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A COMPARATIVE STUDY ON THE EFFECTIVENESS OF MENTAL
PRACTICE AND PHYSICAL PRACTICE IN TEACHING BOWLING
TO COLLEGE WOMEN

A Thesis Presented to
the Faculty of the Graduate School
Appalachian State University

In Partial Fulfillment
of the Requirements for the Degree
Masters of Arts

by
Donna Spencer Speas
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ABSTRACT

Fifty-six college women selected from two one-hour college activity classes participated in the study. One class, designated as Group A, met on Tuesdays and Thursdays at 9:30 a.m. The second class, designated as Group B, met at 11:00 a.m. on Tuesdays and Thursdays. Both classes met nineteen times for periods not to exceed fifty minutes. Classes were taught by the investigator and identical teaching methods were applied to both groups, except for the experimental process which took place from the seventh to the sixteenth class meetings. During the experimental process mental practice was applied to Group A along with a regular physical practice routine. At this time Group B used physical practice only. The "t" technique was used to measure the improvement of Group A and Group B from pre- to post-testing sessions. Group A improved significantly at the .05 level, and Group B improved significantly at the .01 level. Group B improved significantly more than Group A at the .01 level. It was concluded that in teaching bowling to a class of college women whose membership consists of 80% with limited experience, 10% with no experience and 10% with competitive experience, the instructor should be advised to use physical practice in preference to mental practice in the teaching of the basic skills involved.

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CHAPTER I

INTRODUCTION

The sport of bowling reached its peak in popularity in 1956 at which time bowling was an athletic event as well as a dominant game in social circles. In 1956, by number of participants, bowling was rated the number two sport in America, second only to fishing.¹ The popularity of bowling has decreased in the last decade in social circles, though it remains in great demand on college campuses.

Bowling is a sport requiring little physical strength which appeals to individuals of all capabilities. Bowling may be participated in by any age group for reasons such as mere enjoyment or competition. The adaptability of bowling to the interests of a variety of people designates it as a most practical sport for the application of mental practice. The use of mental practice would always be optional, therefore not onerous to bowlers who do not desire to use it.

¹Dean Summers, "Effect of Variations of Delivery and Aim on Bowling Achievement of College Women," Research Quarterly, 27:77, March, 1957.

THE PROBLEM

Purpose of the study

It was the purpose of this study to determine, by experiment, the effectiveness of mental practice in the teaching of the motor skills and techniques involved in bowling for college women.

Scope of the study

The experiment which involved two bowling classes was conducted during the spring quarter of 1970 at Appalachian State University, Boone, North Carolina. The classes met on Tuesday and Thursday for nine and one-half weeks for a total of nineteen class meetings. Each class period was scheduled for fifty minutes. One class was scheduled at 9:30 a.m. and the other at 11:00 a.m. The 9:30 class was designated as the mental practice group, known as Group A. The 11:00 class participated in physical practice only and was referred to as Group B.

Group A originally contained thirty-one students. Three of the students were dropped from the study, leaving twenty-eight students. Group B originally contained twenty-nine students. Twenty-eight members of the group completed the study.

The subjects in Group A ranged in age from eighteen (18) years, two (2) months, to twenty (20) years one (1) month. The mean age of Group A was nineteen (19) years, four (4) and one-half (1/2) months. The students in Group B

ranged in age from eighteen (18) years to twenty-one (21) years and two (2) months. The mean age of Group B was nineteen (19) years and one (1) month.

The investigation was restricted to class meetings and, the students were given explicit instructions not to practice outside of class periods. The students were reminded periodically of this "no outside practice" rule.

These classes were limited to women who were obtained for the study by regular class registration at the beginning of the quarter. The participants in the study were required to be present at each class meeting. This policy was made emphatically clear on the first day of class. All those who did not wish to adhere to the policies set by the instructor were strongly advised to drop the course.

Both courses were taught by the investigator. The same policies of conduct and attendance were followed for both classes, and identical introduction methods to bowling were followed.

THEORETICAL FRAMEWORK

Definition of terms.

Aiming. Aiming is the procedure followed by the bowler to line up with his pins.

Pin-aiming. In this method of aiming the bowler keeps her eyes on the pin or pocket she is attempting to hit. Her eyes remain at this position throughout the entire approach, delivery, and followthrough.

Spot-aiming. In spot-aiming the point of aim is shifted from the pins sixty feet away to a point on the lane somewhere between the bowler and the pins. The eyes of the bowler are not shifted from the designated spot until the delivery has been completed and the ball has passed over the spot.

Deflection. Deflection is the bending or turning of the ball from its normal course or the pins from their given positions.

Delivery. Delivery is the method of releasing the bowling ball.

Straight. The straight ball revolves around a one hundred and eighty degree axis from the point of release to the point of aim.

Hook. The hook ball has a double movement, forward and side rotation which causes a great amount of deflection of the pins.

Curve. A ball which veers to the right and then again to the left when delivered by a right-handed bowler is referred to as a curve ball. The curve ball has a more pronounced rotation than the hook ball.²

²Parke Cummings (ed.), The Dictionary of Sports (Dominion of Canada: The Capp Clarke Company, Limited, 1949), p. 78.

Back-up. The back-up ball is a reverse hook.

