts and tumbling were high. Superior groups showed a significant degree of learning over normal and subnormal groups. It was found that fifth and sixth graders showed a definite and positive relationship of intelligence to fundamental muscular skills.

Johnson (30) tested three hundred college freshmen men and women and found that intelligence as measured by the Thurstone Psychological Examination of College Freshmen was not related to skill as measured by the Johnson Physical Skill Test. The coefficient of correlation between the two tests was -.059.

Davies (17) experimented with classes in archery at the college level. One group received no instructions other than safety measures and the other group, the tuition group, received instructions. A slight relationship was found between the mental ability test scores and the achievement of students given instructions. The brighter students tended to profit more by instruction than did the duller students. She also found that the mental ability of uninstructed students had little effect on their achievement. They did not use their ability to find ways of improving their scores.

Harmon and Oxendine (28), Brace (14), and Seegers and Postpichal (46), studied the relationships of intelligence to physical ability and found the relationships to be positive but too low to be of any predictive value.

Seegers and Postpichal found I.Q. correlations higher for the more complicated skills.

Brace studied the motor learning of feeble-minded girls and compared I.Q. scores to skills and various tests of motor ability.

He found:

1. Intelligence in terms of I.Q. of feeble-minded girls, has a slight relationship to ability to learn gross bodily motor skills of the sport type. The low relationship is of no predictive value.

2. In the case of feeble-minded girls, I.Q. appears to have more relationship to motor learning, motor ability, strength, and athletic ability than in the case of normal girls.

3. One explanation of findings may be that with individuals of very low intelligence slight differences in intelligence may have a significant effect upon ability to learn and to perform gross bodily motor skills. It may also be possible that among youth of a very low level of intelligence the amount of intelligence has a significant bearing upon the amount of participation in physical activities that take place during the important period of physical growth. It appeared to Brace that emotional reaction patterns rather than lack of physical ability may have operated to produce poor performance. (14:274)

Reynolds and Stacey (43) found in a mirror drawing task that girls of subnormal intelligence were inferior to the normal group but they improved greatly. There was more variability in the subnormal group.

Mass Practice vs. Distributed Practice

Many studies in psychological areas have been concerned with the massing and distribution of practice. From these studies, it was found that the length of the rest interval between distributed practices is an important factor in studying the effectiveness of the practice.

Murphy (38) found that there was no loss of learning among college women who threw the javelin for accuracy five

times per week, three times per week, and once per week.

Ammons and Willing (10), in a rotary pursuit task found that continuous practice led to poorer performance at all stages of practice and that proficiency increased rapidly for the first twenty minutes of practice and more slowly after. Continuous practice lasted for ten minutes followed by twenty minutes of rest, and distributed practice was in cycles of one minute work and two minutes of rest.

Gentry (23) found in a study of code translation and mirror reading that output was greater under conditions of distributed practice. Six groups were used under varying practice conditions. Gentry concluded:

1. Output was greater under conditions of distributed practice and least under conditions of massed practice.

2. Changing conditions of practice from massing to distribution shows an increase in output and from distribution to massed shows a decrease in output.

3. When conditions of practice differ by a rest period variable, output is significantly different. Differences in practice conditions produce different results which are not due to lack of learning, but to differences in practice conditions.

4. The superiority of distributed practice over massed practice is held to be due to greater facilitation of performance received from factors which effect efficiency, and not due to an increase or a decrease in learning. (23:53-54)

Lorge (36), in a study of mirror reading, code learning, rotation of a stabilimeter at ninety degrees,

and the learning of nonsense syllables, found that learning under distribution was more efficient than massing and that the differences in achievement were attributed to the rest time interval.

Harmon and Oxendine (28), in a mirror tracing experiment, found that relatively long practice periods are desirable during the early phase of the learning process. After considerable skill was developed, the efficiency that was shown late in practice was not carried over to the next practice.

Verbal Training

> "Because of the many factors involved, the study of acquisition of a complex motor skill is difficult, unless the skill can be analyzed into its component parts in some way. One possible method of analysis is according to the kinds of cues or information provided during learning. A comparison of the relative roles of various types of cues within a single skill should be useful in that it will determine their relative effects on learning of the skill." (12:371)

In moving a lever to the proper position, five groups, each utilizing a different practice technique, were tested. Cues were visual, kinesthetic, and verbal. The groups were as follows:

Group A - standard practice group

Group B - verbal stimulus giving numbers and direction, e.g., six right and three forward.

Group C - verbal response groups in which the subjects described verbally how he would move the stick to reach the correct position in terms of distance from the center and direction of movement.

Group D - kinesthetic response in which the subject moved the stick without the aid of colored lights. When he thought he was in the correct position, the lights were turned on so that he could see how close he had come.

Group E - verbal stimulus-kinesthetic response in which no lights were used. Subjects were asked to move the stick to a verbal description given by the experimenter. Descriptions were six inches to the left and away from you at an angle of about thirty degrees. (12:379)

Battig found that the standard practice group was best. Of the experimental groups, the verbal stimulus was best. Standard practice group, verbal stimulus, and kinesthetic response group were significantly better than no practice.

McAllister (37) tried various kinds of verbal training to find out the effects they had on motor performance. Using a Star Discrimeter, she experimented with seven groups of subjects. The types of verbal pretraining were:

Irrelevant - in which they were to associate pairs of words unrelated to the motor task.

Relevant-Stimulus - associate words unrelated to the motor task with stimuli which simulated those of motor tasks.

Relevant - Stimulus - Response - learned to associate substitute stimuli with response words based on "degrees," "a clock," or "directions." Two groups given pretraining with clock analogue practiced on a motor task. (37:329)

McAllister concluded that relevant-stimulus-response pretraining facilitated subsequent performance.

Visual Practice

It is believed that motor learning may take place more rapidly when a person can observe the skill to be performed. This can occur through observation of others in class or through audio-visual aids.

Irwin (62) found that the sound film-strip method, the silent loop film, and verbal instruction method are equally effective in improving the tennis playing ability and the knowledge of women students.

Lockhart (35) found that the rate of improvement in learning of the motion picture group was more consistent than that of the control group who had not used the motion picture as a bowling instructional device. At the beginning of the experiment both experimental and control groups had about the same mean score, but by the end of the third week, the experimental group surpassed the control group and continued to be superior throughout the remaining periods of observation.

Reminiscence

In considering the many elements which effect motor learning and practice, reminiscence must not be forgotten. Although the amount of reminiscence which occurs while performing a skill is not known, it is known that reminiscence does take place.

Fox and Lamb (19) conducted a study of seventh grade girls in a softball repeated throws and bat for distance test.

After the pretest, class instruction was given for ten periods over four weeks prior to the administration of a posttest. During the five weeks following the posttest no practice was permitted and then a retest was given. Seventeen weeks later the retest was repeated.

It was concluded that improvement in the softball skills of throwing and batting for distance did occur during a long interval without practice. It appeared that reminiscence was more apt to appear after a relatively long no practice interval than after a short period of time. These results were significant at the one per cent level of confidence.

