EFFECTS OF MASSED AND DISTRIBUTED PRACTICE
UPON MOTOR LEARNING AND RETENTION
OF A NOVEL CROSS MOTOR TASK

APPROVED:

Graduate Committee:

[Signatures]

Major Professor
[Signature]

Minor Professor
[Signature]

Committee Member
[Signature]

Committee Member
[Signature]

Dean of the College of Education
[Signature]

Dean of the Graduate School
[Signature]

The problem of this study is to investigate the effects of massed and distributed practice conditions upon the learning and retention of a novel gross motor task. The task was a soccer dribble around three evenly spaced standards. It was practiced and learned within a three-week period during the spring semester of 1971 at North Texas State University. There was a total of 101 freshman and sophomore male students who volunteered as participants in the study.

The participants were randomly assigned to one of four practice groups after each received a pre-test which consisted of three trials of the soccer dribble task. These four practice groups and their practice conditions were as follows: (1) the No Practice Group (NP), consisting of twenty-six subjects who received no practice on the soccer task; (2) the Massed Practice Group (MP), consisting of twenty-five subjects who received seventy-two concentrated practice trials of the soccer task totaling twenty-four trials per subject on three consecutive days; (3) the Distributed Practice Group (D20), consisting of twenty-four subjects who received
seventy-two spaced practice trials of the soccer task totaling twelve trials per subject on six practice days with a twenty-second rest interval after each trial; (4) the Distributed Practice Group (D5), consisting of twenty-six subjects who received a five-minute rest interval after six of twelve practice trials of the soccer task during each of six spaced practice sessions totaling seventy-two trials.

During a two-month experimental period a post-test and a retention test were administered to each subject in addition to the pre-test. Each of these tests also consisted of three trials of the soccer task for each participant. The effects of the four practice conditions during the first month, which was considered the learning phase, were investigated by comparison of each group's (NP, MP, D20, D5) pre-test and post-test mean score on the soccer task, utilizing the analysis of covariance statistical technique. At the end of the second month, which was considered the retention phase, statistical comparisons of post-test and retention test scores were made by also using analysis of covariance. The .05 level of confidence was established for each statistic.

The mean gains during the learning phase comparisons indicated that the two distributed practice groups (D20 and D5) exceeded the massed group (MP) and the control group (NP).
However, during the retention phase comparison of test scores, the mean gains of subjects in the massed group were greater than those of both the distributed practice groups and the control group. A performance curve was charted for each experimental group at the end of their practice to indicate the progress they made while learning the soccer task. The performance curves disclosed consistent amounts of improvement for the D20 and D5 practice groups with the D5 group showing the greatest improvement during their three-week practice period. Although the massed group (MP) decreased in performance on the second of three days of concentrated practice, the participants had a steady rate of improvement on the final practice day. Their overall performance, however, was bettered by both distributed practice groups.

One of the recommendations for future study in this area of motor learning is that research be conducted using different gross motor activities to further the understanding of the learning process utilizing particularly elementary and junior high school students.
EFFECTS OF MASSED AND DISTRIBUTED PRACTICE
UPON MOTOR LEARNING AND RETENTION
OF A NOVEL GROSS MOTOR TASK

DISSERTATION

Presented to the Graduate Council of the
North Texas State University in Partial
Fulfillment of the Requirements

For the Degree of

DOCTOR OF EDUCATION

By

Thomas R. Murphree, B. S., M. S. E.
Denton, Texas
August, 1971
# TABLE OF CONTENTS

| LIST OF TABLES | v |
| LIST OF ILLUSTRATIONS | vi |

## I. INTRODUCTION
- Statement of the Problem
- Purposes of the Study
- Hypotheses
- Background and Significance of the Study
- Definition of Terms
- Limitations
- Basic Assumptions
- Procedures for Collection of Data
- Treatment of Data
- Chapter Bibliography

## II. REVIEW OF THE LITERATURE

Chapter Bibliography

## III. PROCEDURES OF THE STUDY
- Selection of the Subjects
- Testing of the Subjects
- Experimental Facility and Equipment
- Description and Administration of the Gross Motor Task
- Equating of Practice Groups
- Practice Procedures of Each Practice Group
- Chapter Bibliography

## IV. PRESENTATION AND ANALYSIS OF THE DATA
- Practice Data Collected from Experimental Groups
- Treatment of Test Data
- Results of the Test Data
- Additional Results of Practice Data
- Chapter Bibliography
<table>
<thead>
<tr>
<th>Chapter</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>V. SUMMARY, FINDINGS, CONCLUSIONS, AND RECOMMENDATIONS</td>
<td>77</td>
</tr>
<tr>
<td>Summary</td>
<td></td>
</tr>
<tr>
<td>Findings</td>
<td></td>
</tr>
<tr>
<td>Conclusions</td>
<td></td>
</tr>
<tr>
<td>Recommendations</td>
<td></td>
</tr>
<tr>
<td>APPENDIX</td>
<td>85</td>
</tr>
<tr>
<td>BIBLIOGRAPHY</td>
<td>92</td>
</tr>
</tbody>
</table>
LIST OF TABLES

<table>
<thead>
<tr>
<th>Table</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>I. Composition of Practice Groups and Best Pre-Test Score for Each Subject</td>
<td>51</td>
</tr>
<tr>
<td>II. Best Score Means of the Pre-Test for the Four Practice Groups</td>
<td>52</td>
</tr>
<tr>
<td>III. t-Test for the Significance of the Difference Between the Means of Pre-Test and Post-Test for the No Practice Group</td>
<td>59</td>
</tr>
<tr>
<td>IV. Means of Pre-Test and Post-Test Scores and Gains of Each Practice Group</td>
<td>60</td>
</tr>
<tr>
<td>V. Summary of Analysis of Covariance of the Pre-Test to Post-Test Gain Scores of All Practice Groups</td>
<td>61</td>
</tr>
<tr>
<td>VI. Tukey's Test for the Significance of Difference Between the Adjusted Means of the Pre-Test and Post-Test for All Practice Groups</td>
<td>62</td>
</tr>
<tr>
<td>VII. t-Test for the Significance of the Difference Between the Means of the Post-Test and Retention Test for the No Practice Group</td>
<td>65</td>
</tr>
<tr>
<td>VIII. Means of Post-Test and Retention Test Scores and Gain of Each Practice Group</td>
<td>66</td>
</tr>
<tr>
<td>IX. Summary of Analysis of Covariance of the Post-Test to Retention Test Gain Scores of All Practice Groups</td>
<td>67</td>
</tr>
<tr>
<td>X. Tukey's Test for the Significance of the Difference Between the Adjusted Means of the Post-Test and Retention Test for All Practice Groups</td>
<td>68</td>
</tr>
<tr>
<td>XI. Mean Scores and Standard Deviations for Each Practice Group after Each Twelve Trials During Practice Sessions</td>
<td>71</td>
</tr>
</tbody>
</table>
**LIST OF ILLUSTRATIONS**

<table>
<thead>
<tr>
<th>Figure</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Performance Curve for the Massed Practice Group on the Soccer Dribble Task</td>
<td>73</td>
</tr>
<tr>
<td>2.</td>
<td>Performance Curve for the Distributed (D20) Practice Group on the Soccer Dribble Task</td>
<td>74</td>
</tr>
<tr>
<td>3.</td>
<td>Performance Curve for the Distributed (D5) Practice Group on the Soccer Dribble Task</td>
<td>75</td>
</tr>
</tbody>
</table>
CHAPTER I

INTRODUCTION

Physical educators and coaches maintain that an individual must practice in order to learn and adequately perform a motor skill. Moreover, it is felt that practice is an important aspect to consider in any skill acquisition (3, 10, 15).

Singer states:

There is more to learning than mere practice, for practice alone does not make perfect. Practice must be accompanied by such conditions as the performer being aware of his direction or goal, and, in general, by motivation or the desire to improve (19, p. 166).

Knapp and Dixon (8) think that other factors must be considered if the performer is to benefit from practice. These are: (1) duration of the practice sessions; (2) length of the rest period between the practice sessions; (3) practice method; (4) speed of movement; (5) characteristics of the learner; (6) activity of the learner during the time between practice periods; and (7) the complexity of the skill.

Usually there are many skills to be learned within a physical education or athletic activity. Therefore, the maximum utilization of time during practice sessions is of paramount importance for physical educators and coaches.
However, several questions relating to practice continue to be of interest to them. These are: When a student or player is given a certain amount of time to acquire a skill, how should the time be distributed during a practice session? Is it best to have long or short practices and short or long rest periods? Also, as a result of these different distributions of practice and rest, how is retention of a skill affected? An attempt was made to answer particularly these questions during the course of this study.

Statement of the Problem

The problem of this study was to investigate the effects of massed and distributed practice upon the learning and retention of a novel gross motor task. The motor task was a soccer dribble around three evenly-spaced standards.

Purposes of the Study

The following purposes were formulated to further clarify the study

1. To gain further information concerning the effects of massed practice and distributed practice upon motor learning and retention while utilizing a novel soccer task.

Altogether, four different practice conditions were included in the study. These were: (1) no practice; (2) distributed practice with a twenty second rest after each task trail;
(3) distributed practice with a five minute rest after half of the task trials during each practice session; and (4) massed practice.

2. To analyze the data of the study and interpret the findings for teachers of physical education, coaches, and others who are interested in maximum utilization of time for practice sessions of their particular activity.

Hypotheses

To carry out the purposes of this study, the following hypotheses were formulated:

1. There will be no significant differences in the results of the No Practice Group on the pre-test and post-test performances of the soccer dribble.

2. There will be no significant differences in the soccer dribble mean gain performance of the Distributed Practice (five minute rest) Group and the Distributed Practice (twenty second rest) Group.

3. The Distributed Practice (five minute rest) Group will show a significantly greater soccer dribble mean gain in performance than will
   (a) the No Practice Group
   (b) the Massed Practice Group

4. The Distributed Practice (twenty second rest) Group will show a significantly greater soccer dribble mean gain in performance than will
(a) the No Practice Group
(b) the Massed Practice Group

5. The Massed Practice Group will show a significantly greater soccer dribble mean gain in performance than will the No Practice Group.

6. There will be no significant difference in the results of the No Practice Group on the retention test and post-test performances of the soccer dribble.

7. There will be no significant differences in the retention scores on the soccer dribble between the Distributed Practice (five minute rest) Group and the Distributed Practice (twenty second rest) Group.

8. There will be no significant difference in the retention scores on the soccer dribble between the Massed Practice Group and the

   (a) Distributed Practice (five minute rest) Group
   (b) Distributed Practice (twenty second rest) Group

9. The (a) Distributed Practice (five minute rest) Group, (b) Distributed Practice (twenty second rest) Group, and (c) Massed Practice Group will show a significantly greater retention score on the soccer dribble than will the No Practice Group.
Background and Significance of the Study

A survey of the related studies indicates that significant research has been done in the area of massed and distributed practice. Studies of this nature were conducted as early as 1885 (6), but through the years most of them have emphasized fine motor learning through experiments with the pursuit rotor, mirror-tracing, and stylus maze. Very little work has been done which emphasizes learning and retention of gross motor skills by using massed and distributed practice conditions (19).

Mohr (13) reports that in the psychological field, forty-five studies were related to massed and distributed practice. Most of these studies indicated that a type of distributed practice is more advantageous than massed practice. Singer (19) notes, however, that additional study is needed to further the understanding of psychological generalizations as they apply to the learning of gross motor skills.

