NOBLE, SUSAN W. The Effects of Two Different Distributions of Practice on the Learning and Retention of a Novel Skill. (1972) Directed by: Dr. Marie Riley. Pp. 75

An examination of the literature on the effects of practice distribution on the learning and retention of motor skills reveals contradictory and inconclusive results. The purpose of this study was to determine the effects of two different practice distributions on the learning and retention of a novel motor skill.

A pilot study was conducted prior to the experiment in order to develop the scoring device and to determine the practice procedure. The subjects for the experiment were college women in the required physical education program at Sweet Briar College. Throwing a ball with a lacrosse stick at a swinging target was selected as being a skill resembling skills taught in physical education classes while still being completely novel to the subjects.

Subjects were divided into two groups of twenty-five each by drawing assignments. Each subject had three practice sessions and a retention test twenty-eight days following their third practice. All subjects had a period of instruction in the skill prior to the first practice. Subjects in Group A practiced thirty continuous trials in each session and in the retention test. Subjects in Group B practiced thirty trials with a three-minute rest interval after the tenth and twentieth trials for all three practices and for the retention test. Each trial for both groups consisted of starting behind a line twenty-four feet from the target, running forward, and throwing the ball at a swinging target before crossing a restraining line twelve feet from the target.

Repeated Measures Analysis of Variance was used to examine the scores within each of the two groups in order to determine whether there were changes in the scores over the three practices. There was a good deal of variety in the scores obtained by the subjects and their scores showed fluctuation from practice to practice. There was no specific pattern to the changes nor were the changes significant. Any apparent differences were probably due to the large amount of variation in the individual scores and not to the practice conditions.

The Fisher's "t" Test of Significance of Difference Between Correlated Means was used to determine whether any changes occurred in the ability of subjects to perform the skill during the period of no practice. There were no significant differences between the scores obtained by subjects on the third practice and those they obtained on the retention test for either Group A or Group B.

Comparisons between Groups A and B on the three practices and on the retention test were made using the Fisher's "t" Test of Significance of Differences Between Uncorrelated Means. There were no significant differences between Groups A and B on any of the practices or on the retention test. The lack of a significant difference between Groups A and B on the first practice would appear to indicate that the two groups were from the same population. Any apparent differences between Groups A and B on the three practices and on the retention test were probably due to chance and not to the difference in the practice distributions of the two groups.

# THE EFFECTS OF TWO DIFFERENT DISTRIBUTIONS OF PRACTICE ON THE LEARNING AND RETENTION OF A NOVEL SKILL

by

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A Thesis Submitted to
the Faculty of the Graduate School at
The University of North Carolina at Greensboro
in Partial Fulfillment
of the Requirements for the Degree
Master of Science in Physical Education

Greensboro
1972

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ACKNOWLEDGEMENTS

The author would like to express appreciation to Dr. John Lawther, whose help during the planning of this study was invaluable; and to Dr. Gail Hennis for her time and patience. The author is indebted to Miss Katherine Macdonald and to the students of Sweet Briar College, without whose help and encouragement, this study would not have been possible. A particular debt of gratitude is owed to Dr. Marie Riley for her understanding and good humor as well as her many late evenings, long distance.

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# CHAPTER I

## INTRODUCTION

An important part of the early learning of the skills in physical education seems to be the practice that the student has after the initial instruction has been given. In order for the practice period to be made most beneficial, there are a number of questions that need to be answered when planning the sessions. How long should the practice period be? How often should rest be given and how long should these rest intervals be? How often should the student practice the skill? These are some of the questions that need to be considered when planning for efficient use of practice time.

The level of performance of a skill immediately after the practice period is of little importance if that skill is then forgotten after a period of no practice. Learning is defined as "...relatively permanent change resulting from training and experience" (7:2). If a high level of performance is not retained after a period of no practice, then little permanent learning can be said to have occurred. What practice schedules produce the most efficient learning? Are the same schedules as efficient for immediate performance as for retention? The questions that should concern a lesson planner for performance also need to be considered when planning for retention.

A considerable number of studies have been done investigating the effects of practice distribution on learning using the laboratory motor

skills such as the stabilimeter and pursuit rotor. There have been fewer studies using sports skills. The findings of this research have been varied and often contradictory. A number of these studies have been discussed in Chapter 3. The conclusions of the experts in motor learning reflect the contradictions in the research (1, 6, 7, 8, 9). Some feel that early massing produces greater learning while others feel that early distribution is more effective.

There has been much less research in the area of the effects of practice distribution on the retention of skill. Again, the results of the research have been contradictory and inconclusive. There was disagreement in the conclusions of the experts. Some favored early massing while others favored early distribution (7, 8, 9). A third point of view points to other factors having a greater effect on retention than practice distribution (10). These factors include the level of original learning, the nature of the task, and the amount of time between learning and retention.

In view of the contradictions among the experts and in light of the existing research on the effects of practice distribution on learning and retention, the writer was interested in examining the effectiveness of two different distributions of practice on the learning and retention of a motor skill which resembled the skills taught in the physical education program while still being completely novel to the subjects. The skill of throwing a ball with a lacrosse stick at a swinging target was selected as being one which met this criterion.

# CHAPTER II

# STATEMENT OF THE PROBLEM AND DEFINITION OF TERMS

## STATEMENT OF THE PROBLEM

The purpose of this study was to determine the effects of two different distributions of practice on the learning and retention of the novel skill of throwing a ball at a swinging target with a lacrosse stick.

## DEFINITION OF TERMS

Learning. Learning is the level of performance attained after practice as stated in quantitative terms.

Retention. Retention is the level of performance after a period of no practice as stated in quantitative terms.

Continuous practice. Continuous practice consists of performance trials taken one after another with only enough time between trials to prepare for the next one.

# CHAPTER III

## REVIEW OF LITERATURE

Much research has been done on the effects of different schedules of practice and rest periods on the learning of verbal and motor skills. The various schedules of practice and rest periods that have been studied include: (1) massed or continuous practice with no rest intervals; (2) distributed or spaced practices with rest intervals of constant length; (3) massing of practices in the initial stages of learning with gradually increasing lengths of rest intervals as learning progresses; (4) initial spacing of practices with gradually decreasing lengths of rest intervals as learning progresses; (5) initial massing of practices with irregular rest intervals; (6) initial spacing of practices with irregular periods of massed practice (1:270). The studies investigating the effects of these various practice and rest schedules will be examined first in the area of laboratory tasks such as the learning of lists of nonsense syllables and motor skills such as mirror tracing and pursuit rotor. The aforementioned skills are used because they are considered to be unique to the laboratory and would involve no previous learning. The studies using sports skills will be examined later in this chapter. The results of the studies involving laboratory skills must be applied to the learning of meaningful materials with great caution (7:84). Some are included because they offer valuable suggestions and guides to researchers in their design of further study procedures as well as their implications from the conclusions in them.

Laboratory Studies

In the 1920's, Snoddy (60) developed the stabilimeter, which involves the tracing of a six-sided star pattern with a stylus. Contacts with the sides of the pattern are recorded electronically as errors. He began a rather lengthy series of investigations into the nature of the learning curve and the effects of various distributions of practice on that curve. In his earliest experiment (60) Snoddy divided the curve into two parts on the basis of his results. The first part he called the Adaptive Phase and the second part the Facilitation Phase of learning. Improvement during the Adaptive Phase of learning was a positive function of the length of time between circuits on the stabilimeter. Improvement during the Facilitation Phase of learning was dependent upon the number of repetitions of trials rather than on the amount of rest. The amount of learning during the early or Adaptive Phase was greater with distributed practice while the amount of learning during the later or Facilitation Phase was more affected by the amount of practice rather than the practice schedule (60).

Snoddy further developed his theories of learning in a book published in 1935 (10). He called the two phases of learning Primary and Secondary Mental Growth. He felt that these two stages of learning were opposite in character and a plateau in the learning curve occurred at the point where the greatest interference between the two occurred. He said of the two phases: "Primary growth appears early and is very stable; Secondary growth appears later and is highly unstable" (10:99). Snoddy tested his theories on mental growth using the stabilimeter skill

a number of times. He theorized that early spacing and later massing of practices produced more efficient learning.

Doré and Hilgard (27) challenged these findings in an experiment using the Koerth pursuit rotor. They used groups of twenty-five subjects each. One group received trials of thirty seconds each with rest intervals between trials increasing from one minute to eleven minutes. The second group also received thirty-second trials, but their rest intervals were decreased from eleven minutes to one minute. Both groups received the same total amount of practice time. The group which had received early massing with increasing amounts of rest, had a higher final score. This led the investigators to conclude that early massing was more advantageous for learning the pursuit rotor skill.

Snoddy replied to this apparent contradiction (59). He stated that Doré and Hilgard had changed some of the variables and had not truly replicated his study. They had made time a constant instead of one of the variables. He continued to maintain that early spacing was more beneficial to learning.

In the first of a series of studies on the effects of different schedules of practice and rest on learning, Travis (63) also used the pursuit rotor as his task. He reported that a one minute rest interval between two-minute work periods resulted in a consistant rise in the learning curve. The subject who practiced continuously with no rest intervals for the same total amount of practice time showed a consistant decrease in efficiency. Travis used a total of four college males as subjects, three receiving rests between trials and one having continuous practice.

In a second experiment conducted immediately following the first (64), Travis had forty college men learn a pursuit-oscillator task, which involved the learning of a hand-eye coordination. The subjects were divided into five groups. The groups received rest periods of five minutes, twenty minutes, forty-eight hours, seventy-two hours, or one-hundred twenty hours between practice periods. He reported that the group which received the five-minute rest intervals learned the skill more effectively than the other groups. The group which had had twenty-minute rests was nearly as efficient.

Two years later, Travis conducted two more experiments to further investigate different practice and rest schedules (65). He used the pursuit-oscillator skill again. He had three groups of college students practice with different schedules of work and rest. Group I, N=eighteen, practiced one minute and had three minutes rest between trials. Group II, N=ten, practiced five minutes with five-minute rest intervals. Group III, N=ten, practiced five minutes with twenty-minute intervals between trials. Group I had a significantly higher initial score than the other two groups. Group III had a significantly higher final score and a greater total gain than either of the other two groups.