Fox and Young (20) studied the effects of reminiscence on learning badminton skills in college women. One group had a week of instruction, a pretest, five more weeks of instruction, a posttest, three weeks of practice, a second posttest, six weeks of no practice, first retest, twelve weeks of no practice, and a second retest.

The second group had one week of instruction, a pretest, five weeks of instruction, a posttest, six weeks of no practice, a retest, twelve weeks of no practice, and a second retest.

It was concluded that reminiscence did occur on the wall volley skill but did not occur in a short serve skill. The additional three weeks of instruction did not contribute significantly to long term retention on the wall volley test.

Knowledge of Results

In a test of any type, knowledge of results of previous tests acts as a motivating factor toward the improvement of performance on future tests.

Lavery and Suddon (33) studied the effects of delay of knowledge of results in the acquisition of a motor skill. The results indicated that within thirty trials the rate of acquisition is a function of the number of trials in which knowledge of results is delayed; retention is not. If ninety trials are given, the subjects in a five trial delay condition eventually reach the level of acquisition reached by the 0-trial delay and they retain the skill better.

Retention and Relearning

When a skill is learned at any time in life and it is later relearned, the possibility of retention of former learning must be considered.

Purdy and Lockhart (42) retested college women on the nickel toss, ball toss, foot volley, lacrosse, and bongo board, and relearning of motor skills which were practiced nine to fifteen months previously. On the first day of the retest a brief review of instruction was given. On the following two days no instruction was given. Motivation was given by showing the previous scores of the subjects so that they might compare their performance.

Conclusions were:

1. A high degree of skill was retained after approximately one year of no practice. The group retained 94% of its best performance on original learning. 89% of the subjects displayed reminiscence on one or more skills.

2. Relearning to previous skill level was rapid after a year of no practice. After three days of practice, the total group retained the level of proficiency acquired in the ten days of original learning.

3. The skill group retained their relative position in learning, retention and relearning of gross motor skills. High skill had significantly better scores than average or low skill groups; average skill group had significantly better scores than the low skill group.

4. When the proportion of skill retained and relearned was considered, the differences among the classified skill groups were small. (42:269)

Summary

Research has shown that physical practice is influenced by many factors. Intelligence appears to have some effect on motor ability but the relationships found have been too low to be of any predictive value. Differences which did occur were greater when extreme levels of intelligence were compared. It was found that distributed practice was more effective than massed practice although some evidence was revealed that massed practice might be good during the initial stages of learning. In studies on verbal training, it was found that verbal stimuli were effective devices for learning and that films, filmstrips, and film loops were equally effective as visual aids.

Groups who used visual aids improved their skill more rapidly than did the control groups. After long periods without practicing a skill, it was found that improvement did occur and that this might have been due to reminiscence which appeared after a long no practice interval rather than after a short one. When the knowledge of results of previous tests were given to subjects, it served as motivation for them to improve scores. Retention was apparent when a gross motor skill was relearned after a year of no practice. After three days of practice the skill level achieved during the original ten days was equalled. As research methods are improved upon, other factors which influence motor learning will undoubtedly be revealed.

## MENTAL PRACTICE STUDIES

Much research in the field of psychology has been done on implicit learning or mental practice. Although many of these studies involve maze patterns, mirror tracing, nonsense syllable learning, and finely coordinated skills, it appears that these findings should have some bearing upon the learning of gross motor skills.

Having studied the effects of varying amounts of verbal training on the learning of a motor skill, Baker and Wylie (11) found that with time used as a measure of learning, no significant transfer effects occurred following eight trials of memorizing verbal expressions related

to the final task of pressing the appropriate one of four switches. Twenty-four trials, however, did yield a significant amount of positive transfer to performance of a motor task.

Bills (13), in an experiment involving just mental work, found that muscular tension as used in his study, increased the efficiency of mental work and that the increase in efficiency gained by tension was enhanced with practice when speed was the criterion. He also found that the added efficiency gained by using tension tends to increase as the subject grows more fatigued.

To induce tension, the subjects grasped and squeezed continuously at a constant pressure a hand dynamometer.

Davis (16) explained the increase in muscular tension observable during mental work as dependent on the rest period in which less work is done during the test period, the amount of practice in the performance tested, the distracting stimuli operating during the test period, and the amount of work completed.

When a subject prepared for the more difficult of two performances, Freeman (21) found through the photographic registration of the thickening of muscles that there was an increased spread of neuromuscular excitation. Here the subjects were placed in a device resembling the ancient pillory or "stock" and displacements of levers, resting on the muscles, were photographically recorded.

It was also found that practice in the activity to be performed reduced the spread of neuromuscular activity and work output was increased.

Geldreich, in a study of the physiological concomitants of mental work stated:

> Implied in this concept of mental work in this study is the understanding that mental work is the result of activity of the total organism and not the mere "emission" of a few grams of brain cells, that energy is transformed and expended, and that changes in energy distribution occur within the "mental organ system" which alter the accomplishments of the individuals. (22:1)

In a color-naming experiment the task was to learn to respond to the perceived color by pressing the key as fast as skill and motivation permitted. The physiological changes effecting respiration, heart beat rate, blood pressure, level of skin conductance, and galvanic skin response were recorded. Geldreich found that:

1. Trends of changes in rate of color naming and blocking were due to factors present in mental work operation and organization of the mental worker.
2. The average rate of respiration and heart rate are significantly greater during mental work than the motor component, sensory component, or control period.
3. Changes in rate of respiration and heart beat during mental work probably represent momentary adjustments made to the demands of energy mobilization in response to changing work situations.
4. Relative blood pressure increases during mental work but decreases during the motor or sensory components.

5. The level of palmar skin conductance is greater during mental work than rest, motor, or sensory components.

6. Changing physiological activities reflect changes in energy mobilization. As color-naming work output decreases, the amount of energy mobilized decreases. Mental work output is a function of the momentary mobilization of energy, the momentary and previous conditions of the circulatory and neuromuscular systems, and the momentary receptivity of the subject to further stimulation. (22:26-27)

In a ball and socket learning task, Gilmore and Stolurow (24) had practice and no practice groups receive mental training or rest conditions. In comparing the conditions, it was found that the transfer effect was positive for motor and rest conditions and that the motor condition yielded significantly greater transfer than rest. Mental rehearsal produced a negative transfer effect which was significantly different from both motor and rest.

Perry (39) studied the effects of actual and imaginary practice on five different tasks. It was found that imaginary practice is more effective in tasks which consist of learning facts that may be observed without actual movement. In all but the symbol digit substitution test he found that imaginary practice was good if the I.Q. was over 124.

Ruben-Rabson (44) studied the effects of mental rehearsal on piano playing and found it to be reliably superior to other practice. It reduced the number of keyboard trials and achieved retention as good as the group which had extra keyboard trials. The mental practice group

analyzed the music, practiced, mentally practiced, and then performed with the criterion being a perfectly played piece. The success of the mental practice group might possibly be due to distributed practice.

Sackett (45) found that symbolic rehearsal was beneficial to retention of a maze habit after one week and that some evidence showed that the greater the number of rehearsals the higher the degree of retention.