Some significant investigations of recent years have been done by physical educators relating to gross motor skills. A summary of the studies is as follows:

A study by Neimeyer (14), who compared massed and distributed practice in volleyball and badminton skills, disclosed that distributed practice was superior to massed practice in the performance of early learning trials in badminton, but in later learning, practice distribution
appeared to have no effect. Performances during the late learning period in volleyball indicated, however, that massed practice was significantly better. It was concluded that beginners learning a gross motor skill might benefit most with short but frequent practice periods. Also, practice periods may be lengthened and may be less frequent after some proficiency is achieved.

An earlier study by Young (22) compared the effectiveness of learning between two distributions of practice in archery and badminton classes. Practice performances for four days per week were compared with the two days per week for a total of nineteen meetings in archery and sixteen meetings in badminton. The results revealed that more effective learning in archery took place under massed practice, while in badminton more rapid learning was produced by wider distributions or practice.

In a more recent investigation of the effects of massed and distributed practice, Stellmach (20) had four groups of forty subjects per group utilize the stabilometer and a ladder climb. Two groups practiced each skill for eleven minutes under different distributions of practice and rest. Results of this study indicated that the amount of learning was the same regardless of the type of practice.
Knapp, Dixon, and Lazier (9) repeated a juggling experiment that Knapp and Dixon (8) had conducted with two groups of thirty-five subjects in each group. The initial experiment showed that the five minute per day practice group learned the skill in less practice time than the fifteen minute every-other-day group. However, the latter group acquired the skill in fewer practice periods. The repeated experiment also disclosed that the five minutes per day group learned to juggle significantly faster than the more concentrated fifteen minute group.

Although other studies by Massey (11) and Webster (21) favored distributed practice over massed practice, Harmon and Oxendine (7) and Scott (17) found conflicting evidence as to which produced most effective acquisition or skills. Mohr concludes, "... that the evidence is far too scanty to uphold the supposition that distributed practice will result in more effective learning than will massed practice" (13, p. 350).

Relatively few investigations have been carried out to determine retention of gross motor skills which utilized massed or distributed practice methods, but Purdy and Lockhart (16) studied retention and relearning of five novel gross motor skills after a period of no practice. Although the distributions of practice were not of concern in this
undertaking, they found that there were significant differences among those classified as high, average, and low skill groups in learning, retention, and relearning. They further mentioned that only one study was found to substantiate the general agreement of other authors that gross motor skills once learned are retained to a great degree, even after long periods of time.

A novel basketball task of bouncing the ball from the free throw line into the basket was utilized by Singer (18) to study the effects of massed and distributed practice upon skill acquisition and retention. Three groups of forty male college students in each group practiced under different conditions. Group A continuously practiced the basketball task for eighty trials. Group B had distributed practice with five minute rests after each twenty shots up to eighty trials. A twenty-four-hour rest interval was given Group C between each set of twenty shots. The findings showed that Group C performed significantly better than the other two groups. One month later in testing for retention of the task, the massed group (Group A) and the distributed group (Group B) subjects had better performances than the remaining group (Group C).

Cratty (3), Lawther (10), and Singer (19) call for more research in this area involving gross motor skills. It is
maintained that the question of whether massed or distributed practice is most productive for learning remains largely unanswered. Furthermore, Cratty suggests the following role for physical educators in their research on motor learning:

Concern should be directed toward the rather permanent change of movement behavior brought about through practice, "motor learning." Interest should be generated in variations of practice and the influence of various factors upon learning proficiency (3, p. 9).

It is hoped that this study will further the research in this area of motor learning and significantly contribute toward answering some of the questions that physical educators and coaches have in regards to massed and distributed practice.

**Definition of Terms**

**Distributed Practice** is theoretically defined as a series of spaced practices that includes several areas of practice during each session (5). Operationally, distributed practice in this study was practice of a soccer dribble under varying rest intervals during a three week period.

**Gross Motor Task** is theoretically defined as a task involving movement of large muscle groups resulting in the movement of the whole body (3). Operationally, the gross motor task in this study was a soccer dribble which was a novel or unique learning task for each subject.

**Massed Practice** is theoretically defined as concentrated practice over a period of time in a specific area (5).
Operationally, massed practice in this study was practice of a soccer dribble during three consecutive days.

Motor Learning is theoretically defined as a change in motor performance brought about through practice (3). Operationally, motor learning in this study was the acquisition of the soccer skill as determined by gains in performance from pre-test to post-test.

Retention is theoretically defined as the level of performance following extended periods of no practice (1). Operationally, retention in this study was determined one month after the post-test of each practice group.

Limitations

This study was limited to freshmen and sophomore male students enrolled in various sections of the required physical education activity program at North Texas State University during the 1971 Spring semester. This study was further limited to those students who indicated no previous soccer or speedball experience.

Basic Assumptions

It was assumed that the subjects who participated in this experiment would cooperate and provide an honest effort during the practice trials of the gross motor task and did not practice the task other than at the specified time of their assigned group.
Selection and Description of the Gross Motor Task

Clarke and Clarke (2) emphasize that the usual sports and games so commonly taught in activity classes are poor as learning modalities in research and, therefore, recommend a novel task. A novel task will afford greater internal validity in an investigation since it is new to the subject and has not been practiced before (1).

The gross motor task that was utilized for this study, a soccer dribble, was considered as novel or unique since the subjects who were selected had not been previously exposed to it. A soccer dribble, according to Means and Jack (12), is a series of short, controlled kicks made by a player (subject) who is advancing the ball. The kicks are generally accomplished with either the inside or the outside of the foot. In the study, the complete task consisted of each subject maneuvering a soccer ball from a starting point around three standards that were spaced eight feet apart in a straight line. It was considered as a complex task since the subject had to rely on several different abilities while performing it. For instance, speed, balance, and eye-foot coordination are but a few of these abilities. Means and Jack (12) also state that the value of the soccer dribble is particularly unique in its development of agility and dexterity of the legs and feet.
The following items of equipment were used in the administration of the gross motor task to each subject:
(1) a soccer ball; (2) three wire baskets; (3) a stop watch; (4) a Personal Information/Scorecard per subject (Appendix A).

Procedures for Collection of Data

One hundred and one subjects participated in the study. The subjects were volunteers who were selected from various sections of Physical Education 116 classes. Each subject was given a pre-test, consisting of three trials of the gross motor task, which also served as an equating test. Upon completion of the pre-test each subject was then assigned to one of four practice groups on the basis of the best performance score of the three trials.

The four groups and practice conditions of each group were specified as follows: (1) The control group, which was called the No Practice Group (NP), received (a) a pre-test; (b) no practice for three weeks; (c) a post-test; and (d) a retention test.* (2) The Massed Practice Group (MP) received (a) a pre-test; (b) practice for three consecutive days which included twenty-four task trials on each practice day; (c) a post-test; and (d) a retention test. (3) The Distributed

*The retention test for each practice group was given one month after completion of the post-test.
Practice (twenty second rest) Group (D20) received (a) a pre-test; (b) practice for three weeks which included twelve task trials on each practice day with a twenty second rest interval after each trial; (c) a post-test; and (d) a retention test.

The method of assignment of all subjects to a practice group was accomplished by a rotating and reversing procedure. Although a more detailed description of the procedure is presented in Chapter III, a brief summary of the method is as follows:

Each subject was given a number and was assigned to one of four practice groups (NP, MP, D20, D5) according to his best performance score on the pre-test trials. The subject who made the lowest time was considered to have made the best performance score on the soccer task. The subject who made the highest time was considered to have made the worst performance score on the task. Therefore, in the assignment of subjects to practice groups, the scores ranged from the lowest to the highest made on the task. Subject number one who made the best performance score was assigned to the NP group; subject number two who made the next best performance score was assigned to the MP Group; subject number three—to the D20 Group; and subject number four to the D5 Group. Since there were only four groups the procedure now reversed,
and subject number five was assigned to the D5 Group; subject number six—to the D20 Group; subject number seven—to the MP Group; and subject number eight—to the NP Group. This rotating and reversing procedure after each series of four assignments was followed until all subjects were placed in a practice group. The procedure was utilized in order to equalize each group prior to their specified practice sessions.

The scores that each subject made on all test trials and practice trials of the soccer dribble task were recorded on a Personal Information/Scorecard (Appendix A).

Treatment of Data

A t-test for related samples was used to test hypotheses one and six.

An analysis of covariance was used to test hypotheses two, three, four, and five. In these hypotheses the co-variables were the pre-test scores, while the criterion variables were the post-test scores.

An analysis of covariance was also used to test hypotheses seven, eight, and nine. In these hypotheses the covariables were the post-test scores, while the criterion variables were the retention scores.

All nine hypotheses were tested at the .05 level of significance.
The findings of the investigation are reported in appropriate tables and graphs in Chapter IV.
BIBLIOGRAPHY


CHAPTER II

REVIEW OF THE LITERATURE

The major purpose of the present study was to investigate the effects of massed and distributed practice conditions upon the learning and retention of a gross motor skill. As previously stated in Chapter I, a gross motor skill involves movement of the large muscles of the human body. Physical educators who have employed this type of skill learning in their research utilized such gross motor activities as archery, bowling, badminton, swimming, volleyball, and ladder climbing. The review of the literature reveals that research in the area of massed and distributed practice has dealt primarily with learning of fine motor skills. Such skills are usually precision-oriented ones which involve eye-hand coordination. In an attempt to determine both learning and retention, many of the psychological studies surveyed in this chapter included such fine motor tasks as line drawing, various maze tasks, mirror tracing, the pursuit rotor, and other instruments which involved eye-hand coordination. A description of these tasks is included within the review.
The studies, primarily arranged in a chronological format, emphasize pertinent research concerned with verbal learning, the numerous psychological experiments related to fine motor skill learning, and a small but growing number of investigations pertaining to gross motor learning. The majority of them have utilized massed and distributed practice conditions.

One of the first studies that used varying distributions of practice and rest was conducted in 1885 by Ebbinghaus (20). He used only himself in the investigation in an attempt to determine the effects of rest periods between practices which dealt with verbal learning. Ebbinghaus concluded that the learning and retention of meaningful poetry and nonsense syllables was better when the rest periods were interpolated between practices. Despite the limitations of this study, it served as a stimulus for further research of the learning process using massed and distributed practice conditions.

In an early study by Swift (55), typewriting was learned within a fifty-day period in which he used himself as the only subject. Although massed and distributed practice conditions were not specified in this experiment, he demonstrated the long-term permanence of motor skills. The researcher waited two years before practicing the typewriting skill again, and within eleven days regained the proficiency
he had acquired at the conclusion of the initial fifty-day learning period.

In another investigation by Swift (56), in 1906, ball juggling was practiced by two subjects to determine amounts of learning and retention. The task involved the juggling of two balls with one hand. After the last practice period Swift waited almost two years before administering a retention test to each subject. The test disclosed that both subjects performed better than after the original practice period.

Pyle (47) was concerned with the learning of typewriting skill in another early study using massed and distributed practice conditions. Two groups of ten subjects per group practiced a schedule of forty-five hours. One group practiced for two thirty-minute periods for forty-five days. The other group practiced ten thirty-minute periods for nine consecutive days with a thirty-minute rest between each practice period. The investigation revealed that the distributed practice group was superior to the massed practice group.

