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The purpose of this study was to compare the effects of massed and distributed practice on the learning of the forehand and backhand drives in tennis.

The study was conducted at the University of North Carolina at Greensboro, during the spring term of 1968. The subjects were undergraduate women students in two beginning physical education tennis service classes. The twenty-eight subjects were matched in pairs according to their Scott Motor Ability Test scores and according to their past tennis experience. The entire experiment was conducted in a gymnasium. One class practiced the forehand drive against the wall for fifteen minutes twice a week for three weeks under massed conditions, while the other class practiced the forehand drive against the wall for fifteen minutes twice a week for three weeks under distributed conditions. The same procedure was followed for the backhand drive sessions except the two groups reversed conditions of practice.

The Broer-Miller Forehand Drive Test was administered to both classes after completion of the forehand drive practice sessions and the Broer-Miller Backhand Drive Test was given to both classes after completion of the backhand drive practice sessions. During the third class period after the backhand

drive test was given, the Scott-French Revision of the Dyer Wall Test was administered to determine the combined forehand and backhand drive performance of the sequential massed-distributed condition class and the distributed-massed condition class.

The statistic employed for all three comparisons was the Fisher's "t" test for the significance of difference among small uncorrelated groups.

Results revealed that in the backhand drive performance by both groups, the distributed condition group was superior to the massed condition group at the one per cent level of confidence.

Under the conditions of this study the following conclusions were drawn:

1. Fifteen continuous minutes of practice on the forehand drive each period twice a week is just as effective as having fifteen minutes of practice with a change of activity spaced between every five minutes of practice.

2. Distributed practice of fifteen minutes with a change of activity spaced between each five minutes of practice is more beneficial than massed practice of fifteen continuous minutes in learning the backhand drive.

3. The sequence of learning the forehand drive under massed conditions, the backhand drive under distributed conditions, and vice versa does not seem to affect performance.

MASSED VS. DISTRIBUTED PRACTICE ON THE LEARNING OF THE FOREHAND AND BACKHAND DRIVES IN TENNIS

by

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APPROVAL SHEET

This thesis has been approved by the following committee of the Faculty of the Graduate School at The University of North Carolina at Greensboro.

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Oral Examination
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TABLE OF CONTENTS

LIST OF TABLES

CHAPTER I

INTRODUCTION

For many years research has been conducted concerning various time distribution effects on learning. Psychologists began this work using verbal tasks and the pursuit rotor, and physical educators followed up with research in the area of individual and team sports' skills. However, results found in the area of sports' skills are inconclusive because few studies have been done. Even fewer studies have been done experimenting with subjects' rate of learning under the conditions of a typical class situation.

The investigator has always been interested in the sport of tennis because it is an exciting, popular sport which may be played by two people or four people, may be played indoors or outdoors, and may be played by both men and women at all stages of life. It is an active, challenging game which requires a certain amount of concentration, agility, and endurance. The opportunities for play and advancement are unlimited.

As a player and teacher, the investigator was concerned about facilitating the learning of tennis so that more people could participate in their leisure time. Americans today have

been accused of sluggishness and it is a known fact that one of the leading problems in the United States is a lack of exercise. For exercise to be meaningful, people need to feel secure in the activity. Many of our physical education activity classes do not provide enough time for individuals to develop their skills. Thus, it is important for physical educators to make better use of class time. This study was undertaken to ascertain the optimal amount of time to be spent in class practice.

CHAPTER II

STATEMENT OF THE PROBLEM

The purpose of the experiment was to compare the effects of massed and distributed practice on the learning of the forehand and backhand drives in tennis.

Limitations of the Study

1. The entire study was conducted indoors.
2. Over-all tennis ability was not measured, but only the forehand and backhand drives.
3. Only fourteen pairs of subjects could be equated.
4. There was no control over outside class practice during the experiment except that of the subjects being on the honor system.
5. Hot weather may have affected the performance of the subjects toward the end of the experiment.
6. Some subjects could have been more interested and motivated than others.

Definitions of Terms

Massed practice - fifteen continuous minutes of practice against the wall twice a week

Distributed practice - fifteen minutes of practice against the wall twice a week with a change of activity spaced between every five minutes of practice.

Reminiscence - improvement in performance following a period of no practice.

Inhibition - restraint of action in learning motor skills or in retaining previously learned skills.

Psychomotor skill - a skill which involves a limited part of the body with emphasis on the mind.

CHAPTER III

REVIEW OF LITERATURE

Massed and Distributed Practice

A great amount of research has been done on distribution of practice in verbal, psychomotor, and motor learning. Various combinations of massing and/or distributing practice have been studied, including: (1) massing of practice with no rest intervals; (2) distributing practice with rest intervals of constant length; (3) massing at beginning of practice and slowly increasing the length of rest intervals; (4) distributing at beginning of practice and decreasing the length of rest intervals; (5) initial massing with rest intervals introduced irregularly; and (6) initial distributing of practice with periods of massed practice introduced sporadically. (3)

The early studies, from 1885 to about 1920, were concerned with verbal tasks such as learning nonsense syllables. (51) Following these studies came those investigating the learning and retention of meaningful materials. Distributed practice (51) was defined as a length of practice with rest intervals incorporated in it, and massed practice was defined as a length of practice with no rest intervals. In the learning and

retaining of nonsense material distributed practice seemed to yield better results. Distributed practice seemed to yield better results in learning and retaining meaningful material also.

In the early 1900's researchers began to explore the effects of massed and distributed practice on the learning of motor tasks as well as to continue study on verbal learning. Investigators in the fields of psychology and physical education experimented with hand movements, archery shooting, javelin throwing, mazes, mirror tracing, and pursuit rotors.

Leuba and Hyde (33) tested hand movements in four groups of subjects by finding their progress in skill in writing English prose in German script. Group I worked twice per day, Group II once daily, Group III on alternate days, and Group IV on every third day. Group III was significantly better than the other groups.

Archery ability was investigated by Lashley. (52) The twenty-seven subjects, ranging in age from fourteen to thirty years, were divided into five groups. Group A practiced twelve shots per day for thirty days; Group B practiced five shots per day for twelve weeks; Group C had twenty shots per day for four weeks; Group D had forty shots per day for four weeks; and Group E had sixty shots per day for four weeks. All the

subjects were novice archers and were not equated at the beginning. After completion of three hundred sixty shots by each group the scores were compared. The five shots per day group was superior to all the other groups in final accuracy and improvement. The sixty shots per day group was second in accuracy. The lowest in accuracy was the twelve shot per day group. Lashley's conclusion from this evidence was that, when practice is distributed throughout many short sessions over a long length of time, more learning can occur than when practice is massed in a few long periods.