Smith and Harrison (49) studied the effects of visual, motor, mental, and guided practice on speed and accuracy of performing an eye-hand coordination task using a three-hole stylus. They found that the visual and mental groups reduced the total number of errors as well as significantly increasing performance in terms of correct hits and total number of trials. The results warrant conclusion that visual practice and mental practice improved accuracy on a punchboard learning task, whereas motor practice and guided practice did not.

Summary

Research on mental practice revealed many effects on the learning of motor skills. Evidence has shown that there is a positive transfer of memorization of verbal phrases to the performance of a motor skill and by increasing muscular tension the efficiency of mental work was increased. As subjects became more fatigued, added efficiency was enhanced by tension. During mental work there was an increase in

muscular tension which was dependent on the length of the rest period, distractions, the amount of practice, and the amount of work completed. Practice of an activity reduced the neuromuscular activity, but when subjects prepared for the more difficult of two activities, neuromuscular excitation increased. Physiological changes occurred during mental practice resulting in an increased rate of respiration, heart rate, blood pressure, and palmar conductance. Retention of a motor task was increased when the number of mental practices were increased and the number of errors in performing a motor skill were decreased while performance was increased through the use of mental practice.

## MENTAL PRACTICE STUDIES RELATED TO PHYSICAL EDUCATION

Although research in mental practice has been done in the field of psychology, within the past decade much has been done in physical education. Many studies have been based on previous studies done in psychology but have physical education skills as the selected tasks.

Perhaps one of the earliest studies on mental practice was done with weight-lifting by Shaw (47). Three students lifted weights and sat back to repeat the task in their minds. The students could not imagine their weight-lifting efforts without unconsciously contracting their

muscles. An electrical indicator revealed greater muscular activity when the students thought of lifting heavier weights than when they were mentally lifting lighter weights.

Vandell, Davis, and Clugston (53) attempted to determine the function of mental practice in dart throwing and basketball free throws. The groups were tested for I.Q., educational age, chronological age, motor ability, and physique. On the junior high school level, dart throwing was the skill involved. The motor practice group improved seven per cent, the mental practice group four per cent, and the no practice group went down two per cent.

At the high school level the basketball free throw was used. The no practice group did not improve, the physical practice group improved twenty-three per cent, and the mental practice group improved twenty-two per cent.

Although motor practice proved superior in both cases, the improvement of the mental practice group is significant.

In a ring toss experiment, Twining (52) found that through fifteen minutes of mental practice a day for twenty days, college men improved 36.2 per cent. The physical practice group improved 137.3 per cent. Twining felt that mental practice occurred during the first five minutes only.

Halverson (59) compared the effectiveness of mental practice on the one hand push shot. It was found that

mental practice was effective, but not as effective as actual practice. Mental practice was effective in development of a concept of skill which did result in actual improvement in performance. The kinesthetic method was also effective in development of motor skill.

Harby (27) used a movie demonstrating the movement to be learned as a form of mental practice. It was found that mental practice was effective in learning a physical skill and that mental and physical practice combined are probably more effective than either mental or physical practice alone.

In a study of the underhand free throw, Huffman (61) found that mental practice and physical practice were about equally effective in improving the performance of a free throw.

A combination of actual and mental practice was experimented with by Hertz (60). Besides overt practice, there was a verbal explanation, demonstration, and mental practice through loop films designed for enabling a student to improve skill by a visual concept of correct method. A comparison was made and no statistical difference was shown, although improvement occurred in the overt practice, overt practice-implicit learning method, and the kinesthetic method. Similar results were obtained in the Wilson (58) study of the tennis forehand and backhand drives. There was also no marked difference in highly skilled and lesser skilled players.

Mitchell (64), Clark (15), Start (51), Waterland (56), and Kelsey (31), all found that mental practice was effective in learning or improving skill.

Muscular endurance was increased through mental practice of five minute periods. Although mental practice only increased endurance doing sit-ups by twenty-nine per cent in comparison to physical practice increase of 322 per cent, the fact that it increased merits consideration.

Whether in physical practice or mental practice, similar factors have similar effects on motor learning depending on the conditions of the experiment.

Reminiscence, tension, verbal cues, visual cues, intelligence, length of practice, and distribution of practice all seem to have an effect on learning.

In a speech before the Music Teachers National Association, Small discussed "the learning of motor skills by symbolic thinking" (48:83). The approach used was that "idea is the father of the action" (48:83) and idea was used synonomously with symbolic thinking. For the man-machine combination, a certain input into the man produces a certain output through the machine, and as the input changes so will the output.

> . . .We do not necessarily need to be actually seeing, hearing, or touching something (sensory input) in order to initiate muscular activity on our part (output); we may simply have the idea of the desired movements which is sufficient to start them into being.

> In plain fact then, if ideas are effective in initiating and, therefore, in perfecting motor skills, why not use them for that purpose? Why not let them provide guidance for fingers and arms, etc., instead of rather blindly letting these parts of the body find their way by uneconomical trial and error? If we are going to do so however, we have to generate the ideas and know what to do with them. This is a process which each individual must go through. (48:84)

Small then lists six steps of procedure for generating the ideas. Although it is subjective, muscular control can be improved by going through the mental counterparts of it. This speech was an attempt to indicate ways of facilitating the development of powers to image and formulate ideas for recall which will assist in the important task of learning a motor skill.

Small's six steps for mental practice in learning a motor skill are directed to music but are applicable to any motor learning situation. It is possible that they are the six basic steps to learning any type of skill whether motor or mental.

In order to give direction in building up ideas and in using them as symbolic tools in learning motor skills, Small lists the following steps as required procedure in the order believed essential to follow:

> 1. Determine the typical muscular skills required by your instrument and its music. Analysis should be in terms of specific or concrete muscular activity involved in the performance. There are some excellent guides already in existence for accomplishing this. . . .

2. Determine as well as possible the mechanics and physiology involved in executing the skilled movements. Again, scientific analysis and study have provided us with help. The work of Steinhausen on the physiology of the bow arm, of Ortmann on the physiological basis of piano playing, . . . all bear upon this item.

3. Determine your particular difficulties in executing the characteristic movements required by your instrument and its repertoire.

4. Determine, on the basis of your knowledge from items 1 and 2, what you must initiate in the way of movement sequences, of independence or strength of body members, etc., in order to overcome your particular difficulties. These should be so clearly defined in your mind that you can develop your own exercises for overcoming the hazards if need be. You certainly will be in the best position also to select relevant exercising material. But what is really important is that you are then ready to take advantage of the next two steps.

5. Determine what the composition you intend to perform requires in the way of motor skills which you have not yet thoroughly mastered and at what points in the composition they occur.