Experience. This term referred to the amount of previous practice a bowler had acquired prior to entering the Experimental Course.

None. The term none meant that the subject had absolutely no experience.

Limited. The term limited meant that the subject's experience had been unregulated and social in nature.

Competitive. The term competitive designated that the bowler had either bowled in leagues, tournaments, or both.

First-ball averages. This term was used in the study in referring to the average of the total number of pins knocked down by the first ball for ten frames. The sum of three first ball averages was the figure used for the pre-test and post-test scores.

Mental Practice. Mental practice is "the symbolic rehearsal of a physical activity in the absence of any gross muscular movement."³

Warm-up exercises. Warm-up exercises condition the body for a desired activity.

³Joseph B. Oxandine, "Effect of Mental Practice and Physical Practice on the Learning of Three Motor Skills," Research Quarterly, 40:755, December, 1969.

Formal warm-ups. These warm-ups are exercises in which the movements are those which imitate the activity for which the performer is preparing.⁴

Informal warm-up exercises. These warm-ups are exercises in which the movements are the general, free movements undertaken solely for raising the temperature of the muscles.⁵

Limitations.

1. It was not possible to allow for a pure control group because of the college schedule of classes. Only two classes could be experimented with in order to keep classes on the same day and near the same hour.

2. It was not possible to have the groups meet at the same time of day. The investigator decided that if one class was divided into two groups, the groups would each derive inferior or superior attitudes which would influence the study.

3. Though the groups were scheduled as close together as possible, there was a time difference. Individual morning alertness and background noise were factors which added variables to the study.

⁴Hugh Thompson, "Effect of Warm-up Upon Physical Performance in Selected Activities," Research Quarterly, 29:231, March, 1958.

⁵Ibid.

4. Students understood at the beginning of the study that attendance would be required at all class meetings. Situations did arise which necessitated class absences. For this reason make-up games were accepted provided the instructor was present for the games. Those students who were absent more than three times for class meetings were dropped from the study; this number totaled three students. One student dropped the course for unrelated reasons.

5. Students were reminded periodically that they were not to engage in physical practice outside of class. The physical practice was controlled; however, there was no way of controlling the undirected mental practice of either group.

6. Only three games were allowed for the establishment of an average. Bowling is an erratic sport, and an average based on more games would have been preferable.

7. The groups met for the same number of class meetings, but the amount of practice that each student received was actually equated by the number of balls rolled, rather than by time. Students were allowed to leave when they had bowled one game.

CHAPTER II

REVIEW OF LITERATURE

This chapter contains all the pertinent literature surveyed by the investigator in areas of physical practice for bowling activity and mental practice in the acquisition of physical skills.

PHYSICAL PRACTICE
TECHNIQUES IN BOWLING

Since the techniques of bowling vary greatly from instructor to instructor, the author deemed it necessary to analyze the different methods of teaching bowling in order to select the best method for the experiment with mental practice.

The Stance

Gloria Bouvia, a member of Brunswick advisory staff, stated that stance is the first essential to being a good bowler. The stance should be comfortable, free of strain, and relaxed. Bouvia stresses three fundamentals for a proper stance:

1. The weight of the body should be evenly distributed on both feet.
2. The weight of the ball should rest in both hands.
3. The knees should be slightly bent.⁶

⁶Gloria Bouvia, "Bowling with Bouvia," The Woman Bowler, 33:41, September, 1968.

Other necessities of a proper stance include: the ball should be slightly away from the body at waist or chest height; the ball should be supported with the left hand even though the grip has been taken; and the bowler should face the pins with shoulders parallel to the foul line.⁷

Ainsworth stated that the experienced bowler should experiment with different types of stances such as the erect, the crouch, and semi-crouch positions, though she recommended the erect position for the beginning bowler.⁸

The Approach.

The three most widely used bowling approaches are the three-step, the four-step, and the five-step approaches. Cassidy recommended the four or five-step approach, and stated that the three-step approach is a disproportionate approach and increases the amount of work done by the bowling arm. Cassidy recommended the three-step approach only to the uncoordinated person, and he recommended the five-step approach to one desiring to use shorter steps.⁹

⁷Dorothy S. Ainsworth (ed.), Individual Sports for Women (Philadelphia: W. B. Saunders Co., 1959), p. 103-104.

⁸Ibid., p. 103.

⁹Donald Cassidy, Beginning Bowling (California: Wadsworth Publishing Company, Inc., 1962), p. 23.

The Delivery.

The four methods of delivering the bowling ball are the straight, the hook, the curve, and the backup. Falcaro recommended the straight ball for the beginning bowler. He referred to the straight ball as the "natural delivery" and recommended that bowlers start from the beginning and progress to throwing a hook ball.¹⁰

Forslund recommended only the hook ball and did not consider the other types of delivery as being efficient. Cassidy contradicted Forslund as he recommended the hook ball only for serious bowlers because it requires more control.¹¹

Summers conducted a study on the hook ball versus the straight ball and concluded that there was no significant difference in achievement of college women between those who bowled with the hook ball and those who bowled with the straight ball.¹²

The back-up ball is practically obsolete and is never recommended for any bowlers because it is difficult to control

¹⁰Joe Falcaro, Bowling for All (New York: A. S. Barnes and Company, 1943), p. 22

¹¹Ellen Forslund, Bowling for Women (New York: The Ronald Press Company), 1964, p. 16.