In the second experiment, Group I, N=eighteen, practiced one minute and had three-minute rest intervals between trials (65). Group II, N=seventeen, practiced two minutes with three-minute rests and Group III, N=seventeen, had four-minute practices with three-minute rest intervals. The final scores of the three groups were not significantly different even though the total amount of practice time for the different groups was different. Group I had six minutes total practice time,

Group II had twelve minutes, and Group III had twenty-four minutes. From these results, Travis concluded that the schedule for Group I was the most efficient. He hypothesized from the results of the two experiments that short practice periods with relatively short rest intervals were more effective in producing learning of the pursuit-oscillator skill than other schedules of practice and rest.

Hilgard and Smith used the pursuit rotor with seventy-eight college students to study the effects of varying lengths of rest between trials on learning (37). The subjects were divided into three groups. Trials were one minute in length. Each practice session lasted twenty-five minutes per day for four days. Group I had eight trials per day with a total of seventeen minutes rest, Group II had thirteen trials with twelve minutes rest, and Group III had eighteen trials and seven minutes rest. At the end of each day and at the end of all four days, the scores for all three groups were almost alike despite the widely differing number of trials each group had received. The investigators concluded that greater distribution favored more efficient learning since Group I, which had the most distributed practice and the fewest number of trials, received scores equal to those of the other two groups which had had more total practice time.

Franklin and Brozek divided thirty-six young male subjects into six different groups (33). Each had a different practice schedule to learn tests of gross body reaction time and a pattern of tracing. The test of gross body reaction time consisted of reaching down to tap a switch when a light flashed while walking on an inclined treadmill at

moderate speed. The pattern tracing test consisted of tracing a pattern with an electronic stylus which recorded contacts with the sides of the pattern as errors. One group practiced both tests three times per day. A second group practiced once a day and a third practiced three times per week. Two more groups practiced both tests at irregular intervals. A control group had no practice between the initial and final tests. The investigators reported that there were no significant differences among any of the groups including the control group. All the groups except the control group had received the same total amount of practice.

Renshaw had four groups of twenty subjects each practice the pursuit rotor skill for a total of thirty one-minute practice trials (71). Group I received six relatively distributed practices for five consecutive days; Group II had six relatively massed practices for five consecutive days; Group III had ten relatively distributed practices every other day for a total of three days; and Group IV received ten relatively massed practices every other day for a total of three days. The only difference between the groups in experimental conditions was the amount and scheduling of rest periods. The two groups having relatively distributed practices were not significantly different from each other, nor were the two groups receiving relatively massed practices different from each other. The scores for the two relatively distributed practice groups at the end of the learning period were significantly higher than the scores of the relatively massed practice groups. Renshaw theorized that one possible reason for the superiority of the relatively distributed practice groups may be that incorrect responses are forgotten

during the rest periods, whereas massed practice allows no time to forget the incorrect responses.

Ammons conducted a series of studies on the acquisition of pursuit rotor skill. In one, using college women as subjects, he studied the effects of six different lengths of rest intervals between trials of thirty seconds (14). His subjects had rests of twenty seconds, fifty seconds, two minutes, five minutes, and twelve minutes between trials while one group had no rest between trials. All the subjects had the same total amount of practice time on the pursuit rotor. He reported that the groups having the intermediate amounts of rest between trials performed significantly better than the other groups. The two groups having five and twelve-minute rests were the poorest.

In another experiment, Ammons had his subjects practice the pursuit rotor skill for a total of thirty-six trials of twenty-two seconds each (15). One group practiced all thirty-six trials with no rests between trials and the second group had ten-minute rest intervals between each of the trials. The distributed practice group had a significantly higher score in both the number of hits per trial and the duration of contact of the stylus with the target.

Cook and Hilgard attempted to retest Snoddy's theory concerning the effects of early and late distributions of practices and his theory of the nature of the learning curve (25). They used the pursuit rotor skill to test the effects of early massing and distribution and the effects of late massing and distribution on the learning of the skill. Twenty-six male and female subjects were divided into two groups. One group had decreasing amounts of rest-interval time and the other group

had increasing amounts of rest-interval time between trials. Both groups had the same amount of total practice time. They reported no significant difference between the two groups. They were unable to support either Snoddy or Doré and Hilgard.

Ammons and Willig used one hundred twenty-eight eleventh and twelfth grade girls as subjects in a study of the acquisition of pursuit rotor skill under different practice conditions (17). The subjects were rotated among four different sets of learning conditions: (1) continuous/continuous, (2) continuous/distributed, (3) distributed/continuous, (4) distributed/distributed. The first period indicated was the practice period and the second was the test period. Continuous work consisted of ten minutes of practice followed by twenty minutes rest. Distributed work was considered one-minute trials with two-minute rest intervals between trials. The investigators reported that continuous practice resulted in inferior performance at all stages of learning.

Duncan had four groups of female subjects learn the pursuit rotor skill (28). The total time for the experiment was twenty minutes. The groups received five minutes of pre-rest practice, a ten-minute rest, and then five minutes of post-rest practice. Two of the groups had their pre-rest practice under massed conditions and two of the groups received distributed practice before the rest interval. After the rest period one of the pre-rest massed practice groups and one of the pre-rest distributed practice groups received massed post-rest practice while the other two groups had distributed post-rest practice. At the end of the pre-rest practice, the two groups which had received distributed practice were superior to the two which had had massed practice. The two groups having

distributed post-rest practice were both superior to the two which received massed post-rest practice. All the groups showed evidence of reminiscence although there were no significant differences among the groups.

Adams and Reynolds used five groups of basic airmen for an experiment on the effects of massed and distributed practice on the acquisition of pursuit rotor skill (13). There were thirteen to fifteen subjects per group. Each group received forty fifteen-second trials. Massed practice was conducted with five-second rest intervals between trials while distributed practice was conducted with forty-five-second inter-trial rest intervals. A control group had distributed practice throughout the conduct of the experiment. The four experimental groups received five, ten, fifteen, or twenty trials under massed conditions before having a ten-minute rest period. They then received the balance of the forty trials under distributed conditions. The investigators concluded that the massing of trials does not cause any permanent work decrement and that distribution of practice trials is a performance rather than a learning variable. What this means is that any superiority shown by groups receiving distributed practice over the groups receiving massed practices is temporary and that the massed groups will catch up to the others.

Archer investigated the effects of different practice conditions on the ability to perform a task of inverted alphabet printing by college students (18). His subjects were two hundred and forty-three psychology students who were divided into groups of about twenty each. Subjects received twenty trials of thirty seconds each. One set of subjects

received no rest between trials, a second set received fifteen-second rest intervals between trials, and a third set received thirty-second rest intervals. At the end of the twentieth trial, all the groups had a five-minute rest followed by four thirty-second trials under massed conditions. The third group, which had had the longest rest periods, was superior in performance to the other two. Archer concluded that distributed practice was better for learning this task than massed practice. After the five-minute rest, the group which had received massed practice showed considerable reminiscence. The post-rest performance of the three groups was not significantly different, indicating that massing of practice did not cause permanent decrement in performance.

Knapp and Dixon used three-ball juggling to investigate practice factors and learning (43). They were interested in determining the amount of time subjects needed to reach a criterion of one hundred consecutive catches. Their subjects were two groups of college men either majoring or minoring in Physical Education. There were thirty-five subjects in each of the two groups. Group I practiced five minutes daily and Group II practiced fifteen minutes every other day until each subject had reached the criterion. There was a wide variation in the amount of time needed to reach the criterion among the subjects and four failed to reach the criterion at all. The difference between the mean times needed by the two groups to reach the criterion was significant. Group I learned to juggle faster than Group II. The investigators concluded that short, frequent practices were more advantageous than longer, less frequent practices in learning to juggle. They felt that this may have been due to the increased motivation of the distributed group,

Group I, and the fact that the longer practice period allowed more fatigue and frustration to build up.

A follow-up on the previous study was conducted by Knapp, Dixon, and Lazier a number of years later using high school freshman boys as subjects (44). Group I had nineteen subjects and Group II had twenty-five subjects. Again, the subjects practiced either five minutes daily or fifteen minutes every other day until the criterion of one hundred consecutive catches was reached. As in the first study, the mean times taken by the two groups to reach the criterion were compared. Group I, practicing five minutes daily, was significantly faster in reaching the criterion than Group II. The results of the study were then compared with the results of the previous study. There was no significant difference found indicating that the skill of juggling was a learned skill rather than a development due to the maturation of the subjects.

Massey used the stabilimeter to investigate the effects of interpolation of time intervals on the motor skill of tracing a pattern (48). Her subjects were nuns in convents who were engaged in a teacher training program. The seventeen nuns were divided into three different work schedules. The schedules used by Groups X and Y were supposed to duplicate those used in many schools. Group X practiced three times a week (M-W-F) for five weeks for a total of fifteen practices. Group Y practiced five times per week (M—F) for five weeks for a total of twenty-five practices. Group Z practiced an additive schedule; practicing on the first day after their first practice, on the second, third, fifth, eighth, thirteenth, twenty-first, and thirty-fourth days after the first practice; for a total of nine practices. Each practice con-

sisted of three circuits on the stabilimeter with ten-minute rests between trials. The subjects were paced by the investigator, told to go faster when time exceeded errors and slower when errors exceeded time. There was no significant difference between the groups on the ninth practice even though the time span between the first and ninth practices was ten, eighteen, and thirty-four days for the three groups. At the fifteenth practice, Group Y was significantly better than Group X, indicating that five-day per week practice schedules were superior to three-day per week schedules.

Harmon and Oxendine used three groups of junior high school boys as subjects in an investigation of mirror tracing skill acquisition under different schedules (35). All three groups practiced two days per week for five weeks. Group I practiced two circuits per day for a total of twenty circuits; Group II practiced five circuits per day for a total of fifty circuits; Group III practiced eight circuits per day for a total of eighty circuits. The longer practices, five and eight per day, proved advantageous during the early stages of learning. After the third practice, the group practicing two circuits per day improved just as much as the other two groups.

Oxendine conducted a second study using mirror tracing with three groups of college students (52). The fifty-three subjects practiced the skill for nine school days over a period of two weeks. A performance test was given on the tenth day. Group I had an increasing schedule of practices with one circuit on day one to nine circuits on day nine. Group II had a decreasing schedule of practices with nine circuits on day one to one circuit on day nine. Group III practiced

a constant schedule of five practices per day for each of the nine days. The performance test consisted of five circuits. Group III had the best performance score and Group II was the poorest. The investigator concluded that a constant schedule was more beneficial than any variable schedule.