6. Be sufficiently aware of the trouble spots so that as they are approached you can call up the mental symbols and ideas derived from the previous steps which you have found lead you to successful motor performance. Please note that it is not sufficient to just "be aware of trouble spots." You must have the ability through calling up ideas to initiate specific behaviors which you have found guide and coordinate your body machinery properly. When this is done, learning takes place more readily with each appearance of a passage requiring a particular skill and the practice of repertoire is advanced as a means to technical as well as final musical ends. (48:84-85)

Summary

It was found that an increase of muscular activity occurred when subjects imagined lifting heavier weights than

when lifting lighter weights. It was also found that endurance increased when subjects mentally practiced doing sit-ups. In comparisons made of the effects of mental practice and physical practice it was found that physical practice was more effective, but that mental practice was also effective in learning a motor skill. Many studies concluded that a combination of mental and physical practice would be better than just physical practice for learning or improving motor skills.

## BOWLING STUDIES

In a study of bowling, Waterland (56) developed a movement pattern which sent the ball from the foul line to the pins in two and eight-tenths seconds. The time goal was set so that the students would develop a keen kinesthetic perception of the amount of force, direction of force, and position necessary for a successful movement pattern. The students closed their eyes while performing the movement pattern and, after delivering the ball, told the instructor how long it took the ball and in what direction it travelled. Mental practice took place immediately before the ball was delivered.

The performance level of the student in beginning bowling was judged by the speed of the ball. The time scores were recorded each day for all students, and the average time recorded on the fourth day of class was used to indicate the students initial performance. First ball averages

from the last four classes were used to indicate the students accuracy achievement. A comparison was made of the mean scores computed for the first four and last four days. It was found that students with emphasis on kinesthetic awareness and mental practice preceding the overt performance had a greater gain in final time than the overt performance. No significant differences were found when the first ball averages were tested, possibly because of low reliability coefficients for accuracy scores.

Glassow (25) also used kinesthetic perception as a method of teaching bowling. The bowler visualized kinesthetically before delivering the ball. Her first objective after the subjects adjusted to the delivery of the ball was to develop a velocity goal. The ball was to be rolled down the lane in three seconds. While the students practiced to reach the three second velocity no pins were used and the arm swing was developed without the approach. When the desired velocity was achieved the approach was added. The study took place over an eight week period with the first four weeks devoted to reaching the velocity goal. Glassow concluded that the kinesthetic approach to bowling developed a greater velocity which was indicative of an ability to control and develop greater force.

Roloff (65) also performed a study using both kinesthetic and visual aid techniques. Results of this study were not conclusive because of the many variables involved

in the experiment, different teaching methods, different teachers for the different experimental and control groups, and differences in motor ability scores. There was no indication that kinesthesis affected the learning rate of bowlers.

Films were used to induce feeling for the movement involved in bowling. The experimental group did improve in scores but there was no statistically significant indication that the visual aids method was superior in teaching bowling.

Kearns (63) did a study on an analytical approach to teaching bowling which was based on principles of kinesiology and mechanics. The effects of this approach were compared to the traditional method of teaching. She used four classes of beginning bowling; two were experimental groups and two were control groups. The classes met for thirty lessons. The lesson plans for all groups were the same except for the inclusion of principles and visual aids in the experimental groups. The average of the number of pins knocked down on the first balls in each game was calculated to determine accuracy and the means of the initial and final scores were compared.

She concluded:

1. There was no significant difference in game scores based upon initial and final performance in the four groups of subjects.
2. The experimental group was superior in accuracy performance.
3. Instruction in mechanical and kinesiological principles did not appear to enhance learning and improve performance.

4. The traditional method of teaching bowling was as effective as the analytical approach used in this investigation.

5. Both experimental and control groups improved significantly.

Lockhart (35) used a motion picture as an insturctional device for beginning bowlers. Four classes, two control, and two experimental for each of two instructors were used. The film demonstrated superior bowling ability and was shown to the experimental groups both in its entirety and in part in hopes that the students would analyze their own performance.

Game scores and first ball averages were the criteria for comparing experimental and control groups.

After three weeks, the experimental groups surpassed the control groups in performance. The rate of improvement in learning of the movie group was more consistent than that of the control group. During the first two weeks, the performance of the two groups was almost identical but the experimental group continued to improve by the third week while the control group remained at a standstill. Although both groups had about the same mean score, at the end of the third week, the experimental group surpassed the control group and continued to be superior throughout the remaining periods of observation.

Walters (55) compared the perceptual method with the traditional method of teaching bowling. The experimental group utilized visual aids preceding practice of bowling for

the first three days of the learning experience. A slow motion film of spare bowling was shown on the fifth day of the experiment. Charts of spare bowling were also used. The movie shown on the first three days was followed by practice in the dark in which phosphorescent painted pins and balls were used. The students were thus forced to depend on kinesthetic sense. On the fourth day of the experiment they bowled in the light for the first time and kept score. On the fifth day and thereafter, various visual aids were used.

The use of visual aids showed no significant difference between the experimental and control groups. However, the experimental group had fewer learning plateaus which occurred when no special devices were used than did the control group.

Dean (18) used visual aids in the form of charts and a movie to teach bowling. The students bowled prior to seeing the movie so that they could better analyze and appreciate the skill involved. The charts illustrated spare bowling and were available during every class period.

It was felt that the use of visual aids helped the students to win the National Intercollegiate Telegraphic Bowling Tournament in 1940.

Liba and Sloan (34) reported on a study done by Hyde concerning the use of the straight or hook ball. It was reported that beginning bowlers do as well in first ball accuracy when taught the hook ball as when taught the

straight ball. It was also found that bowlers who rolled a ball at a speed of two and two-tenths to three and seven-tenths seconds were more successful with the hook ball, but bowlers using a slower ball, aiming at all ten pins, were more successful with the straight ball.

Summers (50) conducted a study on two types of delivery with variation in the type of aim. The hook ball and the straight ball were the two types of delivery and point of aim variations were pin and spot bowling. She found that beginners attained superior results when they were instructed with spot bowling.

Goellner (26) studied the effectiveness of head pin, spot, and combination bowling, and concluded that head pin bowling was the most successful for the beginning bowler, combination was second best, and spot bowling third. He also found that gutter balls occurred most frequently in the first five frames. More attention should be paid to pre-game warm-up. Goellner's results were in contrast to Summers'.

Psychological factors affecting bowlers were studied by Webster (57). Through the use of a questionnaire, interviews, observation, and collection of scores involved in bowling skill performance, Webster found that practice, distraction, diurnal cycles, seasonal change, and superstitions influenced bowling performance. Bowlers with an average over one hundred sixty were more superstitious.

Summary

Research done in bowling has shown that the pin action is best when the ball is delivered between two and eight-tenths and three seconds. Kinesthetic perception was used in many studies so that subjects would get the feel of the movement pattern before actually bowling. In one study, the subject mentally practiced immediately before rolling each ball. Each of these methods were effective in improving bowling skill. Conflicting evidence was revealed in studying the effectiveness of spot or head pin bowling so that studies have shown both types to be effective. It was found that pre-game warm-up might have an important effect on bowling.

# CHAPTER IV

## PROCEDURE

In order to compare the effects of mental practice and physical practice on the scores of intermediate bowlers, two equated groups practiced for three weeks under two different practice conditions.