One of the first investigations that explored the learning of a gross motor skill was conducted by Lashley (35) in 1915. His experiment, which pertained to the acquisition of skill in archery, included five practice groups that totaled twenty-six subjects. Lashley indicated that improvement
occurred during the early learning of the skill regardless of the distribution of time. However, distribution of practice was found to be more effective during the latter stages of learning the archery shooting.

A different sport skill, javelin throwing, was used by Murphy (39) a year after Lashley (35) conducted his research. Murphy found that ten subjects practicing the javelin throw three days a week attained the skill better than the same number of subjects practicing five days a week.

Much of the research in the area of massed and distributed practice has been done by experimenters who utilized various types of mazes to study the learning process. In 1919, Carr (12) had ten subjects per group learn a pencil maze within a twenty-trial limit. One of the groups received ten consecutive trials on the first day, then one trial per day for ten days. The other group reversed the process and received one trial per day for ten days, then ten consecutive trials on the eleventh day. At the completion of the investigation similar findings were noted by Carr on the performance of each group.

Pechstein (45) and Cook (14) utilized different rat mazes to study learning under massed and distributed practice conditions. Pechstein (45) concluded that difficult motor problems are learned best under massed practice.
Cook's (14) study revealed opposite findings in that distributed practice was better if the maze was difficult, while massed practice was considered the best to use if the maze was simple to perform.

As it has previously been stated, fine motor skills have received the major emphasis by investigators who have studied massed and distributed practice effects upon learning. Variations of the stabilimeter, a mirror tracing apparatus developed by Snoddy (53), and the pursuit rotor, a target tracking device developed by Koerth (34), have been used in many of the fine motor studies. In mirror tracing, a star or some other pattern is placed before the subject in such a way that it can only be seen in a mirror reflection. The subject is then instructed to trace the reflected pattern. His performance is measured in terms of time and errors (7).

Bell described the pursuit rotor tracking task as follows:

A round disk with a small metal target revolves. The target is wired as is the stylus which the subject holds in his hand. The objective is to keep the stylus in contact with the target. When contact is maintained, a circuit is completed and the time on target is recorded on an electrical clock (7, p. 32).

Both of these devices presented a new learning experience for subjects, and have been used to measure the improvement which the subjects attained.
In 1930, Lorge (36) conducted research with nonsense syllables, code work, mirror tracing, and mirror drawing while concerned with both verbal and motor learning. Results of his investigation disclosed that learning under conditions of distribution with a twenty-four hour interval was more effective for each learning activity.

Snoddy (53), as a result of his extensive work with the stabilimeter, advocated the distribution of practice early in the learning process and favored massing of practice in the latter stages of learning. He reached this conclusion after suggesting two opposing processes pertaining to mental growth, which he labeled "primary" and "secondary" growth. He felt that primary growth occurred early in learning, while secondary growth appeared later in the stages of learning and exhibited unstable qualities. Evidence to support Snoddy's concept of primary and secondary growth was demonstrated in studies by Travis (57) and Humphreys (29). In the latter study (29), it was noted that during the early periods of pursuit rotor learning, greater amounts of growth occurred between practices than during practice. The latter stages of learning revealed that a greater growth occurred during the practice period.

Dore and Hilgard (17) also used the pursuit rotor in their research but disagreed with Snoddy (53) by indicating
that the improvement that occurred between practices was not necessarily due to growth, but rather to the stimulation that occurred during the practice periods. They concluded that distribution of practice throughout the learning process was better than the more concentrated practices. In a study by Tsoa (60) a mirror drawing task was performed by subjects. The findings of this experiment did not substantiate Snoddy's (53) theory of primary and secondary growth either, as Tsoa's research showed early massing and later distributing to be most effective.

During this period of the 1930's Travis (57, 58, 59) conducted extensive work with a modified pursuit rotor. In one of the studies by Travis (57) four subjects alternated under massed and distributed practice conditions every other day. He found that rest intervals of one minute between work periods of two minutes resulted in a consistent rise in the learning curve, while continuous practice without rest for the same length of time disclosed a consistent decrease in learning efficiency. Similar results were evidenced in other studies by Travis (58, 59) while using a modified pursuit oscillator in 1939.

Although very few of the early studies which concerned massed and distributed practice included retention of skills, some significant research by Cain and Willey (10),
Newman (41), and Hovland (27) was conducted during the latter years of the 1930's. Cain and Willey (10) studied retention of nonsense syllables with two groups after learning had occurred under massed and distributed conditions. One group of subjects learned the nonsense syllables during a three day period while the other group learned the list of syllables in one period. Both groups were later subdivided and tested one day, three days, and seven days after the completion of practice. On all three testing days, the distributed practice groups had the better results. Newman (41) also used two groups of subjects to learn nonsense syllables in his experiment. A single list was presented to one group while triple lists of nonsense syllables were given to the other group. The group that had learned only one list continually decreased in retention as they recalled 65 per cent of the list after the first hour and 50 per cent after 48 hours. An increase in retention occurred within the group that had learned three lists of nonsense syllables, as they recalled 30 per cent of the lists after the first hour and 40 per cent, 48 hours later. Nonsense syllables were used by Hovland (27) in his research with a massed and a distributed practice group. The massed group received six second rests between trials, while the distributed group was allowed two minute rest periods. The distributed practice
group proved to be the better retainers when tested after six seconds, two minutes, ten minutes, and twenty-four hours.

In 1940, Webster (62) used the gross motor activity of bowling to investigate various lengths of practice and various intervals between practice periods. He found that the group of subjects with shorter and more frequent periods of practice were more effective in learning the skill.

Erickson (21), in a study involving the learning of a fine motor skill under massed and distributed practice conditions found that the distributed practice was best in the later stages of learning, while massed practice was considered more beneficial in the beginning phases. However, Hilgard and Smith (26) obtained opposite findings, and reported the advantages of distributed practice in the early learning of a pursuit rotor task, and found that massed practice was more effective in the later stages of learning.

In 1943, Hull (28) presented his theoretical concepts of reactive inhibition and conditional inhibition. According to Hull, these two inhibitory processes occur when a subject makes repeated responses of an act. He considered reactive inhibition as temporary by nature, while conditioned inhibition is relatively permanent. Thus, Hull's theory attempts to account for the difference in performance levels under massed and distributed
practice conditions. In massed practice, reactive inhibition presumably accrues and depresses the subject's performance as he responds. The temporary inhibition supposedly dissipates during rest, thus allowing the more permanent inhibition to develop. Under distributed practice conditions, reactive inhibition will build up during practice but dissipate during each rest interval. It is claimed that Hull's theory is the most representative one of the work theories and has probably instigated most of the recent investigations in the area of massed and distributed practice (52).

During the late 1940's and early 1950's extensive research was conducted by Ammons (2, 3, 4) with the pursuit rotor in his efforts to ascertain a theory of motor learning. The results of one study (2) indicated that control over the length of the practice period was more effective than the rest period. In another study, Ammons (3) investigated the effect of intertrial rests using the pursuit rotor. The findings that are revealed agree with those obtained in a study which he conducted in 1951 (4). In the latter undertaking, he used two groups of ten college students. A massed practice group practiced thirty-six trials without a rest, while a distributed group rested five minutes between each trial. The study expressed definite advantages for the distributed practice group, as they reached a stable maximum
level of achievement compared to a slow improvement rate for the massed practice group.

The spacing of practice schedules involving the skill of billiard shooting was the primary concern of Harmon and Miller's (24) experimental research. Four different groups of women subjects were used to practice fifty shots in each of nine practice periods. They found that the practice schedules which were most effective in learning one particular shot, also proved to be best for the learning of different types of shots. Their conclusions agree with those of a similar study done by Miller (38) which disclosed that relative massing in the learning process is essential for establishing a foundation, while later distribution is preferred in the learning process of a new skill.

In 1950, Knapp and Dixon (32) were interested in testing the inference made by Travis (57) that longer work periods should be followed by longer rest periods for efficient learning to occur. The motor skill of juggling three balls was selected for two groups of college male students to practice until each subject within a group had successfully made one hundred consecutive catches. In Group I, thirty-five subjects juggled three tennis balls for five minutes each day, while thirty-one subjects in Group II practiced for fifteen minutes every second day. Knapp and Dixon concluded:
The five minute daily practice sessions facilitated more rapid learning than the fifteen minute every second day sessions; and fewer practice periods were needed to learn a motor skill when a longer work-rest distribution is used, as demonstrated by one minute of practice in Group I found to equal one minute and eighty seconds of practice in Group II (32, p. 336).

Duncan (19) conducted an experiment which included a total of 157 undergraduate women who were divided into 4 practice groups. An attempt was made to determine whether the performance superiority of subjects working on the pursuit rotor under distributed practice also represented a learning difference in a situation where the length of the experimental session was the same for all subjects. Although the distributed practice subjects had only one-third as much actual practice as the massed practice subjects, Duncan's results and conclusions indicated that superior performances and learning occurred within the distributed practice group.

Young (64), in 1954, studied the rate of learning in college archery and badminton classes by comparing two types of distributive practice. She found that a two-day-per-week practice schedule was more effective in learning badminton after twenty lessons, while a four-day-per-week practice schedule was better in acquiring archery skill after twenty lessons. Another study in 1954 was conducted by Scott (50) who compared the learning rate of beginning swimmers on a two-day, three-day, and four-day-per-week of practice.
No differences were found to exist between the groups upon the completion of the investigation.

During this period of the 1950's Archer (5) used inverted alphabet writing to determine the retention of subjects who practiced under massed and distributed conditions. The subjects in the distributed group performed better during the learning trials, but results of a retention test revealed that no significant differences existed between the massed and distributed practice groups. Oseas and Underwood (42) found that small differences were apparent in a study of geometric concept learning and retention. However, they concluded that more widely spaced practice trials were favored over the more frequently spaced practice trials.

In 1956, Bourne and Archer (9) found that temporary decrement reduces the performance and learning of a subject who practices a pursuit tracing skill. Digman (16) and Jahnke and Duncan (30) expressed similar findings while utilizing the pursuit rotor. The findings of both of these studies are in agreement with Massey's (37) conclusion, which indicated a distributed pattern of practice as more effective in the acquisition of a fine motor skill.

Knapp, Dixon, and Lazier (33) compared the results of their study in 1957 with a previous one conducted by Knapp and Dixon (32). Both studies were concerned with the effects
of practice upon the learning of a juggling skill. The former investigation included two groups of high school boys, while the latter included two groups of college men. Both age groups utilized a five minute daily practice session and a fifteen minute practice session. The comparison disclosed that no significant differences existed between the high school boys and the college men. It was noted, however, that the five minute daily practice sessions for both age groups produced more paid learning than did the fifteen minute practice sessions.