Rosenbleeth used three-ball juggling to investigate part and whole-part-whole practice along with two schedules of distribution of practice (55). The subjects were eighty college students from the required Physical Education program who were divided into four groups. The criterion was fifty consecutive catches, but all subjects stopped practice after two-hundred and ten minutes whether they had reached the criterion or not. Two groups practiced the part method and two practiced the whole-part-whole method. One group in each method had practice three days per week for ten minutes each practice and the other two groups practiced thirty minutes on one day per week for seven weeks. The thirty-minute practice was called massed and the ten-minute practices were called distributed. The group using the whole-part-whole method and practicing three days per week had the shortest mean time to reach the criterion and the lowest number of failures. The group using the part method and practicing thirty minutes on one day per week had the longest mean time and the greater number of failures. The differences among the groups were not statistically significant, but sixty-eight subjects reached the criterion.

Stelmach used both the stabilometer and the ladder climb to investigate the effects of massed and distributed practice on the learning of two types of balance skill (61). The stabilometer skill

involved standing and maintaining balance on a small platform that was resting on a knife-edge. The ladder climb involved climbing an unsupported ladder. His subjects were one hundred and sixty college men who were divided into four groups. Group I practiced the ladder climb under distributed conditions; Group II practiced the ladder climb under massed conditions; Group III practiced the stabilometer under distributed conditions; Group IV practiced the stabilometer under massed conditions. Distributed practice was sixteen trials of thirty seconds each with thirty seconds rest between trials. Massed practice consisted of eight minutes continuous work. All groups then had a four-minute rest followed by six distributed trials for all groups. Each group had a total of eleven minutes of practice. On the stabilometer, the distributed practice group was superior in the first eight minutes of practice, but the massed group quickly approached them after the four-minute rest period. The results for the ladder climb were similar. Stelmach concluded that the negative effects of the massing of practice on performance were temporary and tended to disappear after a rest period.

Carron developed a peg turn skill to measure the effects of varied distributions of practice on learning by three-hundred college men (24). His subjects were divided into five groups. Each of the groups had a total of one hundred and twenty trials on two days separated by a forty-eight-hour rest. The groups were different only in the distribution of their practices. Reminiscence occurred when massing was made as large as possible. He reported that increasing amounts of massing had a deleterious effect on performance, but that the decrement disappeared after rest.

Sports Skills

Fewer studies have been done using sports skills under different practice conditions. One of the earliest studies of a sport skill was examined closely by this writer. In 1915, Lashley published the results of two experiments on the acquisition of skill in archery (45). In the first study, Lashley compared the ability of four laboratory assistants to learn to shoot with the ability of four skilled laborers to do the same. Each group shot twelve arrows per day at a distance of forty yards from the target until each group had shot a total of three hundred and sixty arrows. The average distance of the hits from the center of the target for groups of arrows was the measure used for comparison. The average for the first forty arrows and the average for the last forty arrows shot by the two groups were compared as were the first one-hundred-eighty arrows and the last one-hundred-eighty arrows. Although the laboratory assistants were slightly better in the beginning and the laborers had a slightly greater total gain, the differences between the two groups were not significant.

In the second experiment, conducted one year later, Lashley used twenty-six volunteer subjects in a study of different distributions of practice in the learning of archery (45). His subjects were males between the ages of fourteen and thirty-two. The subjects were divided into three groups shooting five, twenty, and forty arrows per day with a forty pound bow. The initial instruction was limited to the minimum necessary to prevent accidents and the subjects were to find their own most suitable techniques. The subjects were told not to discuss their methods with each other between practices although they were able to

watch each other in practice. Lashley stated that this observation of each other had no noticeable effect on individual's techniques. Each seemed to develop his own. Rivalry was encouraged and daily scores were posted for all to see. All subjects shot their daily total without pause. All the subjects also took twenty shots per day with an air rifle as a control and as an index of the relative abilities of the groups.

In order to have another distribution, Lashley had a fourth group of subjects shoot sixty arrows per day after the other groups had completed their practice. All other practice conditions were the same as those for the previous groups. The subjects for this fourth group had a narrower age range than the other groups although their average age was the same.

For the purposes of comparison, Lashley included the scores of the previous experiment in which the subjects had shot twelve arrows per day. Comparisons were made only on the first three hundred and sixty shots which Lashley called the initial phase of learning. By taking the difference between the average of the first one-hundred-eighty shots and the last one-hundred-eighty shots, Lashley had a measure of the gain made by each subject. He also compared the difference between the first forty arrows and the last forty arrows as well as the first and last five arrows as additional measures of the gains made by each subject. In all measures, the five-shot per day group was superior in final accuracy and in the amount of improvement made by the subjects. The twelve-shot per day group had about the same amount of improvement made by the subjects, although their initial and final scores were much higher than all the other groups. The sixty-shot per day group had a much

lower initial score and was third in the amount of improvement. The twenty and forty-shots per day groups were about equal. The relative rankings of the groups held up in all measures. Lashley concluded that practice distributed over many days was superior to concentrated practice for acquiring skill in archery.

The year following Lashley's study, Murphy published the results of a study on the effects of different schedules of practice distributions on learning to throw a javelin (51). His subjects were female normal school students in the junior and senior classes. All subjects were right-handed. They had to throw the javelin with their left hand at a seventy-centimeter-square target placed twelve feet away from a stationary position. The seniors were divided into three groups: one practiced five times per week, Monday through Friday; the second practiced three times per week, Monday, Wednesday, and Friday; the third practiced once a week on Thursday. The juniors were divided into two groups; one practiced two times per day and the second practiced once a day. Murphy concluded that learning periods could be distributed over alternate days with no loss in learning. However, for the most efficient use of blocks of time, the five days per week schedule was suggested, particularly in schools.

Hartman sent out a questionnaire on football coaching practices (36). He received eighty-seven replies out of one hundred and forty questionnaires sent. Some of the questions dealt with the length and frequency of practices for the teams. He also asked for the number of games played, and the games won and lost. He then compared the types of practice schedules used to the proportion of games won out of the total

of games played. He concluded, "A team is successful insofar as it learns the science of football by distributing its intervals of practice rather than concentrating them" (36:89).

Cozens studied the effect of different practice schedules on track and field classes over a period of two years (26). He used four classes in the spring of 1927 and four in the fall of 1927 as his first group. His second group consisted of four classes in the spring of 1928 and four in the fall of 1928. Each group was given six events: the one hundred yard dash, the one hundred and twenty yard low hurdles, the half mile run, the broad jump, the shot put, and the discus throw. The first group was pre-tested in all six events during the first three classes of the semester. The remainder of the semester was divided into six equal practice and instruction periods, one for each event. During the last three classes, the subjects were given a post-test. The second group was also pre-tested in all six events. They then had practice and instruction periods scheduled two times per week for the remainder of the semester with the six events being rotated in each practice. Cozens concluded that practices held two times per week were more advantageous than the six longer practices, especially in the events calling for the development of endurance.

Harmon and Miller had college women practice certain billiard shots under different practice conditions (34). Subjects were divided into four groups, each of which received a total of nine practices. Group I was given practices three days per week (Monday, Wednesday, and Friday) for three weeks. Group II practiced an additive schedule; they had practice on days one, two, three, five, eight, thirteen, twenty-

one, thirty-four, and fifty-five following the first practice for a total of nine. Group III practiced each day for nine consecutive days. Group IV had one practice per week for nine weeks. Eleven set shots were used and fifty shots were taken each practice session. Group II, which had practiced using the additive schedule was statistically better than the other three. Group I, the three-day-per week group, was slightly better than Groups III and IV, although not statistically so. The investigators concluded that relative massing at the beginning of the learning process was preferable to widely spaced practices in order to lay a good base of skill upon which to build. Once the foundation has been laid, then spacing of practices seems more advantageous.

Young used students in the required Physical Education classes to investigate the effects of two different schedules on the learning of archery and badminton (67). The subjects were men and women enrolled in the classes and they were equated on the basis of scores on the Scott Motor Ability Test. There were twelve students per class and all classes in both activities were conducted indoors. There were nineteen forty-five-minute classes in each activity. Four archery and four badminton classes met two times per week. Three archery and four badminton classes met four times per week. The archery subjects were measured by scores and the percentage of hits per practice. The badminton subjects were pre- and post-tested with a wall volley test, a short serve test, and a high clear test. In archery, the classes that met four times per week had a significantly more rapid rate of learning as measured by the gain in mean score and the percent of hits per class. The difference, although statistically significant, was low. The two-day per week badminton classes were

slightly, though not significantly, better on the final test scores than the four-day per week groups. Young concluded that the results were inconclusive as the differences were too low to be of real significance.

Niemeyer investigated the effects of part and whole practice as well as massed and distributed practice conditions in swimming, badminton, and volleyball (69). His subjects were three hundred and sixty-six male freshmen and sophomores in the required Physical Education program in college. The massed and distributed conditions were compared in volleyball and badminton only. Sixty-minute practice periods held on Tuesday and Thursday each week for ten weeks were considered massed practice. Thirty-minute practice periods held on Monday, Wednesday, and Fridays for ten weeks were considered distributed practice. The massed groups had a total of one hundred and twenty minutes of practice per week while the distributed groups had only ninety minutes per week. Two volleyball and two badminton classes had massed practices while two volleyball and two badminton classes had distributed practices. The measure used for volleyball was the Brady Wall Volley Test and the badminton measure was the Miller Wall Test. The results for badminton indicated that the distributed condition of three thirty-minute practices per week was more effective for early learning and for overall learning. There was no difference in the later learning of the two groups. In volleyball, the distributed condition was more effective in the early learning, although not statistically so. Massed practice was better in the later learning stages in volleyball. Niemeyer concluded that short, frequent practices were more effective in early learning, even though the total practice time was less than the massed condition. He also stated that once an activity had been

learned to some degree, longer, less frequent practices could be tolerated. He felt that this was partly due to the fact that conditioning reduced the effects of fatigue in longer practices in later stages. He also subscribed to the theory of differential forgetting in early learning. Distribution of practice may cut down on the amount of time in which forgetting may occur.

Kahn used bowling to investigate three different practice schedules (41). He randomly divided his junior high school boys into three groups of eight each. The first group was called the massed practice group and bowled one practice per day for nine days. The second group, called the distributed practice group, bowled one practice per week for nine weeks. The third group received a combination of massed and distributed practice. They had practice on five consecutive days followed by one practice per week for four weeks for a total of nine practices. Each practice consisted of bowling fifteen consecutive balls. The scores of the first, fifth, and ninth practices as well as the total scores were compared. There were no significant gains in the group's ability to bowl and there were no differences between the groups.