## SELECTION OF SUBJECTS

The subjects for this study were selected from the sophomore class enrolled at The Woman's College of the University of North Carolina. The subjects were selected from those girls who had completed a semester of bowling with an average of one hundred or better. Of the sixty-two girls who qualified for this study, each was contacted by a letter, a copy of which is found in the Appendix. Thirty agreed to take part and twenty-three completed the experiment.

The subjects were divided into two groups, equated on the basis of final average after one semester of bowling, motor ability scores from the Scott Motor Ability Test given in their freshmen year, and the verbal scores from the Scholastic Aptitude Test required for college entrance.

## SELECTION OF THE ACTIVITY

The reasons for selecting bowling as the activity used in this study were: 1) bowling lent itself to objective measuring of skill through the use of bowling scores, 2) the subjects had completed a semester course in beginning bowling so that the skill had been learned and teaching skills was not necessary, 3) the subjects had attained a level of skill which was good for the beginning bowling class but not advanced enough to make improvement of their present skill level difficult, and 4) little had been done in the area of mental practice in bowling.

## PROCEDURE FOR THE PHYSICAL PRACTICE GROUP

Since all of the subjects had a semester course in beginning bowling, it was felt that further instructions were not necessary. The physical practice group bowled five lines over a three night period in the first week of the experiment to obtain an initial score. They then bowled one line a night three nights a week for three weeks making a total of nine lines of practice following the initial five lines. Because of scheduling difficulties the subjects chose any three out of a possible five nights to bowl each week. It was felt that the distribution of practice in this experiment was not significant since the length of practice was short. Since not more than one line was bowled per day, and a day or more occurred between practices, it

was felt that the practice sessions could be referred to as distributed during the three practice weeks. This was in keeping with studies done by Murphy (38), Ammons and Willig (10), Gentry (23), and Lorge (36) in which it was found that distributed practice was more effective in bettering performance than massed practice.

Following the three weeks of physical practice, in which the subjects just bowled with no instructions or coaching, a final score was obtained from five lines bowled over a three night period during the fifth week of the experiment.

## PROCEDURE FOR THE MENTAL PRACTICE GROUP

The mental practice group met during the first week of the experiment to bowl five lines over a three night period in order to obtain an initial score. In the three weeks following, the mental practice group met three nights a week to mentally "rehearse" bowling for a total of nine mental practices for a duration of fifteen minutes. On completion of the nine mental practices, a final score was obtained from five lines bowled over a three night period which took place during the fifth week of the experiment.

Having reviewed studies on how learning takes place and on mental practice, the author decided to use various forms of mental practice rather than just one mental practice repeated nine times.

Twining (52), in a ring toss experiment, had his subjects repeat the same mental practice for twenty days. He felt that genuine mental practice only occurred during the first five minutes of the fifteen minute mental practice.

Clark (15) had his subjects read the same mental work sheet once each day to channel the subjects thinking even though memorization may have taken place. The subjects were to imagine themselves shooting five warm-up foul shots and twenty-five for score each day for fourteen days. He found that both the mental practice and physical practice groups showed significant improvement. The mental practice group reported a growth in ability to visualize and imagine the shooting technique to some degree.

Because both Twining (52) and Clark (15) found improvement in the mental practice groups by having the subjects visualize the skill involved, the author felt that it would be advantageous to include visual imagery in the mental practices. She also felt that memorization of a practice should be avoided so that the subjects would not become bored and, therefore, might not put forth their best effort in the mental practice. Rather than have mental practice take place during the first five minutes only, her aim was to have the subjects experience mental practice for the entire practice session. In order to achieve this goal it was felt that the practices must be varied in content as well as interesting. Thus, various kinds of mental practice

were planned. The determining factors as to what would be included in the nine mental practices were drawn from the conclusions of other studies done in the area of motor learning and mental practice.

Visual imagery was used several times during the experiment. The subjects visualized themselves bowling a complete line on two different occasions and kept score on paper of their "mind" bowling. In another practice the subjects visualized themselves bowling while verbal cues or instructions were given.

Baker and Wylie (11), in a study of the effectiveness of a primarily verbal type of mental rehearsal on a motor task found that a significant amount of transfer of learning did take place after a sufficient number of trials. The subjects had to move a stick to an appropriate position according to verbal cues that were given.

McAllister (37) studied the effects of various kinds of verbal pretraining on motor performance and found that relevant-stimulus-response pretraining facilitated the subsequent performance of the motor task which involved a Star Discrimeter.

In this study verbal cues were given by the author and by a record which was usually used with a sound filmstrip. As the verbal instructions were given, the subjects were to visualize themselves going through the motions described verbally and they were to try to actually get the "feel" of

going through the steps without using overt movement of any kind.

Probably one of the most widely used methods of mental practice is the use of movies, filmstrips, and loop films. Hertz (60), Harby (27), Irwin (62), and Lockhart (35) used visual aids to find out what effect they had on learning.

In the Hertz study, overt practice was supplemented by loop films in which the subjects analyzed their own movement and remedied their own faults. The loop films were designed to enable a student to improve skill by a visual concept of the correct method.

Irwin (62) found that the sound filmstrip method, the silent loop film, and the verbal instruction method were all equally effective in improving both the tennis playing ability and the knowledge of women students.

The value of the motion picture in learning a motor skill was studied by Lockhart (35). She found that the movie group improved in learning more consistently than the control group and that after the third week of bowling, the movie group surpassed the control group and continued to be superior throughout the experiment.

Since research has shown that visual aids may be an effective learning device, the author included the sound filmstrip method in her mental practice lesson plans. As the sound filmstrip was being presented, the subjects were to imagine themselves performing the skill shown on the screen.

As another visual aid, an expert bowler was invited to perform while the subjects observed his stance, approach, and delivery. They were instructed to carefully observe different spare situations and changes made by the expert in adapting to each particular situation. They were allowed to ask questions of the expert concerning both form and skill.

Newspaper clippings of "Bowling Tips" (9) which were written by bowling professionals were also used as a visual aid technique. As the subjects read through the twelve clippings of "Bowling Tips" they went over the movements in their minds. They made note of one "tip" from each clipping that would be particularly helpful to them. In a later mental practice they reread the bowling tips which they wrote down in the prior practice getting a mental picture of each tip as they utilized it by "mind" bowling.

At the end of some mental practices a statement was written by the subjects concerning their ability to concentrate during the practice. They were asked to report how well they did and if they were distracted, they were asked to report what it was that distracted them. These statements were kept for each subject so that interpretations of data would be accurately recorded.

Although the mental practices included visual imagery, verbal cues, and visual aids, emphasis was on visual imagery for all of the lesson plans which are found in the Appendix.

The author felt that the mental practice group should have a point on which they would all concentrate so that some measure of consistency within the group would be attained at each practice. Although Summers' (50) and Goellner's (26) studies contradict each other as to the effects of spot bowling, the author chose spot bowling as the point of concentration so that when the subjects visualized themselves bowling, they always saw themselves rolling the ball over a spot rather than at the pins.

## TREATMENT OF DATA

In treating the data for this study, the mean score for each subject was calculated for the first five lines and the last five lines bowled as a measure of performance. The mean scores for the first balls rolled in each frame were calculated as a measure of accuracy for the first five lines and the last five lines. The differences between the means were compared for both groups.