One year after Lashley's study, 1915, came Murphy's study (35) of the effect of practice conditions on the learning of javelin throwing by girls. The subjects were right-handed, had to throw the javelins from a stationary position with their left hands, and were divided into five groups. The girls were juniors and seniors in college. The seniors were divided into three groups: one practiced five times per week, Monday through Friday; two practiced three times a week on Monday, Wednesday, and Friday; and three met once a week on Thursday. Group I of the juniors met two times a day and Group II practiced once a day. The amount of practice was increased by distributing the practice sessions over alternate days or over a week. He concluded that for the amount of time used,

better work can be accomplished by a three days per week distribution than by a five days per week distribution.

Pechstein (38) studied the effects of massed and distributed practice and the whole-part method on maze learning by rats and humans. His experiment had seven groups of subjects. Group I, rats, learned the difficult maze, which he shortened, under the part method and massed conditions. Group II, rats, learned the maze under the part method and distributed conditions. Group III, humans, had the same conditions as I, and Group IV, humans, had the same conditions as II. Two other groups, one rats, one humans, learned the maze under the whole method and distributed practice, and the last group, humans, learned it under the whole method and massed conditions. The part groups learned each part of the maze on a different day in order for four days in a row. The whole groups learned the entire maze right away. The day after the completion of the last section of the maze for the part groups, each rat and human had to connect the units into proper serial order. Each of the massed practice subjects completed the task and some made the connection without an error. The distributed practice subjects had a difficult time making the connections which took them many more trials to meet the criteria for learning which was four out of five

perfect runs. The whole groups did not do as well as the part. Pechstein concluded that when a difficult maze is shortened massed practice with the part method is better for learning.

Snoddy (43) analyzed the learning curve under various conditions of practice concerned with the influence of time intervals on the learning process. He used the task of mirror tracing. Group I, under massed conditions, practiced a series of twenty circuits per day with no rest for twenty days; while Group II, under relatively distributed conditions, practiced twenty circuits with a one-minute rest between each for twenty days; and Group III, under distributed conditions, practiced one circuit per day for twenty days. His findings indicated that in learning to trace the star, one circuit per day was significantly better than several circuits per day separated by one minute rest, and better than a series practice with no rest.

Dore and Hilgard (16) challenged Snoddy's findings that early distributing of practice was better for learning than was early massing. They used the pursuit rotor, had two groups, and equated these on three initial trials. Both groups in the experiment practiced a total of fourteen trials. All trials were of one-minute duration.

Group I practiced within the forty-three minutes of the practice period, at intervals of decreasing rest from eleven minutes to one minute, whereas Group II started at one minute rest and increased to eleven minutes. Group II scored higher than Group I, which showed massing to be more advantageous early in practice.

Travis (45) also used the pursuit rotor in his investigation of practice conditions on learning. The first experiment had four male college students as subjects. Each subject completed eight trials of six minutes each on the pursuit rotor. Three of the subjects had rest periods of three days interspersed between trials and one subject had seven days' rest. There were no significant differences in result of performance by any of the subjects yet all made improvement after each rest up to the third minute of practice in each trial.

The second part of his first experiment included all four subjects when they had completed the eight trials and had almost reached the maximum in learning. Each subject completed two continuous work periods of twelve minutes on two successive days and two work periods of twelve minutes with two minutes' work and rests of one minute between. These four trials were given seven days after the last learning period in the first part of the experiment. The results showed a decrease

in efficiency for the subjects in the continuous work period and showed a consistent rise in efficiency for the subjects after the one-minute rest periods.

Travis (46) tried another experiment two years later, 1939, to determine the length of a practice period in relation to efficiency in motor learning. A modification of the manual pursuit oscillator was used along with three groups of college men. The length of the practice periods was varied: Group I practiced one minute, Group II practiced two minutes, and Group III practiced four minutes. The length of inter-practice rests was constant at three minutes. Each group had six trials in each practice period. Results revealed Group III, which had the most practice, had the lowest percentage score. Group II, with twelve minutes, had the highest score showing that Group III's last half of practice was a waste. The data indicated it is more advantageous to have the practice periods short such as one or two minutes, than long if the inter-practice rests are as short, as three minutes.

The period of the early 1900's up to 1939 found investigators favoring mostly distributed practice of some sort in psychomotor and gross motor skill learning. These investigators laid the foundation in the area of massed and distributed practice. In the 1940's, experiments centered around

psychomotor skill learning in relation to conditions of practice. The pursuit rotor, inverted alphabet printing task, nonsense mazes, mirror drawings, reaction time, billiards, and juggling were the tasks studied.

Hilgard and Smith (25) employed the pursuit rotor in their experiment with seventy-eight college students. Each student practiced on the pursuit rotor for four daily sessions of twenty-five minutes each. Each trial ran one minute but rest times differed so the number of trials varied for each group. Group A had eight trials per day, Group B had thirteen per day and Group C had eighteen trials per day. Group A, the most distributed, came out ahead and was the best throughout the experiment.

Ammons (9) investigated the effects of initially distributed practice in pursuit rotor performance. In one period the subjects rested 0 seconds, twenty seconds, fifty seconds, two minutes, five minutes, twelve minutes, and twenty-four hours between the twenty-second trials. In periods two and three all subjects practiced continuously. The best performance was found in the distributed group or at period one.

Ammons and Willig (10) worked together on an experiment that was designed to show the effects of repeated periods of massed practice with the pursuit rotor. There were four groups of twenty-six subjects each. Each group practiced on the

pursuit rotor for a total of one hundred ten minutes, ninety minutes in training conditions and twenty minutes in test conditions. Group I practiced under massed conditions of ten minutes' work and twenty minutes' rest while Group II practiced under distributed conditions of one-minute work and two minutes' rest. Group III practiced under massed conditions for the training period and was under distributed conditions for the twenty-minute test, whereas Group IV worked under the opposite conditions of Group III. Results revealed that massed practice led to poorer performance at all stages of practice.