Neimeyer (40), in 1962, expressed the need in motor learning for experimentation in actual teaching situations to complement the research which had been done under the closely controlled laboratory conditions. He conducted an elaborate investigation to determine the effect of massed and distributed practice upon the learning of swimming, badminton, and volleyball using 366 college men as subjects. Neimeyer concluded:

Distributed practice of thirty minutes, three times per week was superior to massed practice of sixty minutes, twice a week in early learning of badminton, but in late learning, practice distribution appeared to have no effect. In the late learning period in volleyball, however, massed practice was significantly better. Beginners learning a large muscle activity might well have short but frequent practice periods. After some proficiency is achieved, practice periods may advantageously be longer and less frequent (40, p. 125).
Oxendine (43) in an exploration of the effect of time and practice on the learning of a mirror tracing skill utilized three groups of junior high boys. One group, consisting of forty-seven subjects, completed two circuits of the skill on each practice day. Forty-five subjects in a second group completed five circuits on each practice day. The third group, of forty-four subjects, practiced eight circuits of the task on each practice day. All groups practices two days per week for a period of five weeks. In addition, retention was determined nineteen days after the final practice. Oxendine's findings and conclusions disclosed that relatively long practice periods are desirable during the early stages of the learning process for maximum learning in the mirror tracing skill. However, the number of repetitions during each practice period should grow progressively smaller after a base has been established. In another study conducted by Oxendine (44) fifty-three male college students practices the skill of mirror tracing on three different schedules. One practice group, consisting of twenty-one subjects, practiced on a progressively increasing schedule, i.e., one circuit of practice the first day, two circuits the second day, and up to nine circuits the ninth day. A second group, consisting of sixteen subjects, practiced on a schedule in which each succeeding practice period became
shorter, i.e., nine circuits of practice the first day down to one circuit of practice on the ninth day. The third group, consisting of sixteen subjects, practiced five circuits on each day. Thus, upon the completion of nine practice days each group had practiced the same number of circuits. The researcher concluded that the group using constant units of practice performed the best, followed in order by the increasing practice group and by the decreasing practice group.

An experimental study to determine the effect of various practice patterns upon the learning of a fine motor skill and a gross motor skill was completed by Baines (6) in 1962. Fifth and sixth grade male students were divided into four groups with each group using a designated pattern of practice on two days per week for five weeks. The pattern for Group A constituted a form of the massing technique with five practice periods devoted to four units of practice per period with each skill. A form of distribution was the pattern utilized by Group B with each period devoted to two units of practice with the motor laboratory skill and the motor activity skill. Group C practiced using a decreasing pattern for the motor skill which established a form of massing in the early stages of the decreasing pattern and in the latter stages of the increasing pattern. Group D practiced
the motor laboratory skill by using an increasing pattern and practiced the motor activity using a decreasing pattern which constituted a form of massing and distribution in reverse to the pattern utilized by Group C. The results of Baines' study demonstrated that a significant amount of growth was achieved by each group. Group A (massed) and Group C (massed-distributed) were superior to Group B (distributed) and Group D (distributed-massed) in the early growth of the skills. The distributed pattern (Group B) recorded the greatest gains in achievement throughout the regular practice periods on both skills. A retention test given three weeks after the experimental period, however, revealed that no significant differences existed between the groups.

Purdy and Lockhart (46) retested thirty-six college women on retention and relearning to five novel skills which they had practiced nine to fifteen months previously. The skills included a nickel toss, ball toss, foot volley, lacrosse, and a balancing board. The investigators concluded that gross motor skills may be retained to a high degree by all levels of skill ability after extended periods of no practice, and that relearning to previous levels of proficiency can occur rapidly. On retention of stabilometer performance, which was a novel gross motor task involving the use of major muscle groups, Ryan (48) indicated that
some loss of proficiency did occur even after a three week period of no practice. However, he extended the previous investigation and concluded in another research project the following:

Although rather large losses occurred over no practice periods up to a year, the skill was quickly relearned. The subjects with longer no practice periods required more trials to regain their initial proficiency though (49, p. 51).

In 1965, Singer (51) conducted an extensive investigation to determine the effects of massed and distributed practice upon the learning and retention of a novel basketball skill. One hundred twenty subjects were divided into three groups of forty per group on the basis of the number of successful shots made in the first twenty attempts. Group A practiced the unique skill of bouncing a basketball from the free-throw line into the basket under massed conditions until eighty continuous attempts were completed. Group B attempted eighty trials of the same task but received five minute rest intervals after each twenty attempts until all trials were completed. Group C received twenty-four hours rest after each of four twenty-attempt clusters of the task, thus constituting a distributed pattern of practice. Singer concluded that the acquisition of skill, as demonstrated by an end of practice test, was favored under twenty-four hour rest intervals between trials, with a five-minute pause
only slightly more effective than continuous practice. His findings, according to the different groups, disclosed:

Group A and Group B improved on interpolated rest periods given to them, while Group C performed less well. The differences were not significant, however, between the groups. The final test of retention, which was given one month after practice, demonstrated Group C to be significantly less efficient than Group A and B, with A performing slightly better than B. Evidently, massed or relatively massed practice is more profitable in long-term retention than is widely distributed practice (52, p. 76).

Stellmach says,

Over the years many investigators have examined the effects of distributed practice versus massed practice in motor performance. Unfortunately, most of the data pertains to the pursuit rotor, which is a highly specialized task (54, p. 3081).

This observation by Stellmach (54) instigated his research involving two large muscle motor tasks. The first task consisted of the stabilometer, which required the subject to maintain the body upright while standing on a pivotal platform. The other task required the subject to maintain balance while attempting to climb as high as possible on a free-standing vertical ladder before it toppled. Two groups of forty subjects per group practiced under one of two conditions on each task. The distributed group received sixteen trials spaced with thirty second rest intervals, while the massed group received eight minutes of continuous practice without the rest intervals. Stellmach concluded:
The learning procedure was considerably more efficient under the massed conditions, since the amount of learning was substantially the same as under the distributed conditions, while the total time (actual practice plus inter-trial rest) was approximately twice as large under distributed compared with massed conditions (54, p. 3081).

Carron (13) assigned 300 male subjects to 5 equal experimental groups which differed in the amount of distribution of practice. Using a discrete-trial motor learning task, the peg turn, all subjects were given 120 practice trials on 2 days separated by a 48 hour rest. The purpose of Carron's study was to extend previous findings with respect to the practice conditions under which the phenomena of reminiscence and warm-up decrement occur. He referred to reminiscence as an increase in the level of performance of a subject following periods of no practice. He attributed warm-up decrement as the loss of the secondary responses (i.e., attitudinal and postural adjustments adopted by the subject) during rest. A secondary purpose was included to provide descriptive and evaluative statistics on a new motor learning task, since the bulk of experimental evidence supporting present theoretical concepts had been obtained almost exclusively from the pursuit rotor. Contrary to the researcher's expectation, longer rest periods did not produce greater reminiscence. He found that it varied and was dependent upon the stage of practice. It was reported as
relatively large during the learning phase, or during the early trials of the task. Reminiscence was approximately zero during the intermediate phase, but increased again in the performance phase, or during the latter trials of the task. He found that warm-up decrement occurred in the peg turn under both massed and distributed practice conditions; the longer the rest the greater the amount.

In 1970, Drowatzky (18) used thirty-one normal subjects and twenty-nine mentally retarded subjects to practice under one of three experimental conditions. He compared the effects of massed practice, distributed practice with a twenty second intertrial rest, and distributed practice with a two minute intertrial rest in an attempt to determine whether a difference existed in either the rate of buildup or the rate of dissipation of reactive inhibition. Drowatzky observed differing rates in the buildup of inhibition between normal and retarded subjects and between different practice schedules. His study supported the observation of two different classes of inhibiting factors that occurred on normal subjects under distributed practice with short intertrial rest periods as opposed to subjects under distributed practice with longer intertrial rest periods. In addition, the inhibiting factors appeared to be of temporary nature for both groups of subjects and under all practice conditions. The findings of the study
indicated a superiority of distributed practice during the acquisition of a tracking task.

A foot tracking task was employed by Whitley (63) in 1970 in a motor learning investigation involving two groups of thirty subjects in each group. After thirty-five trials of either distributed practice or massed practice, the investigator reported that learning was significant for both groups, but found no significant differences between them in the amount learned. He also acknowledged the consistent and growing amount of experimental evidence (primarily from gross motor tasks) which had emerged to raise doubts about previous assumptions and generalizations in massed and distributed learning. Whitley concluded that

... recent experiments have caused one to seriously question the traditional belief that distributed practice is significantly better than massed practice in learning motor tasks (63, p. 581).

Generally, leading physical educators have accepted the findings of the psychological studies as they apply to gross motor performance and learning (52). However, the basis for this investigation in motor learning is perhaps summed up best by Whitley:

In recent years the assumptions and generalizations upon which physical educators have based their teaching methodologies have increasingly been questioned. As a result more research has been directed toward methods of practice and the effects that different practice conditions have upon motor learning (63, p. 576).


CHAPTER III

PROCEDURES OF THE STUDY

The participants learned a novel gross motor task in order to carry out the purposes and objectives of this study. The motor learning task, a soccer dribble, was considered as novel or unique since the subjects had not been previously exposed to it. The task consisted of each subject maneuvering a soccer ball with only their feet around three standards which were spaced eight feet apart in a straight line. All subjects learned, practiced, and were tested on the task at an area outside the Men's Gymnasium at North Texas State University.

Selection of the Subjects

Each subject in the study was a male volunteer who was selected from twelve physical activity sections of the required Physical Education 116 program. Those sections which met on Monday, Wednesday, and Friday at 1:00 P.M., and those which met on Tuesday and Thursday at 11:30 A.M., 2:00 P.M., and 3:30 P.M. during the Spring semester at North Texas State University were utilized. The subjects did not have previous soccer or speedball experience.
One hundred and twenty-eight freshmen and sophomore male students volunteered as the subjects for the study. However, prior to the pre-test on February 2-3, 1971, twenty-four of the original number decided not to participate. Thus, 104 subjects ranged in ages 18 to 26, with a median age of 19, and a standard deviation of 1.91 years.

Testing of the Subjects

Each subject was required to take three tests, with each test consisting of three trials of the soccer dribble task. The three tests were as follows: (1) a pre-test, which was given on February 2-3, 1971 prior to actual practice* of the task; (2) a post-test, which was given on March 2-3, 1971 after seventy-two practice trials of the task; and (3) a retention test, which was given on April 1-2, 1971 after a month of no practice of the soccer task.

Selection of the Gross Motor Task

In selecting a novel task, Raducha states:

The task needs to be difficult enough to present an approximately normal distribution of performance scores; and difficult enough so that a subject would not reach his maximum performance in just a few trials; and yet, no so difficult that less skilled subjects would not make some progress in performance (1, p. 67).

*Each subject in each practice group (with the exception of the No Practice Group) received seventy-two practice trials of the soccer dribble task within a three week period. The subjects in the No Practice Group did not receive any practice on the task.
The soccer dribble task was one which was new to each of the subjects in the study. It was considered as a relatively complex task since the subjects relied on such abilities as speed, agility, balance, and eye-foot coordination while performing it. Moreover, a subject did not reach his maximum performance in just a few trials of the task. This is evident by the performance curves of individuals in each practice group, which are presented in Chapter IV.

Experimental Facility and Equipment

The facility which was utilized for the practice and test area in administration of the gross motor task was a flat, grassy area located in front of the Men's Gymnasium at North Texas State University. The equipment used to conduct the study was as follows: (1) four soccer balls; (2) three standards; (3) four stop watches; and (4) a Personal Information/Scorecard for each subject.

The soccer balls used during the administration of the task were of regulation size which held nine pounds of air pressure. This amount of air pressure was checked each day of practice and testing. The standards which were employed for the study consisted of three wire baskets spaced at even intervals of eight feet apart. The stop watches were used to obtain the time to the nearest tenth of a second.
Practice scores and test scores were recorded on each subject's Personal Information/Scorecard upon each completion of the soccer dribble task.