¹²Dean Summers, "Effective Variations of Delivery and Aim on Bowling Achievement of College Women," Research Quarterly, 27:77, March, 1957.

consistently. Though many strikes are achieved by the back-up ball because of its slight angle of deflection, it is a very difficult delivery for a person to use in order to make a spare because of its inconsistency.¹³

The curve ball is an effective ball and achieves many strikes because the ball deflects very little when it hits the pins. This lack of deflection of the ball causes the pins to react against each other in a manner favorable to the bowler. This type ball is commonly referred to as a "good mixer." The disadvantage of the curve ball is that large margins of error are created. If a strike is not obtained with the first ball, the second ball is delivered from a different spot than was the first. Also, the difference in lane conditions occasioned by temperature, humidity, and amount of oil applied to the surface of the lanes greatly affects the rotation of the ball and the amount of curve.¹⁴

The Aim.

There are two methods of aiming: headpin aiming and spot aiming. Goellner concluded that headpin aiming appeared to be the most effective method in teaching beginners to bowl, and that spot bowling appealed to the more advanced bowler.¹⁵ Summers contradicted Goellner's research by his

¹³David A. Armbruster, Basic Skills in Sports for Men and Women (Saint Louis: The C. V. Mosby Company, 1967), p. 58.

¹⁴Cassidy, loc. cit.

¹⁵William A. Goellner, "Comparison of the Effectiveness of Three Methods of Teaching Beginning Bowling," Research Quarterly, 27:386, December, 1956.

finding that the mean difference of spot bowlers and pin bowlers actually favored the group taught under the spot aim method.¹⁶

Warmups.

The effect of formal warmups on bowling achievement was studied by Thompson who found that, over a ten week period, those bowlers who rolled one "pre-game" achieved a mean score of thirty-seven pins higher than those without a "pre-game" warmup because channel balls tended to occur more frequently in the first five frames and decrease as the game progresses.¹⁷

MENTAL PRACTICE

The concept of mental practice has been studied for years. The first formal study was conducted by Anderson in 1899. Anderson believed that gymnasts should be able to learn their gymnastic moves more quickly by mental practice than by physical practice. Though Anderson found merit within this tactic of mental practice, further use of it by other instructors was not evident until the 1930's. Wide spread use of mental practice has developed only within the last decade.¹⁸

¹⁶Summers, op. cit. p. 82.

¹⁷Goellner, op. cit. p. 394

¹⁸Verdelle Clark, "The Effect of Mental Practice on the Development of a Complex Skill," Research Quarterly, 31:561, December, 1960.

There have been many definitions of mental practice. Essentially, mental practice may be defined as "the symbolic rehearsal of a physical activity in the absence of any muscular movements,"¹⁹ Though "mental practice" is the name most commonly given to this "symbolic rehearsal," it has also been referred to as imaginary practice, implicit practice, mental rehearsal, conceptualizing practice, concentration, and symbolic rehearsal.

Methods of Mental Practice.

The process of mental practice assumes many different forms. Examples are: thinking and rehearsal, reading, film, pictures, kinesthesia, relaxation, self-hypnosis, and self-image. The thinking process is incurred whereupon the subject mentally reviews the movements to be performed. When reading is assumed to inact mental practice, the subject reads or is read the process about to be performed. Sometimes the desired performance is filmed and played back to the subject. Johnson states, however, that filming is not as effective since total participation is needed for the effect. The active participation does not occur by viewing films.²⁰

¹⁹Joseph B. Oxendine, "The Effects of Mental and Physical Practice on the Learning of Three Motor Skills," Research Quarterly, 40:755, December, 1969.

²⁰Granville B. Johnson, "Motor Learning," Science and Medicine of Exercise and Sport, Warren R. Johnson (ed.), (New York: Harper and Brothers Publishers, 1960), p. 613.

Kinesthesia is another method of approaching mental practice. The subject is instructed to remember the exact feeling experienced during a successful performance. The kinesthetic approach has become one of the more popular methods of inacting mental practice.

Relaxation is a method used sometimes by itself, but more often in conjunction with other methods. Relaxation stresses a complete release of tensions, a primary concern of mental practice.

Heiss stressed self-hypnosis as a mode to improve bowling and golf scores.²¹ The subject using the self-hypnosis technique goes through a sequence of relaxation exercises, convincing himself that he can perform a given task. If the subject is hypnotised, he actually performs the mental practice subconsciously. The method suggested by Heiss may be very practical when the research by Twining is recognized.

Twining reported that the maximum time period for mental practice must not exceed five minutes per practice session and stated that the mind only gives total concentration for a few seconds at a time without interruption.²²

²¹Jack Heiss, Bowl Better (Chicago: Chicago Press, 1960), p. 27.

²²Wilbur E. Twining, "Mental Practice and Physical Practice in Learning a Motor Skill," Research Quarterly, 20:434, October, 1949.