Renshaw (57) attempted to discover why and under what conditions the advantages of spaced practices over massed practices were found. The pursuit rotor was used and four groups of subjects participated. Each group had thirty one-minute trials on the rotor. Two groups practiced under relatively distributed conditions while the other two had relatively massed conditions. Distributed Group I had a bank of six trials on each of the five consecutive days, while Group II had ten trials on days one, three, and five. In the second series all thirty one-minute trials were taken within a period of one hour for the two relatively distributed groups and for the relatively massed group. Results showed no significant difference between the two

distributed groups in either series, but showed the relatively distributed groups to be higher in final achievement than the massed groups in both series. The investigator felt that the distributed groups had more chances to forget incorrect responses during a longer rest than the massed groups with little rest.

Once again the pursuit rotor was used as Irion (26) studied the length of the rest period needed for reminiscence to occur. Reminiscence defined by Irion was "that increase in the proficiency of performance of a partially learned act which is attributable to the effects of an interpolated rest period." The subjects were one hundred twenty undergraduate psychology students who had never practiced on the pursuit rotor before. Five groups of fifteen subjects participated in the first experiment while four groups of fifteen students and one group of forty-five were in the second. The first experiment dealt with reminiscence as a function of amount of pre-rest practice. Groups I to V had ten, twenty, thirty, and forty pre-rest trials respectively. The length of rest was five minutes except for Group V which had none. The number of relearning trials was five for each group.

In experiment two the number of pre-rest trials was twenty for each. The length of rest varied with each group: 0, .05 minutes, one, three, and five minutes respectively.

The number of relearning trials was five for each. This second experiment dealt with reminiscence as a function of length of rest interval. His results revealed significant amounts of reminiscence occurred following a five-minute rest which was brought in after ten, twenty, thirty and forty trials of practice under experiment one. Reminiscence was found to be a function of the length of the rest interval also.

Cook and Hilgard (13) studied the effects of progressively increasing and decreasing rests on motor learning. Their tool was the pursuit rotor and the subjects numbered twenty-six in each of the two groups. The first group had six one-minute trials on the first day with a three-minute rest between each trial, eleven one-minute trials on the second day with a one-minute rest between each, and sixteen one-minute trials on the third day with twenty seconds rest between each trial. The second group started with the sixteen one-minute trials on the first day with twenty seconds rest between each and was just the opposite of Group I. Distributed practice, or the six one-minute trials with a rest of three minutes between each, was more advantageous in both groups than the massed practice, or the sixteen one-minute trials with twenty seconds rest between each, and than the relatively distributed practices. This revealed that distributed

practice was better than massed practice in early and late learning.

Kientzle (29) studied the properties of learning curves under varied distribution of practice with the inverted alphabet printing task. Five hundred ninety-three students were divided into twelve groups. The trials were one minute long and the score of each group was the number of letters written per trial. The duration of rest periods between trials ranged from 0 seconds to seven days. The number of trials per group ranged from twelve to seventy with the majority of the groups having twenty. During rest all the groups talked and relaxed except Group Eight A which tallied arithmetic problems. She found the groups which did not have as many trials per day gained more than those with more practice. Also, results revealed a more rapid rise in scores by the groups which had some rest than by those which had continuous practice. Last, a change of task had the same effect as rest as proved by the Eight A Group which tallied problems during rest.

The inverted alphabet printing task was employed by Kimble (30) as he investigated distribution of practice in later learning. The five experimental groups, two-hundred twenty-four subjects, were given twenty-one thirty-second trials under the following conditions: the length of the rest pause between trials was 0 seconds for Group I, five seconds

for Group II, ten seconds for Group III, fifteen seconds for Group IV, and thirty seconds for Group V. All groups except the thirty-second group, had a ten-minute rest period between the twentieth and twenty-first trials. The thirty-second group received the last trial thirty seconds after trial twenty. Results revealed that the 0, five, ten and fifteen-second inter-trial rest groups learned faster, in that order, than the thirty-second group. Increase in amount of reminiscence was shown as the rest pause increased to thirty seconds. He concluded that the rate of learning after the first trials bore a complex relationship to the length of the rest between trials and also that the speed of acquisition of the skill increased as a linear function of the degree of distribution of practice.

Cook (14) experimented with nonsense mazes in relation to the length of the rest interval needed for the most efficient learning. He called massing the twenty-second interval and distribution the twenty-four hour interval between trials in both experiments. The first experiment had two subjects, both of whom worked under massed and distributed conditions in the experiment, but in a different order. Subject C practiced in the order DMMDDMMDDMMD and Subject W practiced in the order MDDMMDDMMDDM. The criterion for learning each maze was one errorless trial. Both subjects learned four eight-unit mazes,

four sixteen-unit mazes, and four eight-unit mazes in that order. The twenty-second massed trials were far superior to the twenty-four hour distributed trials because forgetting was more prevalent during the latter.

In experiment two there were eighteen subjects who were required to learn twelve mental mazes. The criterion for learning was one errorless trial. Groups I and II learned the mazes in order, 12345678, and Groups III and IV learned them in order, 34127856. Groups I and III were under massed and distributed conditions in the order, MDDMMDDM and Groups II and IV were under both conditions in the order, DMMDDMMD. The massed condition trials were superior to the distributed condition trials throughout.

Tsao (47) shifted the distribution of practice in his experiment with mirror-tracing. Sixty-four subjects participated in the study. The first two groups, E and F, practiced twelve trials all at once, and Groups G and H practiced twelve trials in two sittings with an interval of twenty-four hours introduced between the sixth and seventh trials. In Groups E and G the first trials through the sixth were spaced with one-minute intervals and trials seven to twelve were massed or continuous. In Groups F and H the procedure was the opposite--trials one through six were continuous and the last trials were spaced. Early massed with later spacing of practices was

better for performance and, when an interpolated twenty-four hour period was introduced for G and H, there were no significant differences between these and the groups which did the practice all at once. Tsao agreed with Dore and Hilgard that early massing of practices promotes more efficient learning.

The Vector Complex Reaction Time apparatus was the tool in Riopelle's (40) distribution of practice experiment. Forty-three male students participated with twenty subjects in the massed group and twenty-three in the distributed group. Forty two-minute trials were given to each subject and the score on the test was the number of correct switches turned in a testing period. The massed practice group received forty consecutive trials in one day while the distributed practice group had four trials per day for a period of ten days. The length of each trial was two minutes and the trials were separated by a fifty-five second rest and a five-second warning period. The superiority of distributed practice over massed practice was shown in the results. Massed practice was better than distributed practice only in the first two trials.