Description and Administration of the Gross Motor Task

The subject positioned himself behind a starting line and waited for the command "Get Set. . .Go!" which was the signal to begin the task. Upon hearing this command, the subject began by maneuvering the ball with his feet through the three standards. The subject had to move the ball in a weaving fashion around each standard, which included circling the one at the opposite end from the starting line. After this maneuver the subject then returned the ball by moving it back through the remaining two standards and past the line. If the subject lost control of the ball, he had to retrieve it and maneuver it back (with his feet) to the point where he lost control in order to correctly complete the task. Thus, the subject was not allowed to by-pass any of the standards. The subject's score was the time it took to complete the task to the nearest one-tenth of a second. After each completion, the score was then recorded on his Personal Information/Scorecard.
Equating of Practice Groups

The 104 males who volunteered as subjects for the study were given a pre-test which consisted of three trials of the soccer dribble task. According to his best (lowest) performance score on the pre-test, each subject was then assigned to one of four practice groups. The practice groups were placed by random assignment into the following order: (1) No Practice Group (NP); (2) Massed Practice Group (MP); (3) Distributed (twenty second rest) Practice Group (D20); and the (4) Distributed (five minute rest) Practice Group (D5). A rotating and reversing pattern was employed after each series of four subjects were assigned to a group in order to obtain initial homogeneity of groups. Table I presents the assignment of each subject to the practice groups, and indicates the best pre-test score that each subject made while performing the soccer dribble task. Also presented in Table I are the four practice groups and the numbered subject within a particular group.

In describing the method of the practice group assignment, subject number one, who made the lowest score during the pre-test was assigned to the first practice group (NP); subject number two, who made the next best score, was assigned to the second practice group (MP);
subject number three, who made the next best score was assigned to the fourth practice group (D5).

**TABLE I**

**COMPOSITION OF PRACTICE GROUPS AND BEST PRE-TEST SCORE FOR EACH SUBJECT**

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>NP9</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>#1 (8.1)</td>
<td>#2  (8.6)</td>
<td>#3  (8.7)</td>
<td>#4  (9.0)</td>
<td></td>
</tr>
<tr>
<td>#8 (9.4)</td>
<td>#7  (9.3)</td>
<td>#6  (9.2)</td>
<td>#5  (9.0)</td>
<td></td>
</tr>
<tr>
<td>#9 (9.5)</td>
<td>#10 (9.5)</td>
<td>#11 (9.6)</td>
<td>#12 (9.6)</td>
<td></td>
</tr>
<tr>
<td>#16 (9.8)</td>
<td>#15 (9.7)</td>
<td>#14 (9.7)</td>
<td>#13 (9.6)</td>
<td></td>
</tr>
<tr>
<td>#17 (9.8)</td>
<td>#18 (9.8)</td>
<td>#19 (9.8)</td>
<td>#20 (10.0)</td>
<td></td>
</tr>
<tr>
<td>#24 (10.1)</td>
<td>#23 (10.1)</td>
<td>#22 (10.1)</td>
<td>#21 (10.0)</td>
<td></td>
</tr>
<tr>
<td>#25 (10.2)</td>
<td>#26 (10.2)</td>
<td>#27 (10.2)</td>
<td>#28 (10.2)</td>
<td></td>
</tr>
<tr>
<td>#32 (10.5)</td>
<td>#31 (10.5)</td>
<td>#30 (10.4)</td>
<td>#29 (10.3)</td>
<td></td>
</tr>
<tr>
<td>#33 (10.6)</td>
<td>#34 (10.6)</td>
<td>#35 (10.6)</td>
<td>#36 (10.7)</td>
<td></td>
</tr>
<tr>
<td>#40 (10.8)</td>
<td>#39 (10.8)</td>
<td>#38 (10.7)</td>
<td>#37 (10.7)</td>
<td></td>
</tr>
<tr>
<td>#41 (10.8)</td>
<td>#42 (10.8)</td>
<td>#43 (10.8)</td>
<td>#44 (11.0)</td>
<td></td>
</tr>
<tr>
<td>#48 (11.1)</td>
<td>#47 (11.1)</td>
<td>#46 (11.0)</td>
<td>#45 (11.0)</td>
<td></td>
</tr>
<tr>
<td>#49 (11.2)</td>
<td>#50 (11.3)</td>
<td>#51 (11.4)</td>
<td>#52 (11.4)</td>
<td></td>
</tr>
<tr>
<td>#56 (11.5)</td>
<td>#55 (11.4)</td>
<td>#54 (11.4)</td>
<td>#53 (11.4)</td>
<td></td>
</tr>
<tr>
<td>#57 (11.6)</td>
<td>#58 (11.6)</td>
<td>#59 (11.6)</td>
<td>#60 (11.8)</td>
<td></td>
</tr>
<tr>
<td>#64 (12.0)</td>
<td>#63 (11.9)</td>
<td>#62 (11.9)</td>
<td>#61 (11.9)</td>
<td></td>
</tr>
<tr>
<td>#65 (12.0)</td>
<td>#66 (12.1)</td>
<td>#67 (12.1)</td>
<td>#68 (12.1)</td>
<td></td>
</tr>
<tr>
<td>#72 (12.2)</td>
<td>#71 (12.1)</td>
<td>#70 (12.1)</td>
<td>#69 (12.1)</td>
<td></td>
</tr>
<tr>
<td>#73 (12.2)</td>
<td>#74 (12.3)</td>
<td>#75 (12.3)</td>
<td>#76 (12.4)</td>
<td></td>
</tr>
<tr>
<td>#80 (12.5)</td>
<td>#79 (12.5)</td>
<td>#78 (12.5)</td>
<td>#77 (12.5)</td>
<td></td>
</tr>
<tr>
<td>#81 (12.8)</td>
<td>#82 (12.9)</td>
<td>#83 (13.0)</td>
<td>#84 (13.0)</td>
<td></td>
</tr>
<tr>
<td>#88 (13.2)</td>
<td>#87 (13.2)</td>
<td>#86 (13.2)</td>
<td>#85 (13.1)</td>
<td></td>
</tr>
<tr>
<td>#89 (13.2)</td>
<td>#90 (13.2)</td>
<td>#91 (13.3)</td>
<td>#92 (13.3)</td>
<td></td>
</tr>
<tr>
<td>#96 (13.7)</td>
<td>#95 (13.7)</td>
<td>#94 (13.6)</td>
<td>#93 (13.3)</td>
<td></td>
</tr>
<tr>
<td>#97 (13.8)</td>
<td>#98 (14.1)</td>
<td>#99 (14.2)</td>
<td>#100 (14.2)</td>
<td></td>
</tr>
<tr>
<td>#104 (16.1)</td>
<td>#103 (15.6)</td>
<td>#102 (15.5)</td>
<td>#101 (14.4)</td>
<td></td>
</tr>
</tbody>
</table>

*The best pre-test score is in parentheses beside each numbered subject in the study. This score is recorded to the nearest one-tenth of a second.*
The method of assignment then reversed for the next series of four subjects, reversed again for the next four, etc. until all subjects were assigned to a specific practice group. It is pointed out that several of the subjects during the pre-test trials made identical best scores. These subjects were randomly assigned to the proper sequential group when tie scores did occur.

In Table II, the best score means of the pre-test are presented for the four practice groups.

**TABLE II**

**BEST SCORE MEANS OF THE PRE-TEST FOR THE FOUR PRACTICE GROUPS**

<table>
<thead>
<tr>
<th>Practice Group</th>
<th>Number</th>
<th>Best Score Means</th>
</tr>
</thead>
<tbody>
<tr>
<td>NP</td>
<td>26</td>
<td>11.49</td>
</tr>
<tr>
<td>MP</td>
<td>26</td>
<td>11.49</td>
</tr>
<tr>
<td>D20</td>
<td>26</td>
<td>11.49</td>
</tr>
<tr>
<td>D5</td>
<td>26</td>
<td>11.46</td>
</tr>
</tbody>
</table>

Each practice group at the time of the pre-test had twenty-six subjects. It is noted that three of the groups (NP, MP, and D20) had an average of 11.49, while the remaining group (D5) had an average of 11.46 on the best scores of the pre-test. According to these averages, the practice
groups were considered to be equated as to initial performance on the soccer dribble task.

Practice Procedures of Each Group

The following practice procedures for each practice group were as follows:

1. **No Practice Group**: The subjects in the No Practice Group attended class with their regular activity sections and did not receive any practice of the soccer dribble task during the experimental period between pre-test, post-test, and the retention test.

2. **Massed Practice Group**: The subjects in the Massed Practice Group attended class with their regular activity sections except for the time of their practice trials of the soccer dribble between the pre-test and post-test. Each subject in this group received seventy-two practice trials of the task, twenty-four each on three consecutive days. They did not receive any practice between the post-test and retention test.

3. **Distributed (twenty second rest) Practice Group**: The subjects in the Distributed (twenty second rest) Practice Group attended class with their regular activity sections except for the time of their practice trials of the soccer dribble between the pre-test and post-test period.
Each participant in this group received seventy-two practice trials of the task; twelve on each practice day during three consecutive weeks with a twenty-second rest interval after each task trail. The subjects did not receive any practice between the post-test and retention test.

4. Distributed (five) Practice Group: The subjects in the Distributed (five) Practice Group attended class with their regular activity sections except for the time of their practice trials of the soccer dribble between the pre-test and post-test period. Each participant in this group received seventy-two practice trials of the task; twelve on each practice day during three consecutive weeks, with a five-minute rest interval after half of the trials. None of these subjects received practice between the post-test and retention test.

The motor learning trials of the Massed Practice Group were performed under concentrated practice conditions during a three-day period, while those of the Distributed Practice Groups were spaced over a three-week period.
CHAPTER BIBLIOGRAPHY

CHAPTER IV

PRESENTATION AND ANALYSIS OF THE DATA

This study utilized four different groups to investigate the effects of massed and distributed practice conditions of a unique motor learning task. The task, a soccer dribble around three evenly spaced standards, emphasized large muscle movements by the participants. It was practiced and learned during a three week period at North Texas State University. In addition retention of the task was investigated by testing after one month of no practice by each group.

One hundred and four freshmen and sophomore students volunteered as subjects for the study. These individuals received a pre-test on February 2-3, 1971. However, three of these subjects were dismissed for not completing all of the requirements during the experimental period. The other requirements in addition to the pre-test was a post-test on March 2-3, 1971 and a retention test on April 1-2, 1971. The number of subjects retained in each practice group was as follows:

(1) No Practice Group (MP) — 26 subjects
(2) Massed Practice Group (MP) — concentrated practice trials totaling twenty-four per subject on three consecutive days — 25 subjects
(3) Distributed Practice Group (D20) -- twenty second rest intervals after each practice trial -- 24 subjects

(4) Distributed Practice Group (D5) -- five minute interval after six of twelve practice trials during a practice session -- 26 subjects

Practice Data Collected From Experimental Groups

Each subject in the MP, D20, and D5 practice groups received seventy-two practice trials of the soccer dribble task during the experimental period. The mean scores for the groups were determined after each series of twelve trials and are presented in the results of the study. Although statistical comparisons of the data obtained from the practice sessions were not made, these data were utilized to indicate the progress of each group during their experimental period. This is shown by a performance curve that was charted from the mean scores of the practice trials on each group.

Treatment of Test Data

In order to test the tenability of the hypotheses that were presented in Chapter I, statistical computations of pre-test, post-test, and retention test data on the soccer dribble trials were processed by the Data Processing Center at North Texas State University.
The statistical technique used in testing hypotheses one and six was the $t$-test of differences between mean scores as described by Popham (2, p. 152). To ascertain the required value of $t$ for significance, the $t$-table was utilized. Both of these hypotheses were tested at the .05 level of significance.