A concept similar to self-hypnosis was studied by Maltz who believed in a changing of the self-image for successful mental practice. Maltz suggested that subjects must have the power of positive thought to insure the effectiveness of mental practice. According to Maltz a person can achieve his goal if his mind is conditioned to accept the material.²³

Mental practice has not been a totally uncommon technique in the past in such sports as football and golf. By means of pre-game strategy practices, coaches and players review possible occurrences and reactions which are likely to happen in the coming game. With the use of this added preparation, the team reactions should be more successful. Each time a golfer reviews his swing without the actual use of a club, he is using mental practice. Empirical evidence shows that almost all athletes subject themselves to some type of mental rehearsal before, after, and during competition.²⁴

The Effectiveness of Mental Practice.

Mental rehearsal under many, but not all conditions, has been shown to be beneficial as a method of learning as well as a method of improving performance.

In an investigation by Singer, mental rehearsal was found to yield significantly better performances in four of five

²³Maxwell Maltz, Psychocybernetics (Chicago: The Paperback Press, 1969), p. 31.

²⁴Robert N. Singer, Motor Learning and Human Performance (New York: The MacMillan Company, 1968), p. 218.

practice tasks than no practice at all. Physical practice was superior to conceptualization on three tasks; however, the mental practice group was favored in one test.²⁵

In a research project conducted by Clark on mental practice and the one-hand foul shot in basketball, mental practice was found not as effective as physical practice at the .05 level.²⁶

In Twining's study mental practice was statistically significant at the .05 level though the improvement by the physical practice group was far superior.²⁷ The mental practice group improved 36.2 per cent, and the improvement for the physical practice group was 137.3 per cent.

Stebbins conducted an investigation concerning the possible differential effects of mental practice during the different stages of learning motor skills and was unsuccessful in determining the best placement of mental practice in the learning process.²⁸ The Stebbin's research did, however, bring forward the concept of combining mental and physical practice groups.

²⁵Singer, op. cit., p. 217.

²⁶Clark, op. cit., p. 564.

²⁷Twining, op. cit., p. 432.

²⁸Richard Stebbins, "A Comparison of the Effects of Physical and Mental Practice in Learning A Motor Skill," Research Quarterly, 39:715, October, 1968.

Singer suggested that mental practice appeared to be as effective or slightly inferior to physical practice. He stated that a combination of physical and mental practice is probably better than mental or physical practice alone.²⁹

Oxendine investigated the effect of different practice schedules of physical and mental practice on the learning and retention of different motor skills and concluded that, given a specific amount of time, a schedule combining both physical and mental practice can prove as valuable as a schedule with entirely physical practice.³⁰

Empirical evidence suggests that beginners benefit more from actual physical involvement in the activity.³¹ Corbin's results suggest that mental practice is only effective with tasks previously experienced by the learner.³² It has been suggested by research that the novice gains faster from physical practice than from mental practice alone.³³

Jacobsen was a forerunner in testing whether the novice or experienced person gains faster by mental practice. He

²⁹ Singer, loc. cit.

³⁰ Oxendine, op. cit., p. 763.

³¹ Singer, loc. cit.

³² Charles B. Corbin, "The Effect of Covert Rehearsal on the Development of a Complex Motor Skill," Journal of General Psychology, 76:150, April, 1967.

³³ Singer, op. cit., p. 216; Clark, op. cit., p. 566; Singer, loc. cit.

spent twenty-three years studying the electrophysiology of mental practice and concluded that the subjects reacted more strongly to the tests on which they had previous experience. There was evidence that specific muscles contract during imagery and that muscles responded the most to those skills with which they were familiar.³⁴

Freeman found valid and important evidence of the spread of neuromuscular activity during mental work by the thickening of muscle groups. Under habituation general neuromuscular activity is reduced as the pattern becomes more specifically localized.³⁵

SUMMARY

Research in bowling methodology has widely decreased since the 1950's, leaving bowling in the minor realms of physical education as far as research is concerned. For this reason it is rather difficult to predict which method of teaching bowling should be used. The author concluded, however, that the most beneficial method of teaching would be the four-step approach because of the natural rhythm, the straight-ball delivery because of the weakness of women's wrists, and the spot method of aiming. Empirical evidence has shown that bowlers are more adept at rolling the ball over a closer spot rather than accomplishing the farther reaching results of hitting the desired pins much further down the lanes.

³⁴ Edmund Jacobsen, "Muscular Phenomenon During Imagination," American Journal of Psychology, 44:697, November, 1949.

³⁵ G. I. Freeman, "The Spread of Neuromuscular Activity During Mental Work," Journal of General Psychology, 5:491, May, 1930.

The aforementioned techniques were the physical methods of teaching selected for the study. The mental practice methods were selected on the basis of economy of time, place, and the possible delimitations for the study.

Though mental practice is currently a widely studied and carefully surveyed theory, it may be said that there is much contradictory evidence in the employment of mental practice techniques. Only further research will prove the validity, practicality, and the "best method" for employing the use of mental practice.

CHAPTER 3

PROCEDURE

This chapter includes all the methodology used in studying two techniques of teaching bowling. One method was mental practice in combination with physical practice; the other method was physical practice alone.

THE PROBLEM

It was the purpose of this study to experiment with a mental practice group and a physical practice group in classroom situations to determine whether or not mental practice would produce a significant improvement in a given teaching situation.