Harmon and Miller (22) conducted a study of beginning college women in billiards. Subjects were divided into four groups and their practices consisted of: Group I, nine times, three days per week for three weeks; Group II, nine times,

additive, first day, second day, third, fifth, eighth, thirteenth, twenty-first, thirty-fourth, and fifty-fifth; Group III, nine practices, one everyday for nine days; and Group IV, nine practices, one per week. Eleven different set shots were used and fifty shots were taken per practice period. Results revealed the additive group to be best, so that neither complete massing nor complete distributing practices were best when learning billiards.

Longley (53) followed up Harmon and Miller's study in billiards. The design of the experiment was similar, except practice occurred on Tuesday, Wednesday, and Thursday of the first week and then each Tuesday for six weeks in a row for the additive group. Performance increased in Longley's study until the last practice period when there was a drop. The rest of the study compared with Harmon and Miller's study and the modified additive group came out best.

Thirty-six men ranging from twenty to thirty-three years of age were the subjects for Franklin and Brozek's (21) study using pattern tracing and body reaction time. There were six groups of six subjects each and the practices were as follows: Group A, three times a day for six days; B, two times a day for nine days; C, once a day for eighteen days; D, three times a week for six weeks; E, irregular practices for six weeks; and

F, different irregular practices for six weeks. After twenty-five body reaction time trials were given at each practice, one administration of the trace test was given. The sequence of twenty-five reactions and one trace was repeated three times each practice. Results showed no differences between any of the groups on either of the tests. In addition, it did not seem to matter if there were irregularly spaced practices.

Juggling was used by Knapp and Dixon (31) in their first study of the effects of different practice distributions on learning. Two groups of thirty-five college men enrolled in physical education participated. The first group practiced five minutes a day and the second one practiced fifteen each second day. When a subject made one-hundred consecutive catches the skill was learned. More rapid learning took place among the individuals in the first group which led the authors to conclude that few periods are needed to learn juggling if a long rest occurs between practices.

In Knapp, Dixon, and Lazier's (32) study with freshmen high school boys, practicing under the same conditions as in the first study, the second results reinforced those of the first investigation.

The period of the 1950's brought in the idea of testing gross motor skills learned as in a typical class situation instead of merely in an experimental test. Along with the

exploration of learning gross motor skills, the investigation of psychomotor skill learning continued.

Duncan (17) did further investigation of the effects of practice conditions on the learning of the pursuit rotor skill. Duncan had one hundred fifty-seven female subjects in his experiment. The women were divided into four groups and the experiment only took twenty minutes. Everyone had a pre-rest practice of five minutes, with a ten-minute rest, and then a five-minute practice post-rest performance. During the pre-rest session two groups were under massed conditions, practicing the full five minutes continuously, while the other two groups were under distributed practice of ten seconds with twenty seconds rest. The post-rest session found one group under massed conditions performing as in the pre-rest session. The second massed group in the post-rest session was given distributive practice and the second distributive group was given massed practice. At the end of the pre-rest period both distributed condition groups were ahead of the massed condition groups in performance even though the distributed condition groups had only one-half as much practice. The post-rest distributed condition groups were significantly superior to the post-rest massed condition groups. Reminiscence was found in all groups. He concluded that the groups who had used distributed practice before rest had not only shown better

performance but had learned just as much as the massed condition groups even though they had less practice.

Adams (8) also used the pursuit rotor in his study on shifting distributions of time in learning. The subjects were basic airmen divided into five groups of thirteen to fifteen men. All groups had forty trials and each trial was fifteen seconds in length. The inter-trial rest was forty-five seconds for distributed practice and five seconds for massed practice. A control group had practice sessions under distributed conditions throughout the study. Groups M-D5, M-D10, M-D15, and M-D20 had initial training of five, ten, fifteen, and twenty massed trials respectively, a ten-minute rest and the remainder of the forty trials under distributed practice. It was discovered that each experimental group made a significant gain after switching to the distributed conditions. The scores of the experimental groups in the first post-rest trial were lower than the control group, C, but following rest, their performance shifted to the level of the control group. He interpreted the findings as meaning massing of practice does not lead to the development of any permanent work damage and that distribution of practice is regarded as a performance rather than a learning variable.

Sixty-four psychology students, male and female, participated in Denny, Frisby, and Weaver's (15) pursuit rotor experiment. They were divided into eight groups and each subject had three practice sessions of six, twelve, and three minutes respectively, separated by rest periods of five minutes and three minutes respectively. Massed practice was continuous while distributed practice had alternating intervals of thirty-seconds work and thirty-seconds rest. The groups performed as follows: (1) D-D-D, (2) D-D-M, (3) D-M-D, (4) D-M-M, (5) M-M-M, (6) M-M-D, (7) M-D-M, and (8) M-D-D. The summary indicated there was conditioned inhibition, which is restraint in performance, in motor learning. The massed conditions seemed to build up inhibition rapidly as performance was lower then, and pre-rest distributed conditions seemed to build up inhibition. However, when a thirty-second rest was secured in distributed practice, this inhibition dropped fifty per cent. Post-rest warm-up was found to begin immediately.

Norris (36) used a two-hand coordination test to test the performance of seven groups of one hundred Air Force trainees. Six of the seven groups were experimental with the last one being the control group. Each group had thirty-two minutes of practice. The control group practiced continuously while the others were given either a ten-minute or two-hour rest period after four, sixteen or twenty-eight minutes of

pre-rest practice. The three groups that had the two-hour rest were (A_4, A_{16}, and A_{28}), and the ten-minute rest groups were B_4, B_{16}, and B_{28}. Each group was tested on pre- and post-rest trial difficulty. Results indicated the length of rest was not a differential determiner of performance in terms of post-rest gains. As practice continued there seemed to be more advantage gained by the groups with longer rest than by those with the ten-minute rest period. Also, the shorter the pre-practice period the greater was the gain over rest so the point of introduction of the rest interval affected performance. The first post-rest trial performance of the other groups was superior to that of the control group that had no rest.

Archer (11) investigated the effects of practice conditions on the learning of the inverted alphabet printing task. The subjects were two-hundred forty-three psychology students. The conditioned inhibition phenomenon in practice was studied in the experiment. All subjects received twenty thirty-second trials. One group was under massed conditions, taking all the trials without a rest. The second group had a fifteen-second rest period between each trial. The third group, like the second, was under distributed conditions, but had a thirty-second rest period between trials. After the twentieth work period all groups had a five-minute rest. Then everyone took four thirty-second work trials under massed conditions.