Stull investigated the effects of three and six practices per week in the acquisition of one skill which required endurance and one which did not (73). The endurance skill was swimming and the other was bowling. His subjects for swimming were twenty-four boys ages eight to thirteen. The measure for swimming was the amount of time needed to learn to swim thirty-five feet. He used forty-six freshmen and sophomore college men as bowling subjects. In swimming, the group receiving six practices per week swam faster and learned more strokes than the other group which had received three practices per week. The three-times per

week group, however, was able to swim farther, indicating the development of a greater amount of endurance. He concluded that shorter, more frequent practices produced greater skill and speed, but that endurance required longer rest periods. The amount of skill in bowling was greater for the group having six practices per week for three weeks than the group having three practices per week for six weeks.

Wagner used forty-two seventh grade boys as subjects in a study investigating different lengths of practice for basketball skills (66). The boys were divided into three equal groups, equated on the basis of a pre-test in field goal shooting, speed dribbling, free throw accuracy, and wall volley ability. All three groups practiced these skills two times per week for six weeks for different lengths of time. They were tested at two-week intervals. The practices were fifteen, thirty or forty-five minutes in length. The results indicated that the longer practice period promoted greater learning during the early phases of learning, but the shorter periods of practice appeared just as productive after some skill had been developed. The longer practice period also developed more consistant performance than the shorter periods. Learning, or reminiscence, occurred during periods of no practice after some degree of skill had been gained.

The following study is included under meaningful skills even though the skill is novel because the apparatus used and the objective to be obtained are familiar. Bouncing a basketball off the floor into the basket was practiced by three groups of forty each under different practice conditions in this study conducted by Singer (58). His subjects were college freshmen men. Group I received eighty continuous trials

on one day. Group II had eighty trials with a five-minute rest period after the twentieth, fortieth, and sixtieth trials. Group III had eighty trials with twenty-four-hour rest periods after the twentieth, fortieth, and sixtieth trials. The most distributed practice, those who had twenty-four-hour rests between each twenty trials, was found to be significantly better than the other two groups in the immediate acquisition of the skill. Reminiscence was observed in the groups having massed and relatively massed practice. These two groups showed improvement after the rest periods while the most distributed practice group showed an initial decrement in performance after their rest periods.

Beale used tennis to investigate the effects of two different schedules of practice on the learning of the forehand and backhand drives (68). She used one hundred and fourteen women as subjects. They were mostly college freshmen beginners in tennis. They were in four typical classes. Two classes met on Monday, Wednesday, and Friday for thirty-five minutes. Two classes met on Tuesday and Thursday for fifty-five minutes per class. All classes met for nine weeks. The Broer-Miller Forehand and Backhand Drive Test with the self-toss was used to measure the initial and final levels of performance for all subjects. There was no significant difference between the groups in either test.

Brassie divided a high school basketball team of nineteen players into two random groups to investigate the effects of two practice schedules on free throw shooting (23). One group practiced one hundred free throws intermittently while the others practiced the one hundred throws consecutively. Subjects were given an initial and final test of one hundred free throws and the percentages of free throws made in games

were used as measures. There was no significant difference between the groups in the final test. The group which had practiced intermittently had a slightly higher score on the final test of one hundred consecutive free throws. This group also had a slightly higher game percentage, though not significant, than the group that had practiced continuously.

Johansson studied the effects of massed and distributed practice on the learning of beginning folk dance (40). Her subjects were women college students in class. They were paired on the basis of the Seashore Test of Rhythmic Perception. Experts rated the subjects on their folk dance ability at the beginning and at the end of the experiment and the subjects all took a written knowledge test on folk dance. Both groups were taught by the investigator. A schedule of fifty minutes per day, five days per week for two weeks was considered massed practice. Distributed practice consisted of twenty minutes per day, five days per week for five weeks. Total practice time was the same for the two groups. Both groups made significant improvement, but the distributed group was superior to the massed group in the performance of the step patterns.

Morris studied the effects of three different distributions of practice on the learning of the volleyball serve by seventh and eighth grade girls (50). The eighty subjects were divided into three groups, equated on the basis of the best score of two initial serve tests. Group I practiced on Monday through Friday; Group II practiced Monday, Wednesday, and Friday; and Group III practiced on Tuesday and Thursday. During the practice sessions, the subjects served ten balls each. All groups had

eight practice periods with a total of eighty balls served each. Analysis of the results showed that no one pattern of distribution was superior to the others in the level of achievement attained by the subjects.

Schroeder used beginning tennis students to investigate two different practice distributions (72). Her subjects were two beginning college tennis classes. Twenty-eight subjects were matched on the basis of the Scott Motor Ability Test and past tennis experience. All classes were conducted indoors. Group I practiced the forehand drive continuously for fifteen minutes each period two times per week for three weeks. They then repeated the procedure with the backhand drive for three weeks. Group II practiced fifteen minutes with five minutes of another activity interpolated after five and ten minutes of practice. They also repeated the procedure with the backhand. After the forehand practice, the Broer-Miller Forehand Test was administered and after the backhand practice, the Broer-Miller Backhand Test was administered. Schroeder reported that there was no significant difference between the groups on the forehand. Distributed practice seemed to be more advantageous in learning the backhand. The difference between the two groups on the backhand was significant.

Practice Scheduling and Retention

The phenomenon of retention was first investigated in 1885 by Ebbinghaus. Using himself as a subject, he learned over twelve-hundred lists of nonsense syllables (2). He reported that the greatest amount of forgetting of the syllables occurred in the first few hours after the cessation of practice. After many years, Ebbinghaus was able to depict

retention on a decelerating curve of forgetting that never completely reached the base line. This curve and variations of it have been reproduced many times in laboratories by many different researchers using nonsense syllables or other verbal skills (11). Travers described the curve in this way: "The curve representing retention generally shows a sharp decline after training ceases. This is followed by a much less marked decline as additional time passes by" (12:332).

One of the earliest experimenters with retention of motor skills was Swift. Using two subjects whom he had trained to juggle two balls in one hand for a previous experiment in 1902-3, Swift tested them in their ability to relearn the skill after twenty-one months of no practice (62). He reported that they relearned very rapidly and seemed to be held back from faster relearning more by fatigue than by forgetting. He said of this factor:

> Since the subjects were obliged continually to work against accumulating fatigue the results of this test seem to show that the nervous system had forgotten little or nothing and that whatever loss in skill the strangeness of the movements during the first and second trials indicated was chiefly muscular (62).

Since these early studies, there has been little research into the effects of different practice schedules on the retention of motor skills. Some studies, concerned primarily with the effects of practice on performance, have made retention checks on the skills used. In Massey's cited earlier, it was reported that the more widely distributed practice group had performance superior to the massed practice group (48). One group practiced three days per week for fifteen practices, another practiced five days per week for twenty-five practices, and the third practiced an additive pattern for nine practices. All groups had reten-

tion tests two weeks after their last practice. Proportionally, the retention of the three groups was the same. Because the five-day-per-week group had learned more initially, they remembered more.

Singer's study, reported earlier, using the novel basketball skill of bouncing the ball off the floor into the basket was completed with a retention test one month after the last practice (58). Although the group having the most widely distributed practices was superior in the immediate acquisition of the skill, the massed and relatively massed groups were significantly better in the retention test.

The three groups of seventh and eighth grade students used by Morris as subjects in his study of different distributions of practice in volleyball serving ability were given a retention test nine weeks after their last practice (50). There were no significant differences among the groups either in the acquisition of the skill or in the retention of the skill.

Reminiscence

The phenomenon of reminiscence may possibly explain the reduction of differences among groups after a rest period in some of the studies cited. Hull investigated this phenomenon in the early 40's. In a series of studies, he used the pursuit rotor task (5). He noted that his subjects' performance often improved after rest periods where there was no practice allowed. This improvement was generally greatest when the amount of massing of practice trials was the largest. Hull theorized that inhibition of response was built up by a fatigue-like condition. He called this Reactive Inhibition (5:391). With rest, this inhibition

would be reduced or even disappear and performance would improve even though no further practice had been given.

Irion had two groups of subjects learn the pursuit rotor task (39). One group had no rest between the original learning and the relearning, while the second group had a five-minute rest between the original learning and the relearning. The original learning consisted of ten, twenty, thirty, and forty trials. The results showed that there were significant amounts of reminiscence after the rest period while there was none between the original and relearning in the group which had had no rest. The amount of reminiscence increased as the amount of pre-rest practice was increased. In a second experiment, where the amount of rest between the original learning and the relearning ranged from thirty seconds to five minutes, reminiscence was found "to be a negatively accelerated, increasing function of the length of the rest period..." (39).

Little research has been done with reminiscence. However, some investigators have noted its occurrence. Harmon and Oxendine, in their study of mirror tracing by junior high school boys, note the presence of reminiscence in all groups (35). The amount of reminiscence among the groups was not significantly different. Reminiscence was observed by Singer in the massed and relatively massed practice groups in his study of the effects of practice on a novel basketball skill (58). On interpolated rest tests, the massed and relatively massed groups showed an improvement while the distributed group showed a slight decrement.

Parker conducted a study on the effects of massed and distributed practice on reminiscence (70). He used the Bachman Ladder Climb on seventy-five high school students. Group A had seven minutes of contin-

uous practice followed by a seven-minute rest. Group B had seven thirty-second trials with thirty-second rest intervals followed by a seven-minute rest. Group C had fourteen fifteen-second trials with fifteen-second rest intervals followed by a seven-minute rest. After the seven-minute rest, all groups had eight fifteen-second trials with thirty-second rest intervals. Group C, which had had the most frequent rest intervals, showed the least amount of reminiscence. Group A, which had had massed practice, showed a greater amount than the other two groups. Parker concluded that although performance is inhibited by massing practice, the decrement is only temporary. After a rest period, the level of performance will improve to the same level as that achieved by a group receiving distributed practice.

Summary

It would appear that the majority of the evidence indicates that initial performance is better when the material to be learned has been practiced under distributed conditions. There is some evidence, however, that seems to suggest that early massing of practice is beneficial to performance as the early massing allows a foundation to be built up. There is also evidence to indicate that early distribution is more advantageous to reduce fatigue, frustration, and boredom. From the limited evidence available, it would appear that the practice condition used for learning does not seem to be a factor in whether the skill is retained after a lay-off. Reminiscence appears to be a temporary effect of massing of practices.