Two college bowling classes were selected for the study. One class met at 9:30 a.m. on Tuesdays and Thursdays. This class was designated as Group A. The second class met at 11:00 a.m. on Tuesdays and Thursdays and was designated as Group B. Both classes met for nineteen instructional periods of fifty minutes each.

Members of the class were given strict instructions that there would be no practice outside of the designated class periods. Students were reminded periodically of this "no outside practice" rule.

SUBJECTS

The subjects of the study included fifty-six college women who participated in one hour bowling activity courses. The women elected to take one of the two experimental courses, but were not informed prior to class registration that the courses were experimental. The subjects were, however, permitted to drop the course if they did not wish to participate.

The subjects in Group A ranged in age from eighteen (18) years two (2) months to twenty (20) years one (1) month with a mean of nineteen (19) years, four (4) and one-half (1/2) month. Group B ranged in age from eighteen (18) years one (1) month to twenty-one (21) years two (2) months with a mean age of nineteen (19) years, one (1) month.

INSTRUCTIONAL PROGRAM

Each class met nineteen times. The classes were taught by the same instructor and were presented in exactly the same fashion.

During the first class meeting the topics of class organization, requirements of the course, etiquette, and an explanation of bowling equipment were discussed. Each student was assigned a permanent lane and bowled only on this lane. Students were told emphatically that there would be no outside practice and that attendance would be required. There would be no cuts given for any excuse. During the second class meeting the two-step approach was demonstrated and explained; student practice followed. The four-step approach without the

ball was explained, demonstrated and practiced. All students were instructed to bowl a straight ball. Scoring procedures were briefly discussed. A review of the four-step approach was conducted in the fourth class meeting. The four-step approach was demonstrated and practiced with the ball. Students rolled 5 frames each. Scoring procedures were reviewed in detail.

Following the brief instructional period, a three-game pre-test was given. Students bowled one game during each class for three consecutive class meetings. Only the first balls of each frame were counted for data though the students were not aware of this fact. Individual instruction did occur during this time.

Individuals were allowed to leave as soon as their game was completed. Each subject rolled the same number of first balls with the exception of the tenth frame when bonus balls were allowed.

The next five weeks of the quarter became the experimental phase. This was the time period when the classes followed different procedures.

Group A followed a mental practice procedure. The students were asked to sit on the benches in the middle of the bowling facility facing the lanes. The instructor read the following passage three times:

Close your eyes

Imagine standing on the bowling approach visualizing your very own spot -- the one you must hit to secure a strike.

Concentrate on your spot. Imagine how it looks when your ball goes over your spot. Imagine the feeling when you roll a strike ball.

Imagine your stance. The ball is at a comfortable height for you. Your knees are slightly relaxed and comfortable.

Think through your approach. Allow your arm to swing freely. Feel the resisting weight of the ball during the backswing. Concentrate on the continuous swing of the arm as if you were coming straight back and straight forward.

Concentrate on the wrist so that the hand will be maintained in the same position throughout the swing.

Again visualize your spot. You are aiming for the spot.

Imagine the followthrough as if you are reaching down and out towards the end of the lane.

Keep your eye on your spot.

You hit your spot. You secured a strike.

Think about how it feels to make a strike.

Open your eyes.

Summary:

Close your eyes.

Visualize your spot.

Concentrate on your spot.

Review your stance and approach.

Concentrate on keeping your wrist straight.

Imagine your followthrough.

Think about how it feels to make a strike.

Open your eyes.³⁶

³⁶Joan C. Waterland, "The Effect of Mental Practice Combined with Kinesthetic Perception When the Practice Precedes each Overt Performance of a Motor Skill," (Unpublished Master's Thesis, University of Wisconsin, 1956.).

This reading took approximately one minute and fifteen seconds, each time totaling three minutes and forty-five seconds. Between each reading the students were asked to open their eyes. A brief intermission of ten seconds was taken before the next reading.

After the mental practice procedure was read three times, the summary procedure was read two times lasting about 45 seconds, again with a ten second intermission.

The total amount of time spent for the mental practice procedure was six minutes and five seconds. In brief summary, the students were mentally practicing bowling five first balls.

All precautions were taken to assure a minimum of background noise in and around the lanes during the mental practice procedures by allowing no spectators and no radios.

After the mental practice, students bowled one complete game and then were allowed to leave. Any individual instruction which was given during this time period was given in terms of the mental practice reading.

During these five experimental weeks a physical practice procedure was applied for Group B. Students bowled five warm-up balls. The students warmed-up by bowling down the line-up five successive times. Each student reset the pins so that each would be attempting to bowl a "strike ball" each time. The average time period taken for the five practice balls was six minutes and thirty seconds.

When the students completed the warm up period, they each bowled one game and then were allowed to leave. Instructions were given generally to correct faults as found in the arm swing, approach and release. The instructions were as concise as possible but not necessarily in terms of the mental practice procedures of Group A.

The last three periods of the nineteen were taken by the post-test. The mental and physical practice procedures were deleted from the class period and students were instructed to bowl one game per period for three meetings. As soon as the game was completed the students were allowed to leave the bowling facility. As in the pre-test, the first ball averages formed the data for the post-test.

Although no class cuts were allowed to any of the members, some cuts were taken. The instructor gave make-up sessions for each class separately at the end of each instructional grouping. To explain further by example, students were not allowed to progress to the post-test until their data for the experimental procedures had been completed. The instructor conducted the make-up sessions as nearly as possible to the actual class period.