Results indicated distributed practice facilitated learning since Group III was superior in performance. After five minutes of rest the massed practice group showed a significant amount of reminiscence. The post-rest performance of the massed and distributed condition groups was not significantly different so that there was no evidence of a permanent work decrement.

Pubols (39) also used the inverted alphabet printing in his experiment. One hundred subjects were divided into ten groups and all subjects were given a total of twenty-one thirty-second trials. The massed condition group worked continuously for the first twenty trials. Between trials one to twenty the distributed condition groups were given the following rest intervals: Group I, 0 rest; Group II, ten seconds; Group III, twenty seconds; Group IV, thirty seconds; and Group V, forty seconds. A five-minute rest period between trials twenty and twenty-one was given the massed experimental condition groups while the control groups continued at their same rate of inter-trial rest intervals (0, ten, twenty, thirty, and forty seconds). The distributed condition groups learned faster and performed better than the massed condition groups up to trial twenty. The distributed condition group with a forty-second rest period between trials performed the best. The massed condition groups with a rest period of five minutes

between the twentieth and twenty-first trials, showed a greater gain in performance from trial twenty to twenty-one than did the control distributed condition groups. There was not any evidence of conditioned inhibition appearing.

Massey (34) investigated the significance of interpolated time intervals on motor learning using the stabilimeter. Seventeen girls, twenty-one years of age, training to be teaching nuns were the subjects. Group X practiced three days a week (M-W-F) for five weeks, totaling fifteen practices. Group Y practiced five consecutive days per week (M-F), for five weeks and ended with twenty-five total practices. The third group, Z, practiced for nine days, one, one, two, three, five, eight, thirteen, twenty-one, and thirty-four, making nine total practices. Three circuits of the stabilimeter were traced each practice session with a ten-minute rest period between trials. The daily score was the total of the time and errors for all three circuits. The groups were equated according to best scores on the first day. There were no significant differences found between any of the groups after the ninth practice. After fifteen practices for X and Y, Y was performing significantly better. The practice conditions were all considered to be distributed because each group had at least twenty-four hours between practices.

Young (49) studied the effects of certain practice conditions on learning archery and badminton which were taught in a typical class situation. Four archery classes comprised Group I, thirty-five men and women beginners. Group II was made up of three classes of twenty-eight beginning students. The first group met two days a week for nine and one-half weeks for forty minutes each period. The second group met four days a week for four and one-half weeks for forty minutes each period. A daily record was kept of the number of ends of six arrows shot and the number of arrow hits on the target plus the score for each end. The shooting average scores were used to measure rate of learning. Group II which met four days a week, relative massing, learned more rapidly than did Group I, as measured by the gain in mean score and per cent of hits.

In badminton Young (49) had men and women beginners. Group I had four classes totaling thirty-five subjects and met two days per week for eight weeks for forty minutes each period. Group II had four classes totaling forty-one subjects and met four days a week for four weeks for forty minutes each day. The thirty-second wall volley, the short serve, and the high clear were the three tests used in this experiment. The wall volley test was given seven times, the short serve test was

administered five times, and the high clear test was given three times. The two-day a week group in badminton had the better learning rate than did the four-day per week group.

In the area of gross motor skills taught as in a typical class situation, Niemeyer (55) investigated the effects of massed and distributed practice conditions on the learning of badminton and volleyball by college men. For the badminton experiment massed practice was defined as sixty-minute classes meeting on Tuesday and Thursday of each week, and distributed practice as thirty-minute classes meeting three times a week on Monday, Wednesday, and Friday. Results revealed that in early and over-all learning the distributed condition group was better than the massed condition group. There were no differences between the groups in later learning. For the volleyball experiment the skills were taught as in a typical class situation and the same time distributions were used as in the badminton experiment. College men were tested and it was found that in initial learning neither group was better, but in late and over-all learning the massed condition group, or two-day per week practice group, was superior in performance to the three day thirty-minute distributed condition group.

Bowling was used by Kahn (28) in his experiment with time distributions in learning. His junior high school boys were divided into three groups of eight and assigned randomly

to each group. One group practiced one session each school day for nine days, and was designated as the massed condition group. One group practiced one session per week for nine weeks and was designated as the distributed condition group. The third group had massed practice for half of the time and distributed practice for the last half of the experiment. During each practice the subjects in all groups bowled fifteen balls in succession. No significant gains or differences were found between any of the groups after comparisons for the first, fifth, final session, and total score.

During the 1960's there was a continuation of psychomotor skill investigation. Also, exploration expanded into additional types of gross motor skills.

Harmon and Oxendine (23) did a study with the mirror drawing task. They used three groups of junior high boys as subjects. The first group did twenty circuits all together practicing two circuits on each practice day. The second group practiced fifty circuits practicing five a day for ten practices, and Group III did eighty circuits practicing eight a day for ten practices. The study was concerned with the length of the practice period. Practice was two days a week for five weeks with one day separating each session. At the early stages of learning the groups of five and eight practices per day showed advantage over the short period of

practice or distributed group. However, after the skill had been established, the short period group improved as fast as the others.

Oxendine (37) further investigated the task of mirror drawing by conducting a second experiment to determine the effects of continually increasing and continually decreasing practice periods on the learning of this skill. The subjects were fifty-three college students who practiced the skill for nine successive school days over a two-week period. Group I's schedule involved the progression of practices from one circuit on the first day to two circuits on the second day and on up to nine circuits on the ninth day. The second group started with nine circuits on the first day and progressively decreased one circuit each day down to one on the ninth day. A third group remained constant, practicing five circuits per day. Results revealed that the constant practice was more effective in over-all learning than either of the two other groups.

Ryan (41) experimented with the stabilometer which was a self-paced balance platform. His purpose was to evaluate the effects of pre-rest distribution of practice on pre-rest performance and reminiscence. There were eight groups of subjects and all received eleven trials of thirty seconds duration. Four

control groups had eleven trials of thirty seconds each with either ten, twenty, thirty, or forty seconds rest between trials. The other four groups were under the same conditions except they had a five-minute rest period after trial eight. Results revealed that there were no significant differences between any of the groups' performances on the first eight trials. The four experimental groups did show a sharp improvement in performance after the five-minute rest but not enough to create a significant difference in performance by the eight groups in trials nine to eleven.

Speed and endurance swimming were tested by Stull (60) in reference to learning in two different time distributions of practice. The subjects were twenty-four boys, eight to thirteen years of age. Group I practiced three times a week for six weeks at one hour a practice, while Group II practiced six times a week for six weeks at one hour a practice. Swimming ability was measured by the timing of swimming thirty-five feet and the distance swum in the endurance test. Results revealed Group II to be better than Group I (the three times a week group), in speed swimming, but Group I proved better than Group II (the six times a week group), in endurance. He did the same study with college men and the results were similar.