# CHAPTER IV

# PROCEDURE

The purpose of this study was to determine the effects of two different schedules of practice distribution on the learning and retention of the skill of throwing a ball at a moving target with a lacrosse stick. The novel skill of a throw with a lacrosse stick was selected as being one with which few people would have had experience. One group practiced thirty continuous trials in each of their sessions while the other group practiced thirty trials per session with three-minute rest intervals after the tenth and twentieth trials. A pilot study was conducted prior to the experiment in order to modify aspects of the skill and the target.

## The Pilot Study

The pilot study was conducted in the spring of 1970. The subjects were college freshman women at the University of North Carolina at Greensboro who had had no previous experience with lacrosse. The purposes of the pilot study were to modify aspects of the conduct of the novel skill and the target as a scoring device. These aspects were:

1. The type and amount of instruction necessary to orient subjects to the skill.
2. The target.
3. The number of trials to be performed in each practice session.

4. The distribution of trials for non-continuous practice.

The Type and Amount of Instruction

The first factor considered was the type and amount of initial instruction necessary to introduce the skill to the subjects. The subjects were seven college freshman women who had had no previous lacrosse experience. Three of the subjects were given no specific instructions. They were told to throw the ball at the wall with their hand and then to try to do the same thing with the stick. The only specific instructions consisted of telling the subjects that the throw with the stick was a lever action caused by pushing with the top hand while simultaneously pulling with the bottom hand. The subjects threw with the stick while standing twelve feet from the wall four times. They then ran from a point twenty-four feet from the wall and threw before reaching the point twelve feet from the wall for ten throws. (See Appendix A, Fig. 1)

The four remaining subjects were given more detailed and specific instructions. After practicing with their hand and being told to think of how they performed the throw, the subjects were given a demonstration of the throw while standing by the instructor. During the demonstration, the instructor explained that the action of the top hand was similar to the throw with the hand. At the same time, the bottom hand pulls into the arm-pit of the top arm. This caused a pushing motion of the top arm and a pulling motion of the bottom arm giving the stick a lever action. After two practice throws standing twelve feet from the wall, the subjects

were given the corrections for high and low throws. If the throw was too low, it was probably due to the fact that the stick was not started from a position close enough to the horizontal. If the throw was too high, the bottom hand was probably lifted too high at the beginning of the throw. After two more standing throws, the instructor gave a demonstration of the throw while running. The lever-action of the stick caused by pushing with the top hand and pulling with the bottom hand was again noted. The subjects then took ten practice throws while running, starting from twenty-four feet from the wall and throwing before reaching a point twelve feet from the wall. After the fifth throw, the low-high corrections were repeated. The only other comments from the instructor were admonitions about waiting to throw until the other subjects were out of the way. The instruction period for the second group lasted fifteen minutes while the time for instruction for the first group was ten minutes.

After their instruction, all subjects were given twenty continuous trials at the target. They started twenty-four feet from the target, ran forward and threw before reaching a point twelve feet from the target. They were encouraged to return to the starting line as rapidly as possible for each succeeding trial. Each subject needed about ten minutes to complete the twenty trials. For this pilot study, the other subjects acted as linesmen, starters, and ball collectors, while the investigator was the scorer and target attendant. The learning that may have occurred through observation was discounted as observation was not permitted during the experiment itself. The group that had been given the non-specific

instruction was tested on one day while the other group was tested on the following day.

The scores for the two groups ranged from no hits to eight hits out of twenty trials. Two subjects had eight hits, one had six, two had five, one had three, and one had no hits. Although not statistically compared, the average score of the two groups was examined. The subjects who had non-specific instruction averaged five and a third hits per twenty trials. The subjects who had more detailed and specific instruction averaged four and three-quarter hits. This result led the investigator to hypothesize that the type of instruction did not cause significant differences. For the remainder of the study, a combination of the two methods was used. Subjects were given two demonstrations and general corrections for high and low throws for a ten-minute period of instruction.

The Target

The target used as a scoring device for the skill was developed by the investigator. The dimensions of the floor area used for the performance of the skill were the same as those used in a test of lacrosse throwing ability developed by Wilkie (72). The target was a three-foot circle of three-quarter inch plywood and was painted bright orange. The target was suspended by a rope attached to the top from a point fifteen feet above the floor. (See Appendix A, Fig. 2)

The possibility of the use of a swinging target was considered during the pilot study. Seven college freshman women were used as the subjects. Three of the subjects took twenty trials at a stationary

target while the remaining four took twenty trials at the target which was swung from alternate sides. All subjects ran from a point twenty-four feet from the target and threw before reaching a point twelve feet from the target. Since the subjects were the same as those who had the two types of instruction, one of the stationary target subjects and two of the moving target subjects were given their initial instruction in a non-specific manner. The other two stationary target subjects and the other two moving target subjects had more detailed and specific instruction.

The scores ranged from no hits out of twenty tries to eight hits out of twenty tries. The average of the scores for the subjects who threw at the stationary target was three and two-thirds hits out of twenty while the average of the scores for the subjects who threw at the moving target was six hits. The investigator assumed from the results that the use of a swinging target was possible.

During the pilot study, the height of the bottom of the target from the floor was five feet. After the pilot study, the target was lowered to four feet. This was done because the investigator felt that many throws which were adequately performed were going below the target.

The Number of Trials Per Session

The second test session of the pilot study was held to determine whether learning (improvement) was still occurring after forty trials. The subjects were five female freshmen who had had no prior lacrosse experience. The day of the test was hot and humid. The subjects had ten minutes of initial instruction throwing against the wall. They

threw with their hand first, then were given the first of two demonstrations with the stick by the instructor. They threw while standing twelve feet from the wall and were given the corrections for low and high throws. A low throw was probably caused by not starting the stick from a position close enough to the horizontal while a high throw was probably caused by raising the bottom hand too high at the beginning of the throw. The subjects were then given a demonstration of the throw while running. They then practiced the running throw ten times, starting from a point twenty-four feet from the wall and throwing before reaching a point twelve feet from the wall. The corrections for high and low throws were repeated after the fifth practice throw. At the end of ten minutes, the test instructions were given. Each subject had forty continuous trials. The other subjects acted as linesmen, starters, and ball collectors.

The scores ranged from one hit to eleven hits out of forty trials. After the testing session, it was discovered that the subject who had gotten one hit had 20/200 vision. The other subjects had two, three, nine, and eleven hits each. Subject number one, who had eleven hits, had hits as late as the thirty-ninth and fortieth trials and subject number five, who had nine hits, had hits as late as trials thirty-one, thirty-two, thirty-three, and thirty-four. None of the other subjects had hits after the thirtieth trial. Fatigue was observed in most subjects after twenty trials causing them to slow their pace. Fatigue seemed to affect the quality of the subjects' throws after the thirtieth trial, except subject number five who seemed to pace herself throughout.

Distribution of Trials

Since one of the experimental groups was to be given distributed practice in each session, it was necessary to determine an effective distribution of trials. The first distribution examined was five trials per practice for a total of thirty trials for the session. The subjects were five female freshmen who had had no previous lacrosse experience. One subject dropped out after ten trials due to a previous knee injury. Instruction was the same as had been given in the prior sessions. When not practicing, the subjects acted as linesmen and starters. Each subject had five trials and then rotated until all had had thirty trials. There was about a five-minute interval between the five-trial practices for each subject.

Three subjects had two hits out of thirty tries and one had nine hits. The subject who had nine hits appeared to be the only one who attained learning of the skill. The hits obtained by the others appeared to be accidental. The investigator assumed that the practice sessions of five trials were probably too short to permit adequate time for correction of errors.

Since a distribution of five trials did not appear to be adequate, one of ten trials per practice for a total of forty trials for each session was examined. Subjects were three college freshman women who had had no previous lacrosse experience. Instruction was the same as that used in the previous sessions. The session was held on Reading Day prior to final exams and the weather was hot and humid. The scores obtained by the subjects were three, six, and seven hits out of forty tries. The investigator felt that practices of ten trials were more

effective than practices of five trials. It was felt that the weather did play a part in the results as the subjects complained of being very fatigued at the end of the session.

Summary

The decisions made as a result of the pilot study and administrative considerations were as follows:

1. Initial instruction in the skill would consist of ten minutes of practice with two demonstrations. During the demonstrations, explanation of the lever action of the stick caused by the push of the top arm with a simultaneous pull of the bottom arm would be made. The general corrections for high and low throws would be given to the subjects. (See Appendix C)

2. The target would be a three-foot circle painted bright orange. The target would be suspended by a rope from a point fifteen feet above the floor so that the bottom of the target was four feet from the floor. The target would be swung from alternate sides for each trial. (See Appendix A, Fig. 2 and Fig. 3)

3. There would be thirty trials in each of the practice sessions. The investigator was more interested in determining the change in performance from session to session and not the amount of change within each session.

4. The distribution of trials for the non-continuous practice sessions would consist of ten trials per practice for a total of thirty trials for the session.

## The Experiment

The experiment was conducted between the Thanksgiving and Christmas holidays in 1970. The fifty subjects were divided into two experimental conditions. Group A had three practice sessions before Christmas and one retention session twenty-eight days later. Subjects in Group A had thirty continuous trials in each of their sessions. Group B also had three practice sessions and one retention session twenty-eight days after the last practice. Subjects in Group B had thirty trials in each session with a three-minute rest interval after the tenth and twentieth trials in each session.

### Selection of a Novel Skill and Scoring Device

The overarm throw of a ball with a lacrosse stick at a moving target was chosen as a novel skill because it is such a unique skill. Very few people have had experience with lacrosse and the equipment. The three-foot swinging target was used as the means of quantitatively scoring subjects' performance. The dimensions of the floor area used in the performance of the skill were the same as those used in a test of lacrosse throwing ability developed by Wilkie (72). Modifications in the procedure used for performing the skill and in the target were made during the pilot study. The lacrosse stick was a regulation women's stick and the ball was an approved indoor, non-bouncing lacrosse ball.

The target was an orange, three-foot circle of three-quarter inch plywood suspended by a rope from a point fifteen feet above the floor. The bottom of the target was four feet above the floor when the target hung stationary. The target was swung from alternate sides for each trial of the practice session. In order to swing the target, an attendant

raised the target sideways until it touched a two inch restraining rod three feet from the center-line and five and one-half feet above the floor. (See Appendix A, Fig. 4) The target was then released from this point as soon as the subject crossed the starting line.