An analysis of covariance was the statistical technique used to test hypotheses two, three, four, and five. The co-variables were the pre-test scores, whereas the criterion variables were the post-test scores in these hypotheses which pertained to learning of the soccer dribble task.

An analysis of covariance was also used to test hypotheses seven, eight, and nine. In these hypotheses, which pertained to retention of the soccer task, the covariables were the post-test scores whereas the criterion variables were the retention scores.

The analysis of covariance statistical technique, as described by Roscoe (3, p. 254), was utilized since the sample population was comprised of intact groups selected from the Physical Education 116 activity classes. An $F$-ratio was given which was evaluated for significance at the .05 level.
Results of the Test Data

Test data were obtained on each subject in the investigation on three different occasions. These tests included: (1) a pre-test, (2) a post-test, and (3) a retention test. Each of these tests consisted of three trials of the soccer dribble task. For interpretation purposes, the test data are reported as follows: (1) The mean scores of the four practice groups, which are presented in the various tables throughout the chapter, are in seconds; (2) smaller mean scores are better than larger mean scores as all subjects were instructed to perform each soccer task trial in the lowest time that was capable of them.

Hypothesis I

An analysis of the significance of the difference between mean scores on the pre-test and post-test for the No Practice Group is presented in Table III.

<table>
<thead>
<tr>
<th></th>
<th>Number of Subjects</th>
<th>Group Means</th>
<th>Standard Deviation</th>
<th>t-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-test</td>
<td>26</td>
<td>13.65</td>
<td>1.84</td>
<td>.27*</td>
</tr>
<tr>
<td>Post-test</td>
<td>26</td>
<td>13.57</td>
<td>1.99</td>
<td></td>
</tr>
</tbody>
</table>

*Not significant at the .05 level of confidence.
As shown, the NP Group had a pre-test mean of 13.65, as compared to a mean of 13.57 on the post-test. For a $t$-value to be significant at the .05 level of confidence with 25 degrees of freedom, it must reach a value of 2.06. A $t$-value of .27 was obtained for the significance between these means. Hypothesis I predicted that there would be no significant differences in the results of the No Practice Group on the pre-test and post-test performances of the soccer dribble. Therefore, this hypothesis was retained, as the difference was not significant.

The gains between the pre-test and post-test scores for each practice group are presented in Table IV.

<table>
<thead>
<tr>
<th></th>
<th>NP</th>
<th>MP</th>
<th>D20</th>
<th>D5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of Subjects</td>
<td>26</td>
<td>25</td>
<td>.24</td>
<td>.26</td>
</tr>
<tr>
<td>Pre-test Mean</td>
<td>13.65</td>
<td>13.52</td>
<td>13.63</td>
<td>13.67</td>
</tr>
<tr>
<td>Post-test Mean</td>
<td>13.57</td>
<td>10.56</td>
<td>10.24</td>
<td>9.93</td>
</tr>
<tr>
<td>Soccer dribble Mean Gain</td>
<td>0.08</td>
<td>2.96</td>
<td>3.39</td>
<td>3.74</td>
</tr>
</tbody>
</table>
As shown, the D5 Group had the greatest mean gain of 3.74 during the learning period of the soccer dribble task. The D20 Group, with a mean gain of 3.39, followed the D5 Group, while the MP Group was next, with a mean gain of 2.96. The least mean gain of .08 was achieved by the NP Group. Table IV also shows that each practice group demonstrated nearly equal performance on the pre-test, which was prior to any practice of the soccer task.

A summary of the analysis of covariance of the pre-test to post-test gain scores for all practice groups is presented in Table V. Using 3 and 96 degrees of freedom at the .05 level of confidence, an F-ratio of 2.76 was required for significance for the practice groups.

**TABLE V**

**SUMMARY OF ANALYSIS OF COVARIANCE OF PRE-TEST AND POST-TEST GAIN SCORES OF ALL PRACTICE GROUPS**

<table>
<thead>
<tr>
<th>Source of Variation</th>
<th>Sum of Squares</th>
<th>df</th>
<th>Mean Square</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interaction (Between)</td>
<td>217.84</td>
<td>3</td>
<td>72.61</td>
<td>29.29*</td>
</tr>
<tr>
<td>Within</td>
<td>238.25</td>
<td>26</td>
<td>2.48</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>456.09</td>
<td>99</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Significant at .001 level.*
The obtained F-ratio of 29.26 indicated that significant differences existed between the groups. In order to determine which differences were significant it was necessary to utilize Tukey's test of comparisons among means, as discussed by Kirk (1, p. 471). The degrees of freedom for this test are equal to N-k-1 (1, p. 472), when N is the number of observations; and k is the number of groups.

An analysis of the significance of the difference between the means of the pre-test and post-test for all practice groups is presented in Table VI.

**TABLE VI**

**TUKEY'S TEST FOR THE SIGNIFICANCE OF THE DIFFERENCE BETWEEN THE MEANS OF THE PRE-TEST AND POST-TEST FOR ALL PRACTICE GROUPS**

<table>
<thead>
<tr>
<th></th>
<th>NP</th>
<th>MP</th>
<th>D20</th>
<th>D5</th>
</tr>
</thead>
<tbody>
<tr>
<td>NP</td>
<td>0.00</td>
<td>9.40*</td>
<td>10.58*</td>
<td>11.63*</td>
</tr>
<tr>
<td>MP</td>
<td>.</td>
<td>0.00</td>
<td>1.17**</td>
<td>2.23**</td>
</tr>
<tr>
<td>D20</td>
<td>.</td>
<td>.</td>
<td>0.00</td>
<td>1.06**</td>
</tr>
<tr>
<td>D5</td>
<td>.</td>
<td>.</td>
<td>.</td>
<td>0.00</td>
</tr>
</tbody>
</table>

*Significant at the .001 level of confidence.

**Not significant.

As shown, the MP Group, D20 Group, and D5 Group differed significantly when compared with the NP Group. However, no significant differences were found among the other possible
comparisons of groups of the learning period results. The data obtained in Table IV, Table V, and Table VI were utilized to test the tenability of hypotheses two, three, four, and five.

**Hypothesis II**

Hypothesis II predicted that there would be no significant differences in the soccer dribble mean gain performance of the Distributed (five minute rest) Group (D5) and the Distributed Practice (twenty second rest) Group (D20). As presented in Table IV, the D5 Group had a mean gain of 3.74, as compared to the D20 Group's mean gain of 3.39. The value of $q$ at the .05 level of confidence, according to the Studentized Range Table (referred to as the $q$-table), with 96 degrees of freedom, is 2.83. The $q$-value that was obtained in the comparison of adjusted means of these two practice groups was 1.06, as presented in Table VI. Therefore, the second hypothesis was retained, as the difference was not significant.

**Hypothesis III**

Hypothesis III predicted that the D5 Group would show a significantly greater soccer dribble mean gain in performance than would the NP Group, and the MP Group. As presented in Table VI, the $q$-value that was obtained from the comparison of means of the D5 Group and NP Group was 11.64. For a
q-value to be significant at the .05 level in this operation, it must reach a value of 3.40. Therefore, this portion of the hypothesis was retained. The q-value that was obtained in the comparison of means of the D5 Group and MP Group was 2.23. For a q-value to be significant at the .05 level in this comparison, it must reach a value of 2.83. Therefore, this portion of the third hypothesis was rejected.

**Hypothesis IV**

Hypothesis IV predicted that the D20 Group would show a significantly greater soccer dribble mean gain in performance than would the NP Group and the MP Group. As presented in Table VI, the q-value that was obtained in the comparison of means of the D20 Group and the NP Group was 10.58. For a q-value to be significant at the .05 level, it must reach a value of 2.83. Therefore, this portion of the hypothesis was retained. The q-value that was obtained in the comparison of means of the D20 Group and MP Group was 1.17. For a q-value to be significant at the .05 level in this comparison, it must reach a value of 2.83. Therefore, this portion of the hypothesis was rejected.

**Hypothesis V**

Hypothesis V predicted that the MP Group would show a significantly greater soccer dribble mean gain in performance
than would the NP Group. As presented in Table VI the q-value that was obtained in the comparison of these two practice groups was 9.40. For a q-value to be significant at the .05 level in this comparison was 2.83. Therefore, the fifth hypothesis was retained.

**Hypothesis VI**

An analysis of the significance of the difference between mean scores on the post-test and retention test for the No Practice Group is presented in Table VII. As shown the NP Group had a post-test mean of 13.57 as compared to a mean of 13.20 on the retention test.

**TABLE VII**

<table>
<thead>
<tr>
<th>t-TEST FOR THE SIGNIFICANCE OF THE DIFFERENCE BETWEEN THE MEANS OF POST-TEST AND RE-TEST FOR THE NO PRACTICE GROUP</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>No Practice Group</strong></td>
</tr>
<tr>
<td>Post-test</td>
</tr>
<tr>
<td>Retention test</td>
</tr>
</tbody>
</table>

*Not significant at the .05 level of confidence.

For a t-value to be significant at the .05 level of confidence with 25 degrees of freedom, it must reach a value of 2.06. A t-value of .86 was obtained for the significance between
these means. Hypothesis VI predicted that there would be no significant difference in the results of the NP Group on the retention test and post-test performances of the soccer dribble. Therefore, this hypothesis was retained, as the difference was not significant.

The gains between the post-test and retention scores for each practice group are presented in Table VIII.

TABLE VIII
MEANS OF POST-TEST AND RE-TEST SCORES AND GAIN OF EACH PRACTICE GROUP
(N=101)

<table>
<thead>
<tr>
<th></th>
<th>NP</th>
<th>MP</th>
<th>D20</th>
<th>D5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of Subjects</td>
<td>26</td>
<td>25</td>
<td>24</td>
<td>26</td>
</tr>
<tr>
<td>Post-test Mean</td>
<td>13.57</td>
<td>10.56</td>
<td>10.24</td>
<td>9.93</td>
</tr>
<tr>
<td>Retention test Mean</td>
<td>13.20</td>
<td>9.93</td>
<td>10.54</td>
<td>10.71</td>
</tr>
<tr>
<td>Soccer dribble Mean Gain</td>
<td>.37</td>
<td>.63</td>
<td>-.30</td>
<td>-.78</td>
</tr>
</tbody>
</table>

As shown in Table VIII, the MP Group had the greatest mean gain in retention of the soccer task, with a .63 recording. This group was followed by the NP Group, which had a mean gain of .37. The D20 Group was next with a mean gain of -.30. The D5 Group, which had the best mean gain during the learning period, recorded the worst retention mean gain of -.78.
A summary of the analysis of covariance of the post-test to retention test gain scores for all practice groups is presented in Table IX. Using 3 and 96 degrees of freedom, an F of 2.76 was necessary for significance at the .05 level of confidence.

**TABLE IX**

**SUMMARY OF ANALYSIS OF COVARIANCE OF POST-TEST TO RE-TEST GAIN SCORES OF ALL PRACTICE GROUPS**

<table>
<thead>
<tr>
<th>Source of Variation</th>
<th>Sum of Squares</th>
<th>df</th>
<th>Mean Square</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interaction (Between)</td>
<td>37.93</td>
<td>3</td>
<td>12.64</td>
<td>6.27*</td>
</tr>
<tr>
<td>Within</td>
<td>193.65</td>
<td>96</td>
<td>12.02</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>231.58</td>
<td>99</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Significant at .001 level.