The data of those students who were absent more than three times during the course were dropped from the study. The instructor decided that four or more class cuts could not be made up without influencing the data of the individual student because variables such as time of day, noise, and student surroundings were present.

No quizzes or tests were given once the pre-test period began. This policy was established to eliminate any excess tensions during class. All students were instructed to put their books on a table provided in the rear of the lanes before the bowling activity began. All announcements were made at the beginning of the class and before Group A began the mental practice procedure.

The foul lights were never turned on during the subject's games. The students were informed of the scoring and rulings of fouls, but the subjects never experienced a foul. The author decided that the fouls would add another variable to the study. When the instructor noticed a student stepping over the foul line, the instructor reminded the student to move back further from the foul line or shorten her approach.

SUMMARY

Fifty-six women in two bowling activity classes were studied to determine if there was any significant difference in a physical practice group and a combination mental and physical practice group.

Each group met the same number of times and bowled the same number of games. Instruction was identical for each group except for an experimental period of five weeks. During these weeks the physical practice group bowled five first ball warmups and then bowled one game. The combination mental and physical practice group mentally imagined bowling five first balls and then bowled one game.

A pre-test and post-test of three games were given to determine whether or not there was a significant difference in the amount of improvement by each group.

CHAPTER 4

STATISTICAL ANALYSIS

This chapter contains all the procedures of analyzing and interpreting the collected data.

RELIABILITY

The pre-test scores of both groups were examined for their reliability. Reliability coefficients were computed by the use of Pearson Product Moment Correlation. Table 1 offers reliability statistics.

Table 1

Pre-Test Reliability Measure Between the
First and Third Pre-Test Scores

Group	Number of Students	Calculated Reliability Coefficients
A	28	.76
B	28	.67

The reliability was determined by comparing the first score of the pre-test with the third score of the pre-test.

Though a higher coefficient of reliability would be more desirable, Lindquist reported that a .50 coefficient would be a minimum to evaluate the level of test reliability.³⁷

³⁷E. F. Lindquist, Education Measurement (Wisconsin: George Banta Publishing Company, 1960), p. 609.

A Pearson-Product Moment Correlation for the post-tests of Group A and Group B was accomplished by using comparative data as for the pre-tests. Table 2 offers these reliability statistics.

Table 2

Post-Test Reliability Measure Between the
First and Second Post-Test Scores

Group	Number of Students	Calculated Reliability Coefficients
A	28	.52
B	28	.83

PRE-TEST COMPARISON OF GROUP A AND GROUP B

To test for significant differences, the independent "t" technique was the method employed.³⁸ The null hypothesis was tested to equate Groups A and B.

Table 3 provides information which determined the "t" ratio.

Table 3

Comparison of Equating Group A and Group B

Group	Number of Students	Mean	Standard Deviation	Standard Error	"t" ratio
A	28	17.43	$\sqrt{68.381}$	$\sqrt{2442}$	-.011
B	28	17.49		$\sqrt{2442}$	

³⁸Henry L. Alder and Edward B. Roessler, Introduction to Probability and Statistics (California: W. H. Freeman and Company, 1964), p. 124.

Since the absolute value of "t" is .011 it was concluded that the probability of selecting from two populations with identical means and identical standard deviations two samples whose means difference is .06 is considerably more than the .05 level, which indicates that this result is not significant.³⁹ The hypothesis that there is no significant difference in the two groups was accepted.

Comparison of Group A and Group B from the Pre-Test to the Post-Test

Group A was tested by using the dependent "t" technique to determine whether or not the group improved significantly from the pre-test to the post-test. Group A improved from a mean of 17.43 to a mean of 19.53, a 12.1% improvement. The difference was significant at the .05 level. The hypothesis that there would be no difference between the pre-test and post-test was rejected.

Group B was tested by the dependent "t" technique to determine if the improvement from the pre-test to the post-test was significant. Group B improved from a mean score of 17.49 to 20.26, a 13.8% improvement. Group B improved significantly at the .01 level. The hypothesis that there would be no difference between the pre-test and post-test was rejected.

³⁹Alder, op. cit., p. 131.

The Inter-group improvement of Group A and Group B is demonstrated by Table 4.

Table 4

Inter-Group Improvement of Group A and Group B

Group	Number of Students	Sample Mean	Standard Deviation	Standard Error	"t" Ratio
A	28	1.44	$\sqrt{109.50}$.197	2.300
B	28	2.73	$\sqrt{10.92}$.62	4.400

A Comparison of the Post-Tests of Group A and Group B

The hypothesis that there would be no difference in the post-test of Group A and the post-test of Group B was tested. Group B proved to be significantly superior by the "student's t-distribution." The improvement of Group B was significant at the .01 level. The hypothesis that there was no difference between the two groups was rejected, and it may be said that Group B improved more than Group A.

The data from the post-test is available in Table 5.