The subject started any place behind an eight-foot starting line that was twenty-four feet from the target. As soon as the subject crossed the starting line, the target was released. The subject ran forward and any time before stepping on or over a second eight-foot line twelve feet from the target, the subject threw the ball at the swinging target. The restraining line was indicated by an eight-foot line with an eleven-foot post at each end of the line. The posts were a bright yellow from a point three from the floor to a point six feet from the floor. Otherwise, they were plain silver aluminum color. The yellow was added to the posts to create greater visability.

As soon as the subject had released her throw, she returned to the starting line and collected another ball from the starter. The subject then repeated the procedure with the target swung from the other side. This was continued until the subject had completed thirty trials with the target being swung from alternate sides.

Each hit on any part of the wood counted as one point. A foot fault at the restraining line caused the trial to be counted as a zero, whether the target was hit or not. If the ball fell out of the subject's stick or was dropped after she had crossed the starting line, the trial was counted and scored as a zero. The subject was permitted to step on or over the restraining line with no penalty after the release of the ball. A subject who crossed the starting line, but who had not released the

ball before the administrators were ready, was able to repeat the trial with no penalty. If the ball had been thrown, the trial counted and was scored as a zero. (See Appendix C)

Selection of Subjects

The subjects were female college students in the required physical education program at Sweet Briar College. Most were members of the freshman class, although there were several sophomores and one junior. There were fifty subjects from three field hockey classes taught by the investigator. None of the subjects had had any previous experience with lacrosse. All students in the three classes who had had even the most limited experience were eliminated and assigned to assist with the administration of the practice and retention sessions.

Assignment to Experimental Groups

Subjects were divided into two experimental groups prior to being given initial instruction in the skill of throwing a ball at a moving target with a lacrosse stick. Upon arrival each subject was given a three-by-five card upon which to put her name and the identifying number of the lacrosse stick she selected. Each card already had a number on it and the letter A or B. The number identified each subject and the letter identified the practice group to which she belonged. Prior to being given out, the cards were mixed so that there was no particular order. Each of the subjects picked up a card as she arrived. The number and letter were the only identifying marks to appear on the four score cards that were attached to the name card that the subject

filled out. Subjects were asked to use the same lacrosse stick throughout the experiment.

Practice procedure. As there were two practice areas, it was possible to have three subjects from Group A and two from Group B practice during each fifteen-minute period. Subjects were asked to sign up for one of the fifteen-minute periods available. They were asked to come for the same fifteen-minute period for each of the practice sessions and for the retention session. The practice sessions were held between 3:15 and 4:30 P.M. or 2:15 and 3:30 P.M. depending upon which class the subjects were in. These time periods were selected because they were the times in which the subjects' classes normally met.

Initial instruction. Eight subjects from Group A and nine from Group B were given their initial instruction on Monday. They then had three practice sessions on the following Wednesday, Monday, and Wednesday. Seven subjects from Group A and seven from Group B had initial instruction on Tuesday and had their practice sessions on the following Thursday, Tuesday, and Thursday. Ten subjects from Group A and nine from Group B were given initial instruction on Thursday and then practiced on the following Tuesday, Thursday, and Tuesday. These were the days that their classes normally met.

Subjects were not allowed to see the target during the period of instruction. They were given instruction in the skill of throwing a lacrosse ball with a lacrosse stick without the target. Instruction consisted of the following: subjects were asked to take their stick, get a ball and spread out behind a line twelve feet from the wall. They

were first told to stand and throw with their hands two times at a spot of their choice about five and a half feet up from the floor. They then moved back behind a line twenty-four feet from the wall. They ran forward and threw with their hand two more times at the same spot before crossing the first line.

The investigator then gave two demonstrations of the throw with the stick while standing. The investigator explained that the action of the top hand and arm, which is the normal throwing hand, was similar to that of the throw without the stick. The subjects were also told that the bottom hand added a pulling motion causing the stick to act as a lever. After the demonstration and explanation, the subjects took four throws standing behind the twelve-foot line. Between the second and third throws, the investigator explained that if the throw was too low, the stick should be started from a more horizontal rather than vertical position. It was also explained that a high throw resulted from the end of the handle being raised too high.

The subjects moved back behind the twenty-four foot line and the investigator demonstrated the throw two times while running and again explained the push/pull action of the top and bottom hands. The subjects then tried the skill three times, starting behind the twenty-four foot line and throwing before crossing the twelve-foot line. After three throws, the corrections for low and high throws were repeated. The subjects were then allowed to practice at their own pace until they had thrown the ball seven more times. These last throws were all performed while running. They had a total of ten running throws. The instruction period lasted ten minutes.

Experimental Treatment of Groups

Group A. Subjects from Group A had thirty continuous trials during each of the three practice sessions and also in the later retention check. After their initial instruction period on Monday, eight of the subjects had their first practice session on the following Wednesday. At that time they were allowed to see the target for the first time and they were given the directions for the conduct of the practice session.

Each subject picked up the stick identified on her name card, gave her name card and score card to the scorer, and went to the starting area. The subjects were told that when the starter told them that the administrators were ready, they could start. The subjects were to run forward and throw the ball at the swinging target before stepping on or over the restraining line twelve feet from the target. After the throw, the subjects were to return to the starting area and get another ball from the starter. They were to do this as quickly as possible, although they did not have to run back. They would be able to start again as soon as the starter indicated that she was ready.

Subjects were told that a hit on any part of the wood counted as one point; a foot fault (at the restraining line) counted as a zero; and that if a ball was dropped after the starting line was crossed, the trial would count and be scored as a zero. Questions were answered only in relation to the procedure and not about the performance of the skill. The subjects were not told about any time limit, but were encouraged to move quickly. The majority of the subjects took six minutes to do the thirty trials, although three or four completed the trials in five minutes and one or two took closer to seven minutes.

The second and third practice sessions for the eight subjects from Group A who practiced on Wednesday, were held on the Monday and Wednesday following the first practice. Subjects came to each session during the same fifteen-minute time period each day. Upon arrival, while waiting, and after practice, the subjects were not allowed to watch others practicing. A summary of the directions for the conduct of the practice session was given to each subject when she arrived. All subjects threw at the same target each session. The practice period for these eight subjects from Group A was held between 3:15 P.M. and 4:30 P.M.

Seven additional subjects from Group A, who had had their initial instruction period on Tuesday, had their practice sessions on the following Thursday, Tuesday, and Thursday between 3:30 P.M. and 4:30 P.M. They were given the same instructions about the conduct of the practice sessions as the preceding group. They also used the same sticks and target for the entire experiment and were not allowed to watch others practicing.

The last ten subjects from Group A had their initial instruction on Thursday and had their practice sessions on the following Tuesday, Thursday, and Tuesday between 2:15 P.M. and 3:30 P.M. The reason for the difference in the hour of practice was that the class normally met at this earlier hour and also that the previous group was practicing during the later hour. This group was given the same instructions for practice as the other groups. They also used the same sticks and target throughout the experiment and were not allowed to observe others practicing.

Group B. Subjects from Group B had each practice session of thirty trials divided into three segments of ten trials each with a rest period

of three minutes between each segment. Each ten-trial practice took about two minutes to complete, so the total practice time for Group B was the same as that for Group A. During the three-minute rest period, the subjects from Group B worked on crossword puzzles. The purpose of the puzzles was to attempt to inhibit mental practice that might occur during the rest interval. The subjects were allowed to use dictionaries which were provided in an attempt to get subjects more involved in the puzzles which were of moderate difficulty. The puzzles were not the same for all subjects and if a subject finished the puzzle she was given a new one. The subjects went to another room to work on the puzzle where they were unable to watch the others practice.

It was possible to have two subjects attend practice in the same fifteen-minute period. While one was practicing, the other worked on her crossword puzzle. After the subject who had been practicing had completed ten trials, she collected her score card and puzzle from the scorer and went to the other room to work the puzzle. The other subject then practiced her ten trials. The two subjects rotated until each had completed thirty trials and each had worked twice on the puzzle. After the thirtieth trial, the subjects were free to leave. There were three subjects who had no partners and therefore, had to have their rest intervals timed.

Nine subjects from Group B had initial instruction on Monday and practiced on the following Wednesday, Monday, and Wednesday between 3:15 P.M. and 4:30 P.M. They were given the same instructions as the subjects from Group A except that they were told to go to another room to work on their puzzles after the completion of ten trials. At the end

of three minutes, they switched with another subject and performed ten more trials. At the end of the second ten-trial practice, they worked on the crossword puzzle for an additional three minutes. After the rest interval, the subjects had one last ten-trial practice after which, they were free to leave. They performed a total of thirty trials and had two three-minute rest periods in which they worked crossword puzzles.

Seven more subjects from Group B had initial instruction on Tuesday and practiced on the following Thursday, Tuesday, and Thursday between 3:30 P.M. and 4:30 P.M. Their practice procedures and conditions were the same as those for the previous nine subjects in Group B. There was an odd number of subjects in this group as there had been in the previous group, so that one had to have rest periods timed.

The last nine subjects from Group B had their initial instruction period on Thursday and practiced on the following Tuesday, Thursday, and Tuesday between 2:15 P.M. and 3:30 P.M. As with the last ten subjects in Group A, the earlier practice hour was due to the earlier class meeting time and the fact that seven subjects from Group B were practicing in the later hour. All other conditions were the same as the other sessions for subjects in Group B.

As with Group A, all subjects in Group B used the same stick and target throughout the experiment. While waiting and after completing the last practice period, the subjects were not allowed to observe the practice of other subjects. Because of the loud sound made by the ball striking the target, it was impossible to prevent subjects from knowing when the target had been hit. Although they were asked not to discuss

the practice sessions during the course of the experiment, several subjects were observed comparing results. As the subjects were not isolated from each other, it was impossible to prevent all these comparisons. The practice administrators were asked not to comment on the performances of the subjects. They were instructed only to clarify the directions for procedure and encourage those who were moving slowly to move more rapidly. At the end of each practice session, all subjects were asked to turn in their name and score cards. The score cards that had been used were removed from the name card and a new one attached to the name card for the next practice. The subjects were not given their previous scores at subsequent practices.

Retention Test

A retention test was given to twenty-four subjects from Group A and twenty-four subjects from Group B on the twenty-eighth day following their third practice session. The interval between the third practice session and the retention test consisted of the Christmas holiday. None of the subjects had the opportunity to practice the skill during this interval. One subject dropped out of the Tuesday-Thursday-Tuesday practice schedule in Group A and one dropped from the Tuesday-Thursday-Tuesday schedule from Group B.