Stull (60) also tested these same college men in beginning bowling in regard to the amount of practice needed in bowling games. Group I, or the distributed condition group, practiced three times a week for six weeks while Group II, or the massed condition group, met six times a week for three weeks. He found Group II scores were higher in every game than Group I except in the first game.

In tennis Beale (50) investigated the effects of two different distributions of practice on the learning of the forehand and backhand drives. The experiment was done using a typical class situation and with one hundred fourteen subjects who were mostly college freshmen beginners in tennis. There were two groups of fifty-seven subjects each; Group I met Monday, Wednesday, and Friday each week for nine weeks for thirty-five minutes each day. Group II met on Tuesday and Thursday for fifty minutes each day for nine weeks. The Broer-Miller Forehand-Backhand Drive Test with the self-toss was used to measure the initial and final performance of the two groups. The investigator found no significant differences between the two groups in performance of either of the tennis drives.

Fox (20) was interested in the area of reminiscence in her study using the wall volley and short serve tests in badminton. Two groups were used, one having six weeks of instruction in a typical class situation, and the other having nine

weeks. The periods of no practice were six and twelve weeks. The wall volley and short serve tests were administered initially to the two groups--at the end of the instructional time and after each non-practice period. The investigator found reminiscence did not occur for either group on the short service test, but found it did occur in the wall volley test during the first non-practice interval for the nine week group and during the second non-practice period for the six week group.

The novel skill of bouncing a basketball off the floor and into the basket was investigated by Singer (42) in relation to three different time distributions. The subjects were college freshmen men. Group I practiced continuously eighty shots at the basket from the free throw line. Group II rested five minutes between four twenty-shot trials, and Group III rested twenty-four hours between each twenty-shot trial. In terms of immediate acquisition of skill the third group was the best. No differences were found between the three groups when they were tested the day after or the following week. When all groups were re-tested a month later, both Groups I and II had higher means than III.

Johansson (27) tested women college students in beginning folk dance and had one massed practice group and one distributed group. The women were all beginners taught by the

investigator. The massed group met fifty minutes a day for five days a week for two weeks, while the distributed group met twenty minutes per day for five days a week for five weeks. The beginners were paired on the basis of the Seashore Test of Rhythmic Perception. Experts rated both groups on folk dance ability at the beginning and end of the experiment and both groups had a written knowledge test of folk dance. Results showed improvement in both groups in dance. However, the distributed practice group performed the step patterns significantly better than the massed group.

In summary, most studies revealed that when learning a new skill short, frequent practices seemed to be the most effective for initial learning. (41) However, once the fundamentals were practiced for a certain length of time, then longer, less frequent practices were better.

Some kind of distributed practice is better than extreme massed practice with no rest, because of the following factors: (1) Fatigue and boredom set in with massed practice; (2) Motivation is greater because learning is forced into a smaller space of time; and (3) Mental practice of the skill can be done when they are in the rest period.

Whether massed or distributed practice is better in most skills varies with the sex, age, intelligence, and level of

skill of the individual involved, with the complexity of the task and with the variations of practice conditions making up massed and distributed practice.

Research in Tennis

Research supporting the Broer-Miller Forehand-Backhand Drive Test (12) without any variations was conducted when the test was first developed by Broer and Miller. The validity coefficient, found by correlating the test scores with subjective ratings of three judges, was .61. The low score was attributed to the inconsistent performance of beginners. A reliability coefficient of .80 was also obtained. The coefficient was obtained by correlating the first seven balls on the forehand drive plus the first seven balls on the backhand drive with the second seven balls of both the forehand and backhand drives.

A later study by Katherine Fox (19) was done on the validity of the Broer-Miller Test. She used the subjective ratings of three judges and correlated these with skill performances. She found an r of .61. She compared the scores of subjects who had no backboard practice to those who did have backboard practice before the test. The results indicated backboard practice did make the Broer-Miller Forehand-Backhand Drive Test a better measure of beginners' ability.

McDonald (54) employed the Ball-boy in her experiment with the Broer-Miller Test and compared this variation with the standard self-toss. The subjects were two groups of college women. The sum of three judges' ratings was used as the criterion. The validity coefficient of the test with the Ball-boy was .78, whereas the validity coefficient with the self-toss and sum of the judges' ratings was only .49. Without the subjective ratings the test with the Ball-boy showed a validity of r = .75 and with the self-toss showed r = .77.

Riccio (58) studied the effects of two types of practice devices, the Ball-boy and the backboard, on learning the forehand and backhand drives in tennis. The Broer-Miller Test was the measure of performance. Two groups of college women who were beginners in tennis were the subjects. One group practiced the drives by hitting against a backboard, while the other hit balls which were tossed by the Ball-boy. No statistically significant differences were found in the two groups' performances.

Solley and Borders (44) also had two groups of college women in their study. Their intention was to evaluate the effectiveness of the Ball-boy in teaching the forehand drive to beginners in tennis. Both groups performed a modified Broer-Miller Test, which had certain variations in the test set-up and in scoring. The first group, previous to the test, had five

hours of classes taught by traditional methods and ten hours' practice with the Ball-boy and the second group had the opposite. The group which had traditional instruction followed by the use of the Ball-boy was superior in performance.

A few other studies (56, 59, 61) used the Broer-Miller Test, but did not reveal additional information other than that already known.

The Dyer Backboard Test of Tennis Ability was revised a few times before it became acceptable for use. With a restraining line of five feet from the wall Dyer (18) found the validity of the test to be r = .92. However, the reliability of the test was not significant.

Scott and French (6) extended the restraining line to twenty-seven and one-half feet in order to encourage good form. The validity of this revision of the Dyer Test was r = .61, with a criterion of subjective ratings. Computed on the performance of college women the reliability was r = .80. Norms were set up for the test also.

Hewitt (24) recently revised the Dyer Test by changing the restraining line to twenty feet from the wall, by taking the average of the three trials as the score, and by starting the test differently. A round robin tournament was the criterion for validity. Four beginning tennis classes had

validity coefficients of .73, .72, .71, and .68 respectively. The reliability of the test, which was given a second time at the next class period, was r = .82. This test was administered to advanced players and the reliability coefficient was .89.