Table 5

Comparison of the Post-Test Scores Between Group A and Group B

Group	Number of Students	Mean	Standard Deviation	Standard Error	"t"
A	28	19.53	$\sqrt{5.15}$.184	3.674
B	28	20.26		.184	

SUMMARY

The reliability of the first and third pre-test and post-test scores of Groups A and B, was tested. For Group A a reliability coefficient of .76 was expressed by the Pearson Product Moment Method. For Group B, using the same method, .67 was the expressed reliability coefficient. For Group A the post-test reliability index was .52, and the reliability index for the post-test of Group B was .82.

The null hypothesis to determine the improvement of the groups was tested by the "students t-distribution." At the beginning of the experiment no significant difference was found between Groups A and B.

From the pre-test to the post-test, Group A improved significantly at the .05 level, and Group B improved significantly at the .01 level from the pre-test. Group A improved 12.1% and Group B improved 13.8%. Group B improved significantly over Group A at .01 level.

CHAPTER 5

SUMMARY, CONCLUSIONS, DISCUSSION AND RECOMMENDATIONS

SUMMARY

The investigation of the effectiveness of mental practice in conjunction with physical practice was conducted in the spring of 1970 at Appalachian State University, Boone, North Carolina. Fifty-six college women participated in the study. The women were selected from two one-hour activity classes. One class designated as Group A, met on Tuesdays and Thursdays at 9:30 a.m. The second class, designated as Group B, met at 11:00 a.m. on Tuesdays and Thursdays. Both classes met nineteen times for periods not to exceed fifty minutes.

Classes were taught by the same instructor, and identical teaching methods were applied to both groups, except for the experimental process which took place from the seventh to the sixteenth class meetings inclusive.

During the experimental process, mental practice was applied for Group A along with a regular physical practice routine. At this time Group B used physical practice only.

Both groups improved significantly from pre to post testing sessions, though the physical practice group improved significantly more than the mental practice group.

CONCLUSIONS

Group A mentally practiced bowling five first balls, then bowled one game for ten weeks. Group B physically practiced bowling five first balls, then bowled one game for ten weeks. The experimental period was the only time the two groups were treated differently. Within the limitations of this study, it can be said that the physical practice group improved significantly over the mental practice group, though both groups measured a significant amount of improvement by the student's t-distribution. Group A improved 12.1%; Group B improved 13.8%. The difference between the improvement of Group A and Group B was significant at the .01 level. The null hypothesis was rejected, and it was concluded that at the end of the experiment, Group A and Group B were not equal.

Based on this study, it may be concluded that in teaching bowling to a class of college women whose membership consists of 80% with limited experience, 10% with no experience and 10% with competitive experience, the instructor should be advised to use physical practice in preference to mental practice in the teaching of the basic skills involved.

DISCUSSION

To control an experiment in a class situation is a difficult task as there are many variables. One of these variables was the time factor. Group A participated one and

one-half hours earlier than Group B. Though the groups were equated at the beginning of the study, the time element may have had an effect on the results of the study. The earlier time period may not have been conducive to the mental practice procedure used as a later time period might have been.

The background noise in the bowling establishment was not constant. All efforts were made to keep radios turned off and to keep the persons quiet who were not participating in the study. All spectators of the bowling activity were asked to leave. The bowling lanes are shared with a billiard parlor and there was no way to keep the billiard players completely quiet. There were also days when the maids found it necessary to clean the facility during the bowling sessions. It was impossible to keep the maids from talking while they were working. The author felt that the background noise affected the mental practice group more than the physical practice group.

Though students were implicitly told that there would be no cuts allowed to the members of the study, some students were absent. Make-up sessions were conducted for those persons who had not been absent more than three times during the quarter. These sessions resembled, as nearly as possible, class sessions, but an exact replica of the class structure was impossible to reproduce.

The previous bowling experience of the bowler was a variable. Eighty percent of the bowlers expressed their experience as limited, but ten percent had bowled competitively and ten percent had no experience. Previous studies of mental practice express the idea that mental practice is more effective on the experienced participant. The investigator, however, was not able to draw any conclusions concerning the above statement because of the wide range of abilities.

The reliability coefficients of the pre-tests and post-tests was not sufficiently high to positively state that the procedure used in testing was ideal. Several factors may have influenced the low reliability coefficients. Perhaps a greater number of students should have participated in the testing group. More students would have allowed for a greater possibility of a random sampling.

Because, at best, bowling scores are erratic, it would probably have been better to have collected data for more than three games for the pre-test scores. At the time the pre-test scores were taken, the students were at a great expansion level in that learning was taking place at a rapid pace: To have waited two or three class periods longer before giving the pre-test might have increased the possibility of gaining a higher reliability. Because the mental practice group had a much lower reliability index than the physical practice group on the post-testing session, it may have been because the number of practice sessions was too few.

The students were instructed that no outside practice would be allowed, and they were reminded periodically of this fact. There did not appear to be any difficulty in abiding with this rule, though nearly ten percent of the subjects expressed a dislike for the ruling.

Another variable which entered into the study was the amount of mental practice performed by the physical practice group. Though no mention of "mental practice" was made to either group, it was very probable that some students accepted the responsibility of thinking through the physical task before attempting.

Though many factors effect a classroom experiment, the instructor felt that these variables were controlled as much as possible.

RECOMMENDATIONS

Several recommendations for further study can be made. The practical research of mental practice of gross body movements to improve skill has been extremely limited. A larger number of students need to be studied under controlled conditions to establish a true relationship between mental practice and skill achievement.