The conditions for the retention test were the same as those for the practice sessions. Each subject used the same stick and target, was tested at the same time of day, and had the same schedule of practice trials. Those who had practiced thirty continuous trials per session had their retention test consist of thirty continuous trials. Those who had their practice sessions divided into three segments of ten

trials each with three-minute rest intervals between each segment had their retention test divided into three segments of ten trials with three-minute rest intervals between segments.

Treatment of Data

The data were examined in three ways. First, Repeated Measures Analysis of Variance was used to determine whether there were differences in the scores obtained in the three practice sessions by subjects in Groups A and B. For the second set of comparisons, the Fisher "t" Test of Significance of Differences Between Uncorrelated Means was used to determine whether there were differences between the scores of Groups A and B on the three practice sessions and on the retention test. The third set of comparisons was made between the scores for subjects in Group A on the third practice and the retention test. The same comparison was made for subjects in Group B. For these two comparisons, the Fisher "t" Test of Significance of Differences Between Correlated Means was used.

# CHAPTER V

## ANALYSIS AND INTERPRETATION

The purpose of this study was to determine the effects of two distributions of practice on a novel skill. A secondary outcome of the study was the determination of whether the novel skill of throwing a ball with a lacrosse stick at a swinging target could be learned and retained as a result of practice. Group A had practice and retention sessions consisting of thirty continuous trials while Group B practiced thirty trials with a three-minute rest interval after the tenth and twentieth trials. All subjects were given a retention test twenty-eight days after the last practice session.

The scores within Group A and Group B were examined for the three practice sessions in order to determine whether there was a change in the scores over the three sessions. For this comparison, the Repeated Measures Analysis of Variance was used. The Fisher's "t" Test Between Correlated Means was used to determine whether subjects in the two groups retained the skill. The Fisher's "t" Test Between Uncorrelated Means was used to compare scores between Groups A and B for the three practice sessions and for the retention test.

### Presentation of Data

#### Within Group A

Scores obtained by the twenty-five subjects in Group A on the three practice sessions were examined by using Repeated Measures Analysis

of Variance. This was done in order to determine whether there was a change in performance over the three sessions. This would also reveal any significant variation among the subjects.

The F obtained between the subjects was 21.525 (See Table 1) which is significant at the five percent level of confidence, therefore, no further examination was done. This was because the significant variation among the subjects would bias all other results. Any other differences probably would be caused by this variation.

The scores of the twenty-four subjects in Group A who took the retention test were compared with their scores on the third practice in order to determine whether there had been a significant change during the period of no practice. The Fisher's "t" Test Between Correlated Means was used for this comparison. The "t" obtained was 1.328 which was not significant. (See Table 3, p. 56)

Within Group B

The scores for the twenty-five subjects in Group B in the three practice sessions were also examined by using Repeated Measures Analysis of Variance. As with Group A, the F obtained between subjects was significant. The F was 4.586. (See Table 2) Again, no further examination was made as any other differences found would have been caused by the variation among the subjects.

The scores of the twenty-four subjects in Group B who took the retention test were also compared with their scores on the third practice using the Fisher's "t" Test Between Correlated Means. The "t" obtained, 0.638, was not significant. (See Table 3, p. 56)

TABLE 1

REPEATED MEASURES ANALYSIS OF VARIANCE BETWEEN SCORES OF SUBJECTS IN GROUP A ON EACH PRACTICE

| Source | Sum of Squares | df | Mean Square | F |
|---|---|---|---|---|
| Between Trials | 24.000 | 2 | 12.000 | 5.082 |
| Between Subjects | 1219.783 | 24 | 50.824 | 21.525* |
| Interaction | 113.337 | 48 | 2.361 | |
| Total | 1357.120 | 74 | | |

* Significant at the 5% level of confidence.

TABLE 2

REPEATED MEASURES ANALYSIS OF VARIANCE BETWEEN SCORES OF SUBJECTS IN GROUP B ON EACH PRACTICE

| Source | Sum of Squares | df | Mean Square | F |
|---|---|---|---|---|
| Between Trials | 144.480 | 2 | 72.240 | 9.443* |
| Between Subjects | 842.008 | 24 | 35.084 | 4.586* |
| Interaction | 367.192 | 48 | 7.650 | |
| Total | 1353.680 | 74 | | |

* Significant at the 5% level of confidence.

Between Groups A and B

Comparisons were made between scores for Groups A and B for all three practice sessions and for the retention test. The Fisher's "t" Test Between Uncorrelated Means was used for these comparisons. There were no significant "t"s for any of the three practice sessions or for the retention test. The "t"s between Groups A and B were 0.56 on the first practice, 0.63 on the second, 1.26 on the third practice, and 1.55 on the retention test. (See Table 4) A "t" greater than 2.060 would have had to be obtained in order to have been considered significant.

## Interpretation

The fact that the difference between Groups A and B on the first practice was not significant would indicate that the two groups were from the same population. Since there were no significant differences in the scores obtained by subjects in Groups A and B between the three practice sessions or between the third practice and the retention test, it was concluded that any differences that did occur were not due to the practice conditions. They were probably due, instead, to individual differences and to chance. There was a wide variation of scores among subjects in all the sessions. (See Appendix D) There was no pattern to the changes nor were the changes significant. This wide variation accounted for the significant F between subjects on the Repeated Measures Analysis of Variance. (See Tables 1 and 2, p. 54) The significant F between trials in the Analysis of Group B was probably due to the fluctuation among the subjects and not to the practice condition.

TABLE 3

FISHER'S "t" TEST OF SIGNIFICANCE OF DIFFERENCE

BETWEEN CORRELATED MEANS

| | Mean-Third Practice | Mean-Retention Test | t |
|---|---|---|---|
| Group A | 8.083 | 7.375 | 1.33 |
| Group B | 9.875 | 9.42 | 0.64 |

N = 24

2.069 = significant "t"

TABLE 4

FISHER'S "t" TEST BETWEEN SCORES OF EACH PRACTICE

AND BETWEEN PRACTICE AND RETENTION

| | Mean-Group A | Mean-Group B | t |
|---|---|---|---|
| First Practice | 6.92 | 6.32 | 0.56 |
| Second Practice | 8.12 | 7.32 | 0.63 |
| Third Practice | 8.12 | 9.64 | 1.26 |
| Retention Test | 7.38* | 9.42* | 1.55 |

N = 25 *N = 24

2.064 = significant "t"

Because there was no significant change in the scores over the practice period and in the retention test for either Group A or Group B, it was concluded that there was no learning or retention of the skill. This study neither supported or refuted any of the findings reported earlier in the Review of Literature.

# CHAPTER VI

# SUMMARY, CONCLUSIONS, AND IMPLICATIONS FOR FURTHER STUDY

## Summary

The purpose of the study was to determine the effects of two distributions of practice on the learning and retention of a novel skill. A pilot study was conducted prior to the experiment in order to develop the scoring device and to determine practice procedure. The subjects for the experiment were college women in the required physical education program at Sweet Briar College. Throwing a ball at a swinging target with a lacrosse stick was the novel skill used in the study.

Subjects were divided into two groups by drawing assignments. Each subject had three practice sessions and a retention test twenty-eight days following their third practice. All subjects had a period of instruction prior to the first practice. Subjects in Group A practiced thirty continuous trials in each session and in the retention test. Subjects in Group B practiced thirty trials with a three-minute rest interval after the tenth and twentieth trials for all three practice sessions and for the retention test. Each trial for both groups consisted of starting behind a line twenty-four feet from the target, running forward, and throwing the ball at a swinging target before crossing a restraining line twelve feet from the target.

Repeated Measures Analysis of Variance was used to examine the scores within each of the two groups in order to determine whether there were changes over the three practice sessions. The Fisher's "t" Test of Significance of Differences Between Correlated Means was used to determine whether there were any changes that occurred during the period of no practice. Comparisons between Groups A and B on the three practice sessions and on the retention test were made with the Fisher's "t" Test of Significance of Differences Between Uncorrelated Means.

## Summary of Results

The results of the experiment were as follows:

1. There were no significant differences within Group A over the three practice sessions.

2. There were no significant differences within Group B over the three practice sessions.

3. There was no significant difference between the scores of the third practice and those of the retention test for either Group A or Group B.

4. There were no significant differences between Groups A and B on any two of the three practice sessions or on the retention test.

## Conclusions

The lack of significant differences in the scores of subjects from Group A and from Group B from one practice to the next indicates that no learning occurred as a result of the practice. Any apparent differences were considered due to the large amount of variation in the individual scores and not to the practice conditions. The two practice

conditions caused no differences between the two groups nor did the conditions appear to cause any significant change in the ability of subjects to perform the skill.

The fact that no learning occurred could possibly be attributed to one of two factors. One was possibly the lack of enough instruction and preliminary practice to provide a foundation upon which the subjects could build during the practice sessions. The second may have been the fact that the subjects did not have instruction include the use of the target. Subjects may have needed more time to become familiar with the equipment and scoring device by having additional practice. They may also have needed more time to try to find and establish the correct way to perform the skill while eliminating incorrect performances.

Implications for Further Research

In planning further study in the area of practice distribution using the skill of throwing a ball at a swinging target with a lacrosse stick, more time should be allotted for practice and instruction. Longer practice periods should be attempted and a greater number of practice sessions should be tried. It might also be advantageous to increase the amount of initial instruction. A longer period of time to try the skill with the instructor providing corrections for incorrect performances may be useful. In this study, subjects did not see the target until the first practice nor were they told what type of target would be used in the experiment. In another study using the target as a scoring device, it may be more advisable to allow subjects to have instruction in aiming at the target and then to practice with corrections from the instructor during the initial instruction period.