An analysis of variance between and within groups was made to test for significances of differences among the groups in both performance and accuracy.

# CHAPTER V

## ANALYSIS OF DATA

### Presentation of Data

The bowling scores and first ball averages for twenty-three subjects were used to determine initial and final ability in bowling performance and accuracy.

The two groups for this investigation were equated on the bases of bowling average at the completion of a semester course in beginning bowling, verbal score from the Scholastic Aptitude Test taken for college entrance, and motor ability score on the Scott Motor Ability Test taken in the freshman year. The scores for the two groups may be found in the Appendix. Fisher's "t" formula was used to compute the significance of differences between means for the three sets of scores. No significant difference was found between the two groups in bowling average, verbal ability, or motor ability. These data are presented in Table I.

The average of the scores from the first five games was calculated for each of the subjects to obtain a measure of initial ability; games fifteen through nineteen were averaged to obtain a score as a measure of final ability. The average number of pins knocked down by the first balls of each frame on the first five games was used as a measure

of initial accuracy; the average number of pins knocked down by the first balls rolled in the last five games was used as a final accuracy score. The averages of both performances and accuracy for the two groups may be found in the Appendix.

R. A. Fisher's method of analysis of variance was used to determine whether or not there was a significant difference between or within the two groups. The mean of the average scores for the two groups of subjects showed that there was no significant difference either between or within the groups.

An analysis of the mean scores of initial performance revealed that all subjects were from a common population since there was not a significant F. These data appear in Table II, page 46. The data for the analysis of variance of the mean scores for the final performance appear in Table III, page 47. A significant F was not revealed, and, therefore it was assumed that there was no significant difference in performance in either between or within groups.

An analysis of variance was also applied to the mean accuracy scores for the two groups of subjects. Neither the analysis of variance for the initial accuracy scores nor final accuracy scores revealed a significant F. These data appear in Table IV, page 48, and Table V, page 49.

The test for significance of difference between correlated means was applied to initial and final performance and initial and final accuracy for both groups. No significant difference was revealed in either group between initial and final performance and initial and final accuracy. Computations for these can be found in Table VI, page 50.

TABLE I

MEANS, STANDARD DEVIATIONS, AND SIGNIFICANCE OF DIFFERENCE BETWEEN MEANS OF TWO GROUPS OF SUBJECTS

| | Physical Practice * N=11 | Mental Practice N=13 | "t" |
|---|---|---|---|
| Bowling Average Mean | 112.7 | 114.9 | .018 |
| Bowling Average Standard Deviation | 11.7 | 9.1 | |
| Motor Ability Mean | 150.9 | 148.0 | .003 |
| Motor Ability Standard Deviation | 22.3 | 24.5 | |
| Verbal Score Mean | 482.9 | 502.3 | .0007 |
| Verbal Score Standard Deviation | 84.6 | 78.8 | |

* After the experiment was begun, one subject withdrew from the study. There was still no significant difference between the two groups of subjects.

TABLE II

ANALYSIS OF VARIANCE OF SCORES OF TWO GROUPS OF SUBJECTS ON THE BASIS OF INITIAL SCORES (AVERAGE OF GAMES 1-5)

| Source of Variation | Sum of Squares | df | Mean Squares | F |
|---|---|---|---|---|
| Between Groups | 271.51 | 1 | 271.51 | 1.25 |
| Within Groups | 4556.41 | 21 | 216.97 | |
| Totals | 4827.92 | 22 | | |

TABLE III

ANALYSIS OF VARIANCE OF SCORES OF TWO GROUPS OF SUBJECTS ON THE BASIS OF FINAL SCORES (AVERAGE OF GAMES 15-19)

| Source of Variation | Sum of Squares | df | Mean Squares | F |
|---|---|---|---|---|
| Between Groups | 492.10 | 1 | 492.10 | 3.045 |
| Within Groups | 3393.21 | 21 | 161.58 | |
| Totals | 3885.31 | 22 | | |

TABLE IV

ANALYSIS OF VARIANCE OF SCORES OF TWO GROUPS OF SUBJECTS ON THE BASIS OF INITIAL ACCURACY SCORES (AVERAGE OF GAMES 1-5)

| Source of Variation | Sum of Squares | df | Mean Squares | F |
|---|---|---|---|---|
| Between Groups | 4.74 | 1 | 4.74 | .101 |
| Within Groups | 985.18 | 21 | 46.91 | |
| Totals | 989.92 | 22 | | |

TABLE V

ANALYSIS OF VARIANCE OF SCORES OF TWO GROUPS
OF SUBJECTS ON THE BASIS OF
FINAL ACCURACY SCORES
(AVERAGE OF GAMES 15-19)

| Source of Variation | Sum of Squares | df | Mean Squares | F |
|---|---|---|---|---|
| Between Groups | 63.86 | 1 | 63.86 | 1.52 |
| Within Groups | 881.14 | 21 | 41.95 | |
| Totals | 945.00 | 22 | | |

TABLE VI

MEAN DIFFERENCE AND SIGNIFICANCE OF DIFFERENCE BETWEEN INITIAL AND FINAL AVERAGE AND ACCURACY SCORES FOR PHYSICAL AND MENTAL PRACTICE GROUPS

| | N | Mean Difference | "t" |
|---|---|---|---|
| Physical Practice Group | 10 | | |
| Average Scores | | 2.4 | .46 |
| Accuracy Scores | | 2.6 | 1.19 |
| Mental Practice Group | 13 | | |
| Average Scores | | 0 | 0 |
| Accuracy Scores | | .15 | .098 |

## INTERPRETATION OF DATA

Statistical analysis of the bowling scores for the two groups revealed no significant differences between the two groups either in accuracy or performance. No statistically significant difference was found between or within groups between initial and final performance and accuracy. A further analysis of the raw data revealed that sharp differences did occur within individual scores, but the decreases and increases in scores appeared to balance. This is particularly true of the mental practice group in which the means of the initial and final performance were identical, yet, there were individual changes within the group.

Phillips and Summers (40), in a study of bowling norms and learning curves, pointed out that in the initial stages of learning the rate of improvement differs with the skill level. It was the writer's opinion that extreme differences in scores due to learning were eliminated with the selection of subjects as they were chosen from a group which had completed a semester of bowling. It was felt that the initial learning stage for each subject should have been reached before this experiment was begun and that the subjects were all at the intermediate skill level. However, results of this investigation led the writer to believe the subjects were still in the process of learning since performance levels were so inconsistent. Phillips and Summers (40) also

point out that limitations in practice of beginning bowlers is detrimental to consistency of performance. According to Goellner (26), patterns of skill performance do not seem to emerge as far as beginning bowlers are concerned. Although these two groups in this investigation were considered to be of intermediate skill level, the writer felt that both of these factors affected the outcome of the experiment.

In the writer's opinion the greatest limitation of this investigation was the time limit. The bowling of nine games between the initial and final performance was not enough to demonstrate a consistent level of performance for the physical practice group. Examination of the raw data showed extremes in scores within individuals. Nine mental practices between the initial and final performances were not sufficient to have an appreciable affect on the final performance.