The obtained F-ratio of 6.27 indicated that significant differences did exist between the groups after this final analysis. In order to determine which differences were significant, Tukey's test of comparisons among means was utilized. Again, the degrees of freedom for this test are equal to N-K-1.

An analysis of the significance of the difference between the adjusted means of the post-test and retention
test for all practice groups is presented in Table X. As shown, the MP Group and D20 Group differed significantly when compared with the NP Group. The D5 Group showed no significant difference in its comparison with the NP Group, but did show a significant difference in its comparison with the MP Group. All other comparisons of retention showed no significant differences.

**TABLE X**

**TUKEY'S TEST FOR THE SIGNIFICANCE OF THE DIFFERENCE BETWEEN THE MEANS OF THE POST-TEST AND RE-TEST FOR ALL PRACTICE GROUPS**

<table>
<thead>
<tr>
<th></th>
<th>NP</th>
<th>MP</th>
<th>D20</th>
<th>D5</th>
</tr>
</thead>
<tbody>
<tr>
<td>NP</td>
<td>0.00</td>
<td>6.16*</td>
<td>3.72*</td>
<td>2.75***</td>
</tr>
<tr>
<td>MP</td>
<td>..</td>
<td>0.00</td>
<td>2.43***</td>
<td>3.40**</td>
</tr>
<tr>
<td>D20</td>
<td>..</td>
<td>..</td>
<td>0.00</td>
<td>0.97***</td>
</tr>
<tr>
<td>D5</td>
<td>..</td>
<td>..</td>
<td>..</td>
<td>0.00</td>
</tr>
</tbody>
</table>

*Significant at the .001 level of confidence.

**Significant at the .01 level of confidence.

***Not significant.

The data obtained in Table VIII, Table IX, and Table X were utilized to test the tenability of hypotheses seven, eight, and nine.
Hypothesis VII

Hypothesis VII predicted that there would be no significant difference in retention scores on the soccer dribble between the D5 Group and the D20 Group. As presented in Table X, the q-value that was obtained from the comparison of means of these two practice groups was 0.97. For a q-value to be significant at the .05 level of confidence in this comparison, it must reach a value of 2.83. Therefore, hypothesis seven was retained, as the difference was not significant.

Hypothesis VIII

Hypothesis VIII predicted that there would be no significant difference in the retention scores on the soccer dribble between the MP Group and the D5 Group, and the D20 Group. As presented in Table X, the q-value that was obtained from the comparison of means of the MP Group and D5 Group was 3.40. For a q-value to be significant at the .05 level in this comparison, it must reach a value of 2.83. Therefore, the first portion of the hypothesis was rejected, as the difference was significant. The q-value that was obtained from the comparison of means of the MP Group and D20 Group was 2.43. For a q-value to be significant at the .05 level in this comparison, it must reach a value of 2.83. Therefore, this portion of the hypothesis was retained, as the difference was not significant.
Hypothesis IX

Hypothesis IX predicted that (1) the D5 Group, (2) the D20 Group, and (3) the MP Group would show a significantly greater retention score on the soccer dribble than would the NP Group. As presented in Table X, the q-value that was obtained in the comparison of means of the D5 Group and NP Group was 2.75. For a q-value to be significant at the .05 level in this comparison, it must reach a value of 3.40. Therefore, this portion of the hypothesis was rejected. The q-value that was obtained from the comparison of means of the D20 Group and NP Group was 3.72. For a q-value to be significant at the .05 level in this comparison, it must reach a value of 2.83. Therefore, this portion of the hypothesis was retained, as the difference was significant.

The q-value that was obtained from the comparison of means of the MP Group and NP Group was 6.16. For a q-value to be significant at the .05 level in this comparison, it must reach a value of 2.83. Therefore, this portion of the hypothesis was retained, as the difference was significant.

Additional Results

Practice Data

Table XI is a presentation of the mean scores for each practice group which were tabulated after each twelve trials
of the soccer task. The subjects in each group received a total of seventy-two trials of the task, with the exception of the No Practice Group. This group was the control group and did not receive any practice trials. The means of each group range from high scores (which were considered the worst performances) in the early practices to progressively lower scores (which were considered the best performances) in the later practices.

**Table XI**

Mean Scores and Standard Deviations for Each Practice Group After Each Twelve Trials During Practice Sessions (N=101)

<table>
<thead>
<tr>
<th>Practice Group</th>
<th>N</th>
<th>1-12</th>
<th>13-24</th>
<th>25-36</th>
<th>37-48</th>
<th>49-60</th>
<th>61-72</th>
</tr>
</thead>
<tbody>
<tr>
<td>MP</td>
<td>25</td>
<td>M</td>
<td>11.62</td>
<td>10.64</td>
<td>11.41</td>
<td>10.76</td>
<td>10.64</td>
</tr>
<tr>
<td></td>
<td></td>
<td>SD</td>
<td>2.91</td>
<td>2.20</td>
<td>2.22</td>
<td>1.71</td>
<td>1.65</td>
</tr>
<tr>
<td>D20</td>
<td>24</td>
<td>M</td>
<td>12.44</td>
<td>11.72</td>
<td>10.97</td>
<td>10.87</td>
<td>10.51</td>
</tr>
<tr>
<td></td>
<td></td>
<td>SD</td>
<td>3.60</td>
<td>3.16</td>
<td>2.41</td>
<td>2.32</td>
<td>2.49</td>
</tr>
<tr>
<td>D5</td>
<td>26</td>
<td>M</td>
<td>12.91</td>
<td>11.63</td>
<td>11.04</td>
<td>10.32</td>
<td>10.08</td>
</tr>
<tr>
<td></td>
<td></td>
<td>SD</td>
<td>2.59</td>
<td>2.67</td>
<td>2.10</td>
<td>2.46</td>
<td>1.78</td>
</tr>
<tr>
<td>NP</td>
<td>26</td>
<td>RECEIVED NO PRACTICE ON THE SOCCER DRIBBLE TASK</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

A consistent improvement in performance was evident for all groups during their practice sessions except for the Massed Practice (MP) Group. Their mean of trials 25-36, which was 11.41, represented the only decrease in performance
during the experimental period. The Distributed Practice (D5) Group had the highest (worst) mean score of 12.91 after the initial twelve trials but showed the greatest improvement after the final twelve trials with a mean of 9.52. The Distributed (D20) Practice Group had a mean score of 12.44 after the initial trials but was exceeded by the Massed Practice (MP) Group's mean score of 11.62. However, the D20 Group finished slightly ahead of the MP Group on the final twelve practice trials of the soccer task by recording a mean score of 10.20 as compared to MP Group mean of 10.33.

A performance curve was charted from these practice mean scores and indicated the progress of each experimental group as they learned the soccer dribble task. Figure 1 shows the performance trend of the MP Group during their three days of concentrated practice. Although the MP Group decreased in its performance on the second day of practice, the participants in this group maintained a steady rate of improvement on the final day of practice.
Fig. 1—Performance curve for the Massed Practice Group

Figure 2 shows the performance trend of the D20 Group during their three weeks of distributed practice with a rest interval of twenty seconds after each task trial. An examination of the performance trend indicates that the D20 Group showed great amounts of improvement during the first week of practice. An investigation of their scores from the second and final week of practice reveals, however, that only a gradual improvement occurred.
The performance trend of the D5 Group is presented in Figure 3. Subjects in the D5 Group were allowed a five-minute rest after half of the twelve trials received during
a practice session. An examination of the performance curve indicates that a steady rate of improvement was maintained throughout their three weeks of practice sessions.

Score in Seconds
13.0
12.9
12.8
12.7
12.6
12.5
12.4
12.3
12.2
12.1
12.0
11.9
11.8
11.7
11.6
11.5
11.4
11.3
11.2
11.1
11.0
10.9
10.8
10.7
10.6
10.5
10.4
10.3
10.2
10.1
10.0
9.9
9.8
9.7
9.6
9.5
9.0

Trials 1-12 13-24 25-36 37-48 49-60 61-72
1st Week 2nd Week 3rd Week

Fig. 3—Performance curve for the Distributed Practice (D5) Group on the soccer dribble task.
CHAPTER BIBLIOGRAPHY


CHAPTER V

SUMMARY, FINDINGS, CONCLUSIONS, AND RECOMMENDATIONS

Summary

The purpose of this study was to investigate the effects of massed and distributed practice conditions upon the learning and retention of a novel gross motor task. The task was a soccer dribble around three evenly spaced standards, which was practiced and learned during a three week period at North Texas State University. The subjects used in the study were freshmen and sophomore volunteers enrolled in various sections of the Men's Activity Program.

Research in this area of motor learning has dealt primarily in fine motor activities throughout the years. However, investigations in recent years have been conducted which utilized gross motor tasks to study massed and distributed practice conditions. The majority of the research favored a distributed or spaced pattern of practice over massed or concentrated practice. The literature suggested that additional studies were needed to further the understanding of psychological generalizations made from the numerous fine motor studies as they apply to learning of gross motor skills and activities. Therefore, this study was conducted under this justification and need.
One hundred and one subjects participated in the study. Each subject was randomly assigned to one of four practice groups after taking a pre-test, consisting of three trials of the soccer dribble task. In addition a post-test and retention test was required of each subject during the two month experimental period. Both of these tests also consisted of three trials of the task. The four groups and practice conditions were as follows:

1. **No Practice Group (NP)** — The Control group, consisting of twenty-six subjects, that received no practice on the soccer task.

2. **Massed Practice Group (MP)** — Twenty-five subjects that received concentrated practice trials totaling twenty-four per subject on three consecutive days.

3. **Distributed Practice Group (D20)** — Twenty-four subjects that received twenty second rest intervals after each practice trial during a practice session of twelve trials.

4. **Distributed Practice Group (D5)** — Twenty-six subjects that received five minute rest interval after six of twelve practice trials during a practice session.

Each subject in the MP, D20, and D5 practice groups received seventy-two trials of the soccer dribble task within a three week practice period. The mean scores for the groups were determined after each series of twelve trials, and these
data were utilized to indicate the progress of each group during their practice sessions.

Statistical comparisons were made of pre-test, post-test, and retention test data which were computed at the Data Processing Center at North Texas State University. The statistical technique used in testing hypotheses one and six was the $t$-test of differences between means. An analysis of covariance was the statistical technique used to test hypotheses two, three, four, five, seven, eight, and nine. All hypotheses were tested at the .05 level of confidence.

Findings

The findings of the study in terms of the formulated hypotheses are presented as follows:

1. There were no significant differences in the results of the No Practice Group on the pre-test and post-test performances of the soccer dribble task.

2. There were no significant differences in the soccer dribble mean gain performance of the Distributed Practice (five minute rest) Group and the Distributed Practice (twenty second rest) Group.

3. The Distributed Practice (five minute rest) Group did show a significantly greater soccer dribble mean gain in performance than the No Practice Group; this Distributed
Practice Group did not show a significantly greater soccer dribble mean gain in performance than the Massed Practice Group.

4. The Distributed Practice (twenty second rest) Group did show a significantly greater soccer dribble mean gain in performance than the No Practice Group; the Distributed Practice (twenty second rest) Group did not show a significantly greater soccer dribble mean gain in performance than the Massed Practice Group.

5. The Massed Practice Group did show a significantly greater soccer dribble mean gain in performance than the No Practice Group.