CHAPTER IV

PROCEDURE

The purpose of this study was to compare the effects of massed and distributed practice on the forehand and backhand drives in tennis.

Selection of Subjects

Two beginning tennis classes of twenty-six students each were taught by the investigator.

A questionnaire, which may be found in the Appendix, was filled out by all the subjects at the second class period. The questionnaire was designed to ascertain the experience of the subjects in tennis at the beginning of the experiment.

The scores on the Scott Motor Ability Test, which was administered to all freshmen and sophomores in service classes at the University of North Carolina at Greensboro in the fall of 1967, were used for equating motor ability.

It was not possible to equate both classes as wholes because one class was far superior to the other on the basis of past tennis instruction and motor ability. Fourteen students from each class were paired and only those students

were used as subjects in the experiment even though all the students in both classes participated. A fifteenth pair was dropped from the study because of outside class practice in the backhand drive. This pair happened to be the only men in the study.

Selection of Skill Tests

The two most common tests used in tennis testing are the Scott-French Revision of the Dyer Wall Test (6) and the Broer-Miller Forehand-Backhand Drive Test (12). The Broer-Miller Test met the criteria for validity and reliability, was administratively feasible indoors, and could be divided specifically into a forehand drive test and backhand drive test. Therefore it was chosen as the post-test for each segment of the study. When the Broer-Miller Test was employed, the Ball-boy was used to toss the fourteen balls to the student. The toss from the machine provided a consistent bounce for the student.

The Scott-French Revision of the Dyer Wall Test was administered at the end of the experiment because it measured the combined forehand and backhand tennis ability of each student and was used for grading in the classes. This test also met the criteria for validity and reliability.

Conduct of the Experiment

The entire experiment was conducted in a gymnasium. The investigator taught both classes by the part method and conducted the experiment for nine weeks. Lesson plans may be found in the Appendix.

A coin was flipped to see which of the two classes would be taught under massed conditions for the forehand drive. Class I, or the three o'clock Monday, Wednesday class, became the massed condition group. The steps listed below were followed:

Forehand Drive

Class I

1. The massed condition class met from 3:10-3:50 every Monday and Wednesday each week for nine weeks.

2. The first two lessons in the forehand drive served as introductory to the practice sessions.

3. The class was divided into two groups of thirteen each. The first group practiced the drive against the wall indoors for fifteen continuous minutes. Seven subjects worked at one wall and six at the other wall of the gymnasium. Meanwhile, the second group of the class received instruction and practice in the serve and volley in the middle of the gymnasium. These

two skills were taught because they could be executed easily within a limited space. At the end of the first fifteen minutes the two groups switched places.

4. For each of six classes, the subjects had a continuous fifteen-minute practice period. In the seventh period the Broer-Miller Forehand Drive Test was administered.

5. During the last practice period before the test, both groups of the class were given practice in the forehand drive with the use of the Ball-boy. This replaced volley instruction in the middle of that day's lesson.

Class II

1. The distributed condition class met from 10:15-10:50 every Monday and Wednesday each week for nine weeks.

2. The first two lessons in the forehand drive served as introductory to the practice sessions.

3. The class was divided into two groups of thirteen each. The first group practiced the forehand drive against the wall for five minutes while the second group received instruction and practice in the serve and volley. At the end of the five minutes the groups switched places. The changing of groups every five minutes continued until each group had had a total of fifteen minutes of wall practice and fifteen minutes of instruction. A graduate student timed for the class.

4. For each of six classes, the subjects had a fifteen-minute practice period with a change of activity every five minutes. In the seventh period the Broer-Miller Forehand Drive Test was administered.

5. During the last class period before the test, the students were given practice in the forehand drive with the use of the Ball-boy. This replaced volley instruction in the middle of that day's lesson.

Backhand Drive

Class I became the distributed condition group and Class II became the massed condition group for the backhand drive practices.

Class I

1. The meeting following the Broer-Miller Forehand Drive Test was the start of the introductory lessons in the backhand drive. As in the beginning of the forehand lessons, these two lessons were given prior to the experimental conditions of the study.

2. The backhand drive for the three o'clock class was taught under distributed conditions. The first group of the class practiced the backhand drive against the wall for five minutes, while the second group received instruction and practice in serving, volleying, scoring, and game strategy. At the

end of the five minutes the groups exchanged places. The changing of groups every five minutes continued until each group had had a total of fifteen minutes of wall practice and fifteen minutes of instruction. A graduate student timed for the class.

3. For each of six classes, the subjects had a fifteen-minute practice period with a change of activity every five minutes. In the next period the Broer-Miller Backhand Drive Test was administered.

4. During the last class period before the test, the students were given practice in the backhand drive with the use of the Ball-boy. This replaced serving practice in the middle of that day's lesson.

Class II

1. The meeting following the Broer-Miller Forehand Drive Test was the start of the introductory lessons in the backhand drive. These two lessons were given prior to the experimental conditions of the study.

2. The backhand drive for the ten o'clock class was taught under massed conditions. The first group of the class practiced the backhand drive against the wall for fifteen continuous minutes, seven at one wall and six at the other end of gymnasium. Meanwhile, the second group received instruction

and practice in serving, volleying, scoring, and game strategy. At the end of the first fifteen minutes the two groups exchanged places.

3. For each of six classes, the subjects had a continuous fifteen-minute practice period. In the next period the Broer-Miller Backhand Drive Test was administered.

4. During the last practice period before the test, the entire class had practice in the backhand drive with the use of the Ball-boy. This replaced serving practice in the middle of that day's lesson.

After two periods of forehand and backhand drive practice outside following the Broer-Miller Backhand Drive Test, both classes took the Scott-French Revision of the Dyer Wall Test indoors. The Scott-French Revision of the Dyer Wall Test was not given after the Broer-Miller Backhand Drive Test in order to allow the students a chance to play tennis outdoors and to have a break in the testing.

Testing Conditions

While practicing against the wall indoors the students in both classes were instructed to start behind a line marked twenty-seven and one-half feet from the wall. They were allowed to go over the line to retrieve balls or to hit a ball, but were advised to try to hit most of the balls from

behind the line. During the experiment there was no control over the chasing of balls, but each student was advised to have more than one ball and to retrieve quickly.

No one was permitted to practice either forehand or backhand drives outside of class until after the Scott-French Revision of the Dyer Wall Test was completed. If anyone practiced the strokes outside of class, he was dropped from the study.

Individual errors were not corrected in forehand or backhand practices, but general errors were discussed at the end of some classes if there were questions.