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Appendix A

PRACTICE AREA AND TARGET

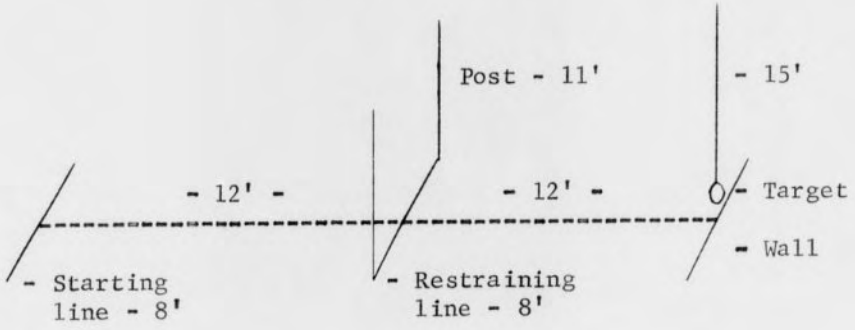


Figure 1

FLOOR DIAGRAM

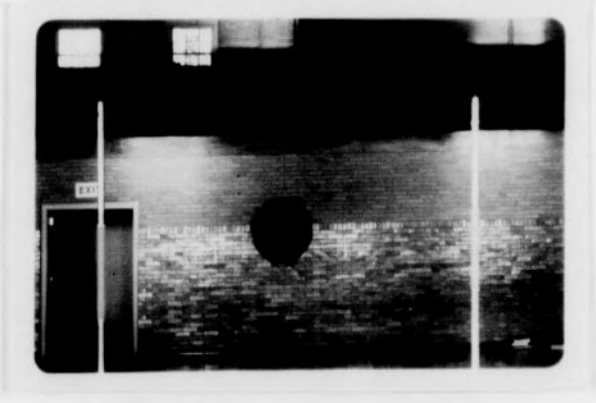

Figure 2

TARGET AND RESTRAINING POSTS

Figure 3

TARGET

Figure 4

RESTRAINING ROD

Appendix B

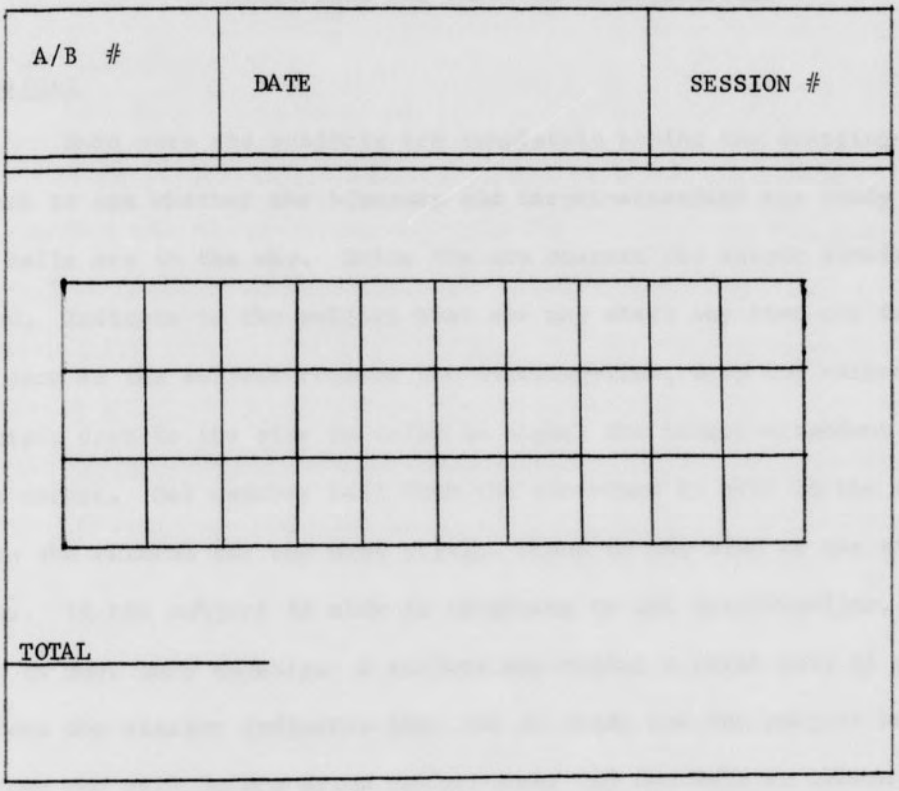


Figure 5

SAMPLE SCORE CARD

## Appendix C

## DIRECTIONS FOR PRACTICE ADMINISTRATORS

### Starters

Make sure the subjects are completely behind the starting-line. Check to see whether the linesman and target-attendant are ready and that no balls are in the way. Raise the arm nearest the target straight overhead. Indicate to the subject that she may start any time she is ready. As soon as the subject crosses the starting-line, drop the raised arm sharply down to the side in order to signal the target-attendant to start the target. Get another ball from the container to give to the subject when she returns for the next trial. Stand to the side of the starting-line. If the subject is slow in returning to the starting-line, encourage her to move more quickly. A subject may repeat a trial only if she starts before the starter indicates that she is ready and the subject has not thrown the ball before being called back. If the ball is thrown, then the trial counts. No comments should be made to the subjects about the performance, but clarifications of procedure are in order.

### Linesman

The linesman may act as the scorer, also.

Stand beside the restraining-line so that the line may be seen without being obstructed by the post. Make sure that there are no balls in the way of the subject. Send balls back to the starter while the

subject is returning to the starting area. Give all other balls to the ball retrievers. If the subject steps on or over the restraining-line before releasing the ball, call "fault" in a loud voice. The subject is allowed to cross the line after the release of the ball.

Target Attendant

The target attendant may also act as the scorer.

Before the subject starts, raise the target up to the side until it touches the restraining-rod. (See Fig. 4, Appendix A) When the starter signals by dropping her arm to her side, release the target so that it will swing. (Do not push it.) As the subject returns to the starting area, raise the target to the other side. Make sure that the target is raised to alternate sides for each trial. Be sure to stay alert and watch the ball at all times; it is possible to be hit.

Scorer

The linesman or target attendant may act as the scorer. It may be easier for the linesman to do so as she has fewer duties.

The scorer should have a clipboard and two pencils. Collect the score sheet from each subject. (Subjects from Group B should have a crossword puzzle attached to their sheet.) Each of the trials has a box to be marked with 1 or 0 for a hit or a miss. (See Fig. 5, Appendix B) Put one (1) in the box when any part of the wood on the target is hit and there are no faults. If the target is missed or there is a fault, place a zero (0) in the box. At the end of thirty trials, record the total number of hits in the space provided in the lower left corner of the score sheet.

Subjects in Group A will perform thirty continuous trials. The subjects in Group B will perform thirty trials with rest periods after the tenth and twentieth trials. For subjects in Group B, call out "ten!" after the tenth trial and "twenty!" after the twentieth trial. Return the score sheet and puzzle to the subject. Collect the score sheet and attached puzzle from the next subject from Group B and repeat the same procedure. Both subjects should perform three ten-trial segments, alternating after each ten trials. At the end of thirty trials, return the score sheets and puzzles to the subjects and remind them to give these sheets to the supervisor.

Ball Retriever/s

Collect balls, making sure to stay out of the subjects' way. Return the balls to the container provided near the starting area.

Supervisor

The investigator acted as the supervisor.

Hand out score sheet to the subjects as they arrive and collect them when they leave. Make sure that subjects who are not practicing do not watch those who are. Be ready to assist other test administrators. Make sure that subjects from Group B rotate after each ten trials. See that the subject who is resting is working on the puzzle. Time the rest intervals with a stopwatch. The interval is three minutes. At the end of two minutes and forty-five seconds, have the subjects stop work on the puzzles and return to the practice area.

General Directions

No comments are to be made to the subjects about their performances. Clarifications of procedure are the only communications allowed other than encouragement of more speed in slow subjects. Refer all questions to the supervisor. Sign for the time period desired. You will work in the same time period for each session.

Appendix D

RAW SCORES - GROUP A

| Ss # | First Practice | Second Practice | Third Practice | Retention Test |
|---|---|---|---|---|
| 1 | 5 | 16 | 14 | 8 |
| 2 | 1 | 3 | 2 | 3 |
| 3 | 6 | 4 | 8 | 4 |
| 4 | 6 | 1 | 5 | 7 |
| 5 | 8 | 11 | 3 | 6 |
| 6 | 10 | 11 | 7 | 6 |
| 7 | 9 | 8 | 9 | 7 |
| 8 | 7 | 5 | 6 | 6 |
| 9 | 5 | 5 | 4 | 5 |
| 10 | 17 | 14 | 12 | 16 |
| 11 | 7 | 8 | 6 | 9 |
| 12 | 1 | 4 | 3 | 11 |
| 13 | 4 | 12 | 14 | 5 |
| 14 | 6 | 11 | 9 | 10 |
| 15 | 13 | 16 | 13 | 14 |
| 16 | 9 | 9 | 14 | 12 |
| 17 | 3 | 8 | 5 | 3 |
| 18 | 6 | 8 | 8 | - * |
| 19 | 10 | 10 | 13 | 7 |
| 20 | 1 | 1 | 2 | 4 |
| 21 | 5 | 8 | 6 | 5 |
| 22 | 6 | 12 | 15 | 6 |
| 23 | 12 | 5 | 9 | 4 |
| 24 | 13 | 12 | 14 | 14 |
| 25 | 3 | 1 | 2 | 5 |
| M | 6.92 | 8.12 | 8.12 | 7.375 |

* Ss # 18 did not take the retention test.

RAW SCORES - GROUP B

| Ss # | First Practice | Second Practice | Third Practice | Retention Test |
|---|---|---|---|---|
| 1 | 6 | 15 | 14 | 20 |
| 2 | 6 | 8 | 4 | 8 |
| 3 | 6 | 9 | 9 | 12 |
| 4 | 17 | 11 | 13 | 7 |
| 5 | 8 | 3 | 14 | 13 |
| 6 | 7 | 14 | 11 | 6 |
| 7 | 12 | 19 | 15 | 20 |
| 8 | 9 | 11 | 19 | 19 |
| 9 | 4 | 3 | 9 | 7 |
| 10 | 4 | 3 | 4 | 1 |
| 11 | 3 | 4 | 6 | 9 |
| 12 | 10 | 5 | 8 | 8 |
| 13 | 2 | 3 | 5 | 1 |
| 14 | 5 | 6 | 4 | 4 |
| 15 | 8 | 12 | 10 | 12 |
| 16 | 10 | 6 | 15 | 6 |
| 17 | 5 | 9 | 10 | 7 |
| 18 | 8 | 7 | 8 | 11 |
| 19 | 3 | 0 | 4 | - * |
| 20 | 8 | 6 | 13 | 17 |
| 21 | 4 | 2 | 6 | 7 |
| 22 | 2 | 9 | 7 | 12 |
| 23 | 4 | 7 | 13 | 5 |
| 24 | 5 | 8 | 12 | 6 |
| 25 | 2 | 3 | 8 | 8 |
| M | 6.32 | 7.32 | 9.64 | 9.42 |

* Ss # 19 did not take the retention test.