The accuracy of the two groups also did not change significantly. It is believed that the reasons for finding no improvement in accuracy are the same reasons as those for finding no improvement in performance.

An analysis of variance revealed no significant F in either performance or accuracy between and within groups. With one and twenty-two degrees of freedom an F of 4.32 was necessary to be significant at the five per cent level of confidence. The F in initial performance was 1.25 and the F in final performance was 3.045, neither of which was significant. The F revealed in initial accuracy was .101

and in final accuracy was 1.52. Although none of the differences were significant, the differences were greater in the final performance.

Within each group the "t" test for correlated groups was used to determine whether there was any change within the group. In the mental practice group the "t" for performance was zero since the mean score remained the same in initial and final performance. The "t" for accuracy was .098. In the physical practice group the "t" for performance was .46 and for accuracy it was 1.19. Since none of the "t's" were significant it may be assumed that any change within the groups may have been due to chance. Both the size of the groups and the time limitation were considered to be important factors in the outcome of this investigation.

# CHAPTER VI

## SUMMARY AND CONCLUSIONS

The purpose of this study was to compare the effects of mental practice and physical practice on the scores of intermediate bowlers.

Twenty-three women from The Woman's College of the University of North Carolina who had completed a semester of beginning bowling with an average of one hundred or better were subjects for this study. The subjects made up two equated groups; one group with thirteen subjects was designated the mental practice group and one group with ten subjects was designated the physical practice group. The original groups had fifteen subjects in each but only twenty-three were able to complete the study.

The two groups met three times a week for five weeks or a total of fifteen times. Both groups bowled five lines over a three night period during the first week of the experiment to obtain an initial score. The two groups met separately during the following three weeks; the physical practice group bowled one line a night, three nights a week for three weeks; the mental practice group mentally practiced bowling three nights a week for three weeks. During the fifth week of the experiment both groups bowled

five lines over a three night period to obtain a final score.

Bowling scores and first ball averages were kept for all games bowled. The mean of the first five lines was used as a measure of initial ability and the mean of the last five lines was used as a measure of final ability. The means for the first balls rolled in each frame of the first five and last five games was kept as a measure of accuracy.

The mean scores for initial and final ability were compared to determine differences between and within the two groups. Fisher's "t" test was used to determine how statistically significant the differences between means were. An analysis of variance was computed for obtaining between and within sample variability. Means between initial and final performance and initial and final accuracy were calculated for both groups to determine if there was a change within the groups. Means for initial performance and initial accuracy and final performance and final accuracy were compared between groups. Statistical analysis of the data obtained in this investigation showed no significant changes either within or between groups. Therefore, based on the limitations of this study, the following conclusions were drawn:

1. Mental practice and physical practice are equally effective in maintaining bowling performance and accuracy.

2. For the two groups of subjects used in this study there was no significant difference in bowling performance or accuracy based upon initial and final performance.

# CRITIQUE

The author believes that the results of this study might have been different or more significant if it were not for the limitations. The size of the two groups was small and the time allotted for the practices was not sufficient for obtaining the best results. It was felt that the length of time for the experiment was the greatest limiting factor and initial and final scores consisting of ten lines each would have revealed a truer picture of the subjects bowling skill, as the scores obtained over ten lines might not have been so extreme. The author could not control the amount of mental practice for each subject.

It is therefore recommended that further study in this area be done with the following suggested as possible studies:

1. Three groups of at least twenty subjects practice over a period of fifteen weeks. One group should be a control group.
2. Various combinations of mental and physical practice should be compared.
3. Mental practice of different types should be tried with different groups. One group might use just visual aids, another use just verbal cues, and another group use just visual imagery.
4. Comparisons should be made between groups of high and low motor ability to find out if mental practice is more effective with either group.

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# APPENDIX

LETTER TO SUBJECTS

Old Infirmary
Woman's College
February 19, 1963

Dear

I am writing to you concerning a study that I am undertaking this semester as a partial fullfillment of the requirements for a Master of Science degree in Physical Education. The purpose of this study is to determine the effects of two different types of practice on bowling scores. In order to carry out this study it is necessary to have a sufficient number of highly skilled subjects.

Because you have attained a high level of skill in your beginning bowling course, you have been selected as a possible participant in this study. Since you are already a successful bowler, it is not necessary for you to receive further instruction, but it is hoped that you desire to improve or maintain your present level of skill through practice. The nature of this study is such that you should find it an enjoyable experience.

It is sincerely hoped that you will participate in this study. Please respond on the enclosed postcard and return it by Monday, February 25th. If you desire further information, you may call me at the address that appears below.

Sincerely yours,

(Signed)Sharon A. Tufts

Old Infirmary
Box 2001
Phone 283
Woman's College

SUBJECT'S REPLY POSTCARD

Please fill out the following information and return this card by February 25, 1963.

Name

Campus Address Phone

I will / will not be able to participate in this study.

PRACTICE APPOINTMENT

Dear _____,

Please meet in the Coleman Gymnasium _____

_____ on _____ at _____ P.M.

If you cannot be there, please call me at

Ext. 283 and leave word. Thank you.

Sincerely,

Sharon Tufts

## PRELIMINARY MEETING

Physical Practice Group

1. Meet at 1:30 P.M. on Wednesday, March 6th in the Seminar Room.

2. Explain what the study is about using an example of a similar type of study that has already been completed.

3. Explain the time involved: completion of three lines of bowling a week for three weeks after the initial five lines are bowled and then five lines for final score. Three nights a week are necessary to bowl the three lines.

4. Explain the rules which must be carefully adhered to in order to obtain the best results.

   a. No one is to bowl other than the time of the experiment throughout the length of the entire experiment.

   b. No one is to observe other people bowl, either at the lanes or on television during the experiment.

   c. No one is to think of themselves bowling at any time other than time spent while actually bowling in the experiment.

   d. If for some reason you choose not to follow these rules, please notify me immediately.

   e. Meet in the bowling lanes prepared to bowl on Wednesday night at 6:30.

Mental Practice Group

1. Meet at 1:45 P.M. on Wednesday, March 6th in the Seminar Room for fifteen minutes.

2. Explain what the study is about and use other studies as examples.

3. Explain the time involved: completion of five lines for initial score, three nights three times a week for mental practice, and five lines for final score.

4. Explain the rules which must be followed throughout the study.

   a. No one is to bowl at any time other than the experimental time throughout the study.

   b. No one is to think about, observe others, read books, or practice bowling in any form throughout the experiment.

   c. It is important that you not even explain to others what you are doing for mental practice so that you will avoid mental practice in other than the allotted time for the experiment.

   d. If you cannot follow the procedure necessary for this experiment, notify me immediately.

   e. If at any time you cannot come to the scheduled meetings, please call me.

## MENTAL PRACTICE NO. 1

Materials: Filmstrip and record on "Delivery" from The Athletic Institute's Bowling series.

Procedure: Explain what mental practice is and what some of the mental practices will be like. Caution them about discussing bowling at any time other than during the experiment. Explain all other pertinent rules and information regarding the experiment.