6. There were no significant differences in the results of the No Practice Group on the retention test and post-test performance of the soccer dribble.

7. There were no significant differences in the retention scores on the soccer dribble between the Distributed Practice (twenty second rest) Group.

8. There was a significant difference in the retention scores on the soccer dribble between the Massed Practice Group and the Distributed Practice (five minute rest) Group; there was no significant difference in the retention scores on the soccer dribble between the Massed Practice Group and the Distributed Practice (twenty second rest) Group.
9. The Distributed Practice (five minute rest) Group did not show a significantly greater retention score on the soccer dribble than the No Practice Group; the Distributed Practice (twenty second rest) did show a significantly greater retention score on the soccer dribble than the No Practice Group; the Massed Practice Group did show a significantly greater retention score on the soccer dribble than the No Practice Group.

Additional findings as a result of the practice mean scores of each experimental group during their practice periods are as follows:

1. The performance curves for the groups during their practice periods indicated consistent improvements in performance (with the exception of the Massed Practice Group's decrease in performance on the second day of practice).

2. The Distributed (five minute rest) Practice Group, which was allowed a five-minute rest after half of the twelve trials during a practice session twice weekly for three weeks, had the greatest amount of improvement in performance.

3. The Distributed (twenty second rest) Practice Group, which had a twenty-second rest interval after each practice trial during each session of twelve trials twice weekly for three weeks, followed next in improvement in performance.
4. The Massed Practice Group, which had concentrated practice during a three-day period with twenty-four trials on each day, followed slightly behind the Distributed (twenty second rest) Practice Group in performance of the soccer dribble task.

Conclusions

As a result of the findings of this study, the following conclusions were shown with regard to the effects of massed and distributed practice upon the learning and retention of a novel soccer task:

1. Practice of a gross motor skill is superior to no practice of the skill.

2. In the learning phase of the soccer dribble task, some differences were evident in the comparisons of the practice conditions and, therefore, are recognized as follows:
   a. Distributed practice with longer rest periods is better than distributed practice with short rest periods.
   b. Distributed practice with longer rest periods is better than massed practice.
   c. Distributed practice with short rest periods is better than massed practice.
3. In the retention phase of the soccer dribble task, differences were evident in the comparisons of the practice conditions and, therefore, are recognized as follows:

   a. Massed practice is better than distributed practice with longer rest periods.
   b. Massed practice is better than distributed practice with short rest periods.
   c. Distributed practice with short rest periods is better than distributed with longer rest periods.

4. It is concluded that the findings of this investigation pertaining to the learning phase are in agreement with the related research in massed and distributed practice, as it was found that distributed practice is favored over massed practice while learning a gross motor activity. However, in the retention phase, the findings contradict previous research in this area, as it was found that massed practice is favored over distributed practice in the retention of a gross motor activity.

Recommendations

The findings of this study suggest the following recommendations to consider in further research of massed and distributed practice. The investigator should
1. Employ more than one motor learning task in an investigation using massed and distributed practice conditions.

2. Analyze retention of a gross motor task after a longer period of no practice of the task (possibly six months to one year).

3. Conduct additional studies in this area of motor learning to further the understanding of the learning process using gross motor activities.

4. Conduct additional studies in this area of motor learning using gross motor activities with younger age groups, particularly elementary and junior high school students.

5. Compare the results of this study with a similar study done at the junior high and high school levels.

6. Utilize the results of a pilot study in a similar study to determine the number of trials necessary to learn a novel gross motor task (in addition to determining the distance of the task, placement of standards, and the rest interval time periods.
APPENDIX A

Personal Information/Scorecard

<table>
<thead>
<tr>
<th>Name</th>
<th>Section</th>
<th>Class</th>
</tr>
</thead>
<tbody>
<tr>
<td>Last</td>
<td>First M.I.</td>
<td></td>
</tr>
</tbody>
</table>

Age Height Weight Practice Group Code No.

TEST RESULTS

<table>
<thead>
<tr>
<th>TEST</th>
<th>DATE</th>
<th>TRIAL 1</th>
<th>TRIAL 2</th>
<th>TRIAL 3</th>
<th>BEST TRIAL TIME</th>
</tr>
</thead>
<tbody>
<tr>
<td>PRE-TEST</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>POST-TEST</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>RETENTION TEST</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

PRACTICE SESSION RESULTS

72 TRIALS

<table>
<thead>
<tr>
<th>#1</th>
<th>#13</th>
<th>#25</th>
<th>#37</th>
<th>#49</th>
<th>#61</th>
</tr>
</thead>
<tbody>
<tr>
<td>#2</td>
<td>#14</td>
<td>#26</td>
<td>#38</td>
<td>#50</td>
<td>#62</td>
</tr>
<tr>
<td>#3</td>
<td>#15</td>
<td>#27</td>
<td>#39</td>
<td>#51</td>
<td>#63</td>
</tr>
<tr>
<td>#4</td>
<td>#16</td>
<td>#28</td>
<td>#40</td>
<td>#52</td>
<td>#64</td>
</tr>
<tr>
<td>#5</td>
<td>#17</td>
<td>#29</td>
<td>#41</td>
<td>#53</td>
<td>#65</td>
</tr>
<tr>
<td>#6</td>
<td>#18</td>
<td>#30</td>
<td>#42</td>
<td>#54</td>
<td>#66</td>
</tr>
<tr>
<td>#7</td>
<td>#19</td>
<td>#31</td>
<td>#43</td>
<td>#55</td>
<td>#67</td>
</tr>
<tr>
<td>#8</td>
<td>#20</td>
<td>#32</td>
<td>#44</td>
<td>#56</td>
<td>#68</td>
</tr>
<tr>
<td>#9</td>
<td>#21</td>
<td>#33</td>
<td>#45</td>
<td>#57</td>
<td>#69</td>
</tr>
<tr>
<td>#10</td>
<td>#22</td>
<td>#34</td>
<td>#46</td>
<td>#58</td>
<td>#70</td>
</tr>
<tr>
<td>#11</td>
<td>#23</td>
<td>#35</td>
<td>#47</td>
<td>#59</td>
<td>#71</td>
</tr>
<tr>
<td>#12</td>
<td>#34</td>
<td>#36</td>
<td>#48</td>
<td>#60</td>
<td>#72</td>
</tr>
</tbody>
</table>

*All scores are recorded in seconds (to the nearest one-tenth).
APPENDIX B

GENERAL INSTRUCTIONS

I am Mr. Murphree, a doctoral student at NTSU. During this Spring semester, 1971 I plan to investigate the effects of massed and distributed practice upon learning and retention of a unique gross motor task, by using each of you who have volunteered to participate. The motor learning task is a soccer dribble around three evenly spaced standards (see Appendix C).

I wish to add that the information that is received from the study, hopefully will give further insight into this aspect of motor learning, and will aid in determining which method of practice, massed or distributed, provides the best results toward learning and retention of a gross motor skill.

Each of you will take a pre-test which consists of three trials of the soccer dribble task. The test area is located at the front entrance of the Men's Gymnasium. On the basis of your best performance score, which incidently is the lowest of your three task trials, you will be assigned to one of four practice groups. As a result of these assignments each practice group will be equated as to initial skill of the task.

Prior to the pre-test, please complete the top portion of the Personal Information/Scorecard (see Appendix A) which you received as you entered the classroom. After you have done this report to me at test area.

After your regular activity class instructor has called the roll at the next class meeting, you are to report to me at this location. At which time I will inform each of you of the practice group to which you have been assigned. Also, specific instructions concerning the different practice groups will be given at the next meeting.
APPENDIX C

GROSS MOTOR TASK INSTRUCTIONS

On the command, "Get Set . . . Go!" you are to begin the task from the starting point by moving the soccer ball with your feet around the three standards. You must maneuver the ball in a weaving pattern around each standard, which includes circling the standard at the end, then returning the ball back to the line by moving it through the remaining standards. It is pointed out should you lose control of the ball you must retrieve it and maneuver it back to the point where you lost control. Thus, you are not allowed to by-pass any of the standards. Your score is recorded on your Personal Information/Scorecard (see Appendix A) to the nearest one-tenth of a second after each task trial completion.
APPENDIX D

INSTRUCTIONS TO NO PRACTICE GROUP

Each of you in the No Practice Group has been assigned according to your best performance score that you made on the pre-test. Those of you assigned to this group will not practice the soccer dribble during the practice period which will be for the next three weeks. However, you will take a post-test on March 2-3, 1971 and a retention test on April 1-2, 1971. Since each of the four groups in the study will have comparisons made of the test scores and the practice scores let me emphasize the importance of this group not practicing the soccer dribble task. Your instructors will be notified of the test dates I have given you in order to release you from your regular activity. I shall look forward to seeing all of you again on March 2-3, 1971. Thank you for your participation and cooperation in this investigation.
APPENDIX E

INSTRUCTIONS TO MASSED PRACTICE GROUP

Each of you in the Massed Practice Group has been assigned according to your best performance score that you made on the pre-test. You will receive massed or concentrated practice of the soccer dribble within a three day period totaling twenty-four trials per day. You will receive a post-test on March 2-3, 1971 and a retention test on April 1-2, 1971. Since comparisons will be made of the test scores and practice scores on the four groups in the study let me emphasize the importance of you providing an honest effort during these periods. Your instructors will be notified of the test dates and the practice periods in order to release you from your regular activity class. I shall look forward to seeing you for your practice sessions at the next class meeting. Thank you for your participation and cooperation in this investigation.
APPENDIX F

INSTRUCTIONS TO D20 PRACTICE GROUP

Each of you in the D20 Practice Group has been assigned according to your best performance score that you made on the pre-test. You will receive distributed practice of the soccer dribble within a three week period totaling twelve trials per day (twenty-four per week) with a twenty second rest interval after each task trial. You will also receive a post-test on March 2-3, 1971 and a retention test on April 1-2, 1971. Since comparisons will be made of the test scores and practice scores on the four groups in the study let me emphasize the importance of you providing an honest effort during these periods. Your instructors will be notified of the test dates and the practice periods in order to release you from your regular activity class. I shall look forward to seeing you for your practice sessions at the next class meeting. Thank you for your participation and cooperation in this investigation.
APPENDIX G

INSTRUCTIONS TO D5 PRACTICE GROUP

Each of you in the D5 Practice Group has been assigned according to your best performance score that you made on the pre-test. You will receive distributed practice of the soccer dribble within a three week period totaling twelve trials per day (twenty-four per week) with a five minute rest interval after half (six) of the trials during a practice session. You will also receive a post-test on March 2-3, 1971 and a retention test on April 1-2, 1971. Since comparisons will be made of the test scores and practice scores on the four groups in the study let me emphasize the importance of you providing an honest effort during these periods. Your instructors will be notified of the test dates and the practice periods in order to release you from your regular activity class. I shall look forward to seeing you for your practice sessions at the next class meeting. Thank you for your participation and cooperation in this investigation.
BIBLIOGRAPHY

Books


Articles


Fox, Margaret G. and Vera P. Young, "Effect of Reminiscence on Learning Selected Badminton Skills," Research Quarterly, 33 (October, 1962), 386-394.


Murphy, Herbert H., "Distribution of Practice Periods in Learning," Journal of Educational Psychology, 7 (January, 1916), 150-162.


Webster, Randolph W., "Psychological and Pedagogical Factors Involved in Motor Skill Performance as Exemplified in Bowling," Research Quarterly, 11 (December, 1940), 42-52.


Unpublished Materials