Pertaining directly to the conducted experiment, it would have been better if all subjects had the same skill level upon entering the study. If the study were larger and more comprehensive, the study could be divided into definite skill groups.

It is the author's opinion that concentration plays a decisive role in bowling, but the extent of this role is not known. Perhaps it would be most beneficial to conduct a study applying different percentages of mental practice to different groups, thereby determining the most appropriate amount of mental practice. Since the previous research studies on mental practice showed less gain from mental practice alone than from physical practice alone, the investigator decided not to control a pure mental practice group. It may be however, that such a group is necessary to better evaluate the relationship of physical and mental practice.

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APPENDIX

APPENDIX A

Raw Score Data of the Sum of the First Ball Averages
for the Pre-Tests and Post-Tests of Group A and B

Group A		Group B	
Pre-Test	Post-Test	Pre-Test	Post-Test
19.3	16.8	21.3	21.0
15.1	13.5	18.3	16.2
20.5	20.5	20.2	23.4
14.5	18.5	17.2	20.7
16.0	17.7	13.5	17.8
21.3	21.4	14.4	16.2
15.4	22.3	13.4	17.5
16.2	18.2	19.3	20.2
21.9	22.0	17.3	21.9
16.5	21.0	14.8	18.5
18.2	17.3	18.5	20.6
15.7	16.3	15.4	19.8
14.5	20.9	19.1	20.2
15.2	18.6	15.7	19.8
17.2	17.9	19.6	21.9
21.3	17.3	19.1	22.2
18.9	21.3	17.4	22.2
20.3	17.8	11.6	16.9
21.0	17.7	19.4	21.2
14.6	19.4	14.8	16.2
19.0	18.7	13.9	17.8
20.8	20.5	20.4	23.3
16.2	15.3	16.9	22.6
17.5	22.4	21.8	25.6
15.0	20.4	17.0	21.0
18.1	22.6	17.7	20.6
11.7	14.7	20.9	23.3
17.4	20.3	20.9	19.1

APPENDIX B

Raw Score Data of the First Score and Third Score
of the Pre-Test for Group A and Group B

Group A Pre-Test		Group B Pre-Test	
1st score	3rd score	1st score	3rd score
4.2	4.6	7.3	7.5
3.8	4.0	5.1	6.9
6.5	7.0	7.5	7.4
4.9	5.8	4.7	4.7
4.6	5.8	3.2	6.5
6.6	6.9	4.1	5.3
4.6	5.4	3.3	5.6
5.0	5.6	6.2	7.0
6.8	7.3	5.4	6.5
4.1	5.4	4.6	6.1
5.0	5.6	5.3	6.4
7.2	7.7	3.4	6.1
5.5	6.0	5.6	7.4
6.6	6.3	5.9	4.8
5.0	5.2	5.8	6.3
5.3	5.9	4.9	6.9
5.0	5.6	3.4	5.4
5.3	5.8	4.1	4.7
7.0	7.6	7.2	6.8
5.4	5.9	4.7	5.7
6.2	6.4	6.7	6.5
6.5	8.5	6.0	6.6
4.8	5.8	7.1	7.2
5.6	6.6	4.6	6.4
6.1	8.1	5.9	5.7
5.4	6.1	5.4	5.1
4.2	5.4	7.2	7.9
5.3	5.8	7.3	7.5

APPENDIX C

Raw Score Data of the First Score and Third Score
of the Post-Tests for Group A and Group B

Group A Pre-Test		Group B Post-Test	
1st score	3rd score	1st score	3rd score
5.0	5.5	5.5	7.7
5.9	6.0	6.8	7.6
5.5	8.5	4.8	5.7
5.6	6.3	7.3	8.5
6.1	6.3	5.8	8.6
6.5	7.0	5.2	5.4
6.9	6.9	5.1	5.3
6.4	6.5	6.6	6.8
7.7	8.1	7.1	7.2
6.1	6.8	6.2	7.6
5.7	7.3	6.4	6.5
5.4	6.5	6.5	6.9
5.8	7.7	6.0	7.5
6.2	6.8	6.9	7.0
5.2	6.3	6.6	6.8
5.2	6.3	6.4	7.4
6.8	7.3	7.4	7.7
6.6	6.7	7.1	7.5
4.6	6.4	6.0	6.3
6.0	7.0	6.5	7.3
6.4	6.7	5.5	5.6
4.9	7.8	5.8	5.9
6.3	7.4	7.6	8.4
3.7	6.7	6.1	7.6
7.3	8.1	8.0	9.7
6.6	7.2	6.7	7.8
7.4	8.2	7.2	7.8
5.4	5.7	6.1	7.0

APPENDIX D

Mean Scores and Ranges of the Pre-Test and
Post-Test Scores examined for
Reliability

Group	Test	Score Number	Mean	Range of Pinfall Average on First Balls
A	Pre	1	5.44	3.8-7.2
A	Pre	3	6.10	4.0-8.5
B	Pre	1	5.42	3.2-7.3
B	Pre	3	6.31	4.7-7.9
A	Post	1	6.01	3.6-7.7
A	Post	3	6.98	3.6-7.7
B	Post	1	6.14	5.1-8.0
B	Post	3	6.92	5.3-9.7