Instructions: Watch the filmstrip and listen carefully to what is being said. Visualize yourself as performing the steps as they are given. Try to actually get the feel of the movement in your mind.

## MENTAL PRACTICE NO. 2

Materials: Two mimeographed sheets containing a total of eight different "spare" set-ups were distributed to each of the subjects. A pencil was also provided.

Procedure: Subjects were told to close their eyes and listen to the verbal instructions read by the experimenter. As the instructions were read the subjects were to visualize themselves actually

doing what the instructor read. They were told that emphasis for the purposes of this study is on "cross-alley" and "spot" bowling. As the last instruction was given subjects were to open their eyes and draw the path that the ball took for that particular spare set-up. At the end of the practice they were to write a statement concerning their powers of concentration or any unusual occurence which may have happened during the practice.

Instructions: "Close your eyes and mentally divide the lane in half." (This instruction was given only once.) The instructions below were repeated eight times, once for each of the eight spare set-ups.

1. I stand with my shoulders parallel to the foul line.
2. My body is relaxed and free from tension.
3. I hold the ball waist high--the weight of the ball in the left hand.
4. I shift the weight of the ball to the right hand so that my pendulum arm can swing freely on a vertical plane.
5. My target is a spot fifteen feet down the lane from the foul line.
6. My eyes never leave this target.

They are then to imagine themselves making the approach and the delivery and then they look

at the spare set-up on the paper and draw the path that the ball took to get the spare.

MENTAL PRACTICE NO. 3

Materials: Each subject was given a pencil and a blank "line" from a bowling score sheet.

Procedure: Subjects were asked to take a seat so that they were not sitting next to anyone and therefore might concentrate better. They were asked to write a statement at the end of the practice regarding their powers of concentration.

Instructions: "Sit back, get comfortable, and close your eyes. You are to imagine yourself in the bowling lanes about to bowl one line. Actually visualize yourself walking to the ball rack, picking the ball up, taking your approach, making your delivery, seeing the ball hit the pins, and watching the ball return for each frame in the line. Try to actually "feel" the weight of the ball, the approach, and delivery. After each ball is rolled, record the score that you mentally bowled. Try to imagine yourself going through this same procedure each time you roll a ball."

## MENTAL PRACTICE NO. 4

Materials: None

Procedure: All subjects were to meet in the bowling lanes to observe an expert bowler from the Greensboro area.

Instructions: Please observe our expert's bowling technique as carefully as possible. Note his position on the lane, stance, approach, and delivery. Be particularly aware of the position of the pins each time and try to think about how you would play them.

## MENTAL PRACTICE NO. 5

Materials: Twelve newspaper clippings of "Bowling Tips" by Marion Ladewig and Don Carter, paper, and pencils.

Procedure: Paper and pencils were given to each subject just before the start of the practice. They were asked to put their name on the paper and number every other line one through twelve. The clippings were distributed and the rotation system explained.

Instructions: Read carefully the newspaper clippings of "Bowling Tips." As you read, try to visualize yourself performing each of the steps given.

When you have finished reading the clipping, write down one important cue that you would find helpful to you in improving your bowling skill. Match the numbers on the clippings to the numbers on your paper.

MENTAL PRACTICE NO. 6

Materials: The Athletic Institute's record on "Delivery" that goes with the bowling filmstrip.

Procedure: Explain that the record goes with the filmstrip that was seen in the first practice session and that this time only the record will be used. Close your eyes.

Instructions: Listen carefully to the record and as the narrator explains the stance, approach, and delivery, visualize and actually try to get the feeling that you are performing each of the given instructions as he gives them.

MENTAL PRACTICE NO. 7

Materials: Papers with bowling tips written on them during practice No. 5.

Procedure: Each subject is given the paper in which she had previously written bowling cues from newspaper clippings.

Instructions: Carefully read and visualize yourself "actually" performing each of the tips as you read through them. Try to keep these tips in your mind.

MENTAL PRACTICE NO. 8

Follow the same procedure as Mental Practice No. 3.

MENTAL PRACTICE NO. 9

Materials: Filmstrip and record from The Athletic Institute on "Aiming and Scoring.

Procedure: Explain that only part of the filmstrip is to be seen since the emphasis is on aiming.

Instructions: Watch the filmstrip and listen carefully to the narrator. Mentally note any helpful hints on aiming. As the filmstrip is narrated try to visualize yourself actually going through the motions of aiming the ball.

AVERAGES OF GAME AND ACCURACY SCORES

| | Mental Practice | | | | Physical Practice | | | |
|---|---|---|---|---|---|---|---|---|
| Subject | IS | FS | IA | FA | IS | FS | IA | FA |
| 1 | 118 | 122 | 72 | 71 | 127 | 147 | 74 | 80 |
| 2 | 110 | 129 | 68 | 79 | 135 | 119 | 72 | 67 |
| 3 | 133 | 122 | 74 | 74 | 125 | 130 | 66 | 78 |
| 4 | 115 | 115 | 77 | 71 | 126 | 132 | 71 | 75 |
| 5 | 141 | 119 | 78 | 72 | 101 | 98 | 65 | 68 |
| 6 | 101 | 105 | 65 | 59 | 114 | 121 | 68 | 66 |
| 7 | 126 | 114 | 70 | 63 | 139 | 119 | 81 | 72 |
| 8 | 90 | 89 | 55 | 58 | 94 | 124 | 59 | 71 |
| 9 | 110 | 99 | 69 | 66 | 120 | 103 | 63 | 62 |
| 10 | 100 | 119 | 61 | 65 | 116 | 128 | 64 | 70 |
| 11 | 96 | 114 | 64 | 66 | | | | |
| 12 | 102 | 98 | 56 | 63 | | | | |
| 13 | 124 | 120 | 67 | 71 | | | | |

* IS - Initial Score
FS - Final Score
IA - Initial Accuracy
FA - Final Accuracy

RAW DATA FOR EQUATING OF GROUPS

| | Mental Practice | | | Physical Practice | | |
|---|---|---|---|---|---|---|
| Subject | BA | MA | VS | BA | MA | VS |
| 1 | 136 | 172 | 637 | 138 | 142 | 428 |
| 2 | 125 | 132 | 503 | 130 | 166 | 435 |
| 3 | 124 | 143 | 583 | 120 | 179 | 472 |
| 4 | 117 | 131 | 401 | 112 | 165 | 495 |
| 5 | 115 | 190 | 529 | 109 | 165 | 603 |
| 6 | 115 | 116 | 589 | 107 | 134 | 622 |
| 7 | 115 | 155 | 415 | 107 | 133 | 388 |
| 8 | 114 | 146 | 643 | 106 | 144 | 398 |
| 9 | 113 | 116 | 418 | 106 | 113 | 560 |
| 10 | 109 | 146 | 384 | 104 | 185 | 381 |
| 11 | 106 | 137 | 431 | 101 | 134 | 530 |
| 12 | 104 | 141 | 495 | | | |
| 13 | 101 | 200 | 502 | | | |

* BA - Bowling Average
MA - Motor Ability
VS - Verbal Score