For motivation each student was informed that he was paired with some other student in the investigator's other tennis class. During each practice period the student was supposed to improve his wall score, or the number of times one can keep the ball going in succession with forehand drive, and later, with backhand drive. He got a green star on a chart if he beat his partner that practice. Everyone's name was on the charts but no one knew with whom he was paired or by how many he beat his partner. Also, within each class, every person received a candy lollipop each practice if he improved his wall score by two or more times of hitting the ball in succession.

Students who missed either the forehand or backhand practices more than twice were dropped from the study. Those who missed one or two practices made up the time before the test was given. The investigator did the timing during those make-ups.

Administration of Tests

Broer-Miller Tests

1. The indoor court was marked off with masking tape and chalk according to the directions in the standard test.

2. The correct height for a tennis net was measured on the portable net.

3. A rope was stretched between two volleyball standards which were held stable by two students and this rope was measured to be four feet above the net. Chalk marks indicated the correct height on the poles.

4. The Ball-boy was set up and thirty fairly new Tretorn balls were placed on top.

A rope was used in place of the string in the tests in order to aid in scoring since it was important in the test to know if the ball went above or below the rope. The two students held the standards tight because the poles could not be screwed into the floor.

Assistants in the administration of the tests included: (1) one main scorer who was a graduate student in physical education and who marked down the score of each ball on the card; (2) three assistant scorers who were students who were stationed on the opposite side and back of the court from the main scorer, and who called out the number of the section in which each ball landed; (3) one student who stood on a bleacher and called out whether the balls went above or below the rope; (4) one student who counted the number of balls hit by each student and who stopped the student at fourteen hits; (5) two ball retrievers who threw balls back to two other students who placed these balls on the Ball-boy; and (6) two students who held the standards keeping the rope taut. The main scorer took one-half the score value of the section in which the balls landed if they went over the rope. Each assistant scorer was assigned to a certain area of the court which she was to cover. Directions for the test with a diagram may be found in the Appendix.

Procedures followed were:

1. One student was tested at a time with no practice.

2. Any balls hitting the top of the net and going into the court or hitting the rope were replayed. Any balls hitting the Ball-boy or ceiling were replayed. Those balls

which the rope-watcher or scorer could not judge were repeated also.

3. After fourteen hits by a student the next of the first group came forward. The second group became the scorers and retrievers. When the first group finished the test, they changed places with the second group. The investigator called out the name of each hitter and kept the line moving.

4. Any absences which occurred on testing days were made-up in the next class period.

Scott-French Revision of the Dyer Wall Test

A twenty-seven and a half foot restraining line was marked off from the wall and the three foot line on the wall was already marked in blue. A racket with several balls on it was placed next to each participant. Directions for the test may be found in the Appendix.

The testing personnel used for the administration of the test were four scorers, two of the tennis faculty and two graduate students; and one timer, who was the investigator. Four students retrieved balls and replaced them on the rackets. Each scorer had a score-card, directions for the test, a clip-board and a pencil.

Procedures followed were:

1. Four subjects were tested at once. Two subjects worked at each wall of the gymnasium and there was one retriever at each of the four testing stations.

2. The investigator started the stop watch for all to begin at once. Each subject took three trials of thirty seconds in succession.

3. The remaining students were in single file formation a short distance behind each hitter at the station to which they were assigned.

4. Any absences occurring on the test day were made-up at the next class period.

Treatment of the Data

The Broer-Miller tests and the Scott-French Revision of the Dyer Wall Test were administered to measure the performances of the fourteen paired students.

The Broer-Miller Forehand Drive Test measured the performance of the pairs after four weeks of instruction. Fisher's "t" test for the significance of difference among small uncorrelated groups was the statistic employed to determine if there was a difference between the massed and distributed condition groups in performance.

The Broer-Miller Backhand Drive Test measured the performance of the massed and distributed condition pairs after the second four weeks of instruction. Fisher's "t" test for the significance of difference among small uncorrelated groups was applied to the results.

The Scott-French Revision of the Dyer Wall Test measured the combined forehand and backhand drive performance of the pairs according to the sequence of practice times such as massed conditions the first four weeks and distributed conditions the second four weeks or reversed. Fisher's "t" test for the significance of difference among small uncorrelated groups was the statistic used to determine whether the massed-distributed sequence or the distributed-massed sequence was superior.

CHAPTER V

ANALYSIS AND INTERPRETATION OF DATA

This study compared the effects of massed and distributed practice on the learning of the forehand and backhand drives in tennis. The experiment was conducted in a gymnasium. Fourteen students from each of two classes were paired according to their Scott Motor Ability Test scores and according to their past experience in tennis. Class I practiced the forehand drive under massed conditions while Class II practiced under distributed conditions. The conditions were reversed for each class when they practiced the backhand drive. After the forehand drive practice sessions were completed, the Broer-Miller Forehand Drive Test was administered to both classes. After completion of the backhand drive sessions, the Broer-Miller Backhand Drive Test was administered. During the third class period after the Broer-Miller Backhand Drive Test was given, the Scott-French Revision of the Dyer Wall Test was administered.

The statistic used for all three comparisons was the Fisher's "t" test for the significance of difference among

small uncorrelated groups. The formula is:

$$t = \frac{\overline{x_1} - \overline{x_2}}{\sqrt{\frac{Ex_1^2 + Ex_2^2}{N_1 + N_2 - 2}\left(\frac{1}{N_1} + \frac{1}{N_2}\right)}}$$

Forehand Drive

Fisher's "t" test for the significance of difference among small uncorrelated groups was employed to determine if there was a significant difference between the massed and distributed condition classes in performance of the forehand drive. The test revealed a t-value of .205--which was less than the criterion value of 2.05. (See Table I, page 55.) There was no difference between the two conditions in terms of forehand test results.

Fisher's "t" test for the significance of difference among small uncorrelated groups was employed to determine if there was a significant difference between the massed and distributed condition classes in performance of the backhand drive. The test revealed a t-value of 2.94--which was more than the criterion value of 2.76 at the one per cent level of confidence. (See Table II, page 55.) Therefore, the distributed group was superior to the massed condition group.

The investigator felt this difference was due to the complexity of the backhand skill as compared to the forehand

TABLE I

SIGNIFICANCE OF DIFFERENCE BETWEEN MASSED AND DISTRIBUTED CONDITION GROUPS IN PERFORMANCE OF THE FOREHAND DRIVE

CLASSES	N	MEAN DIFFERENCE	"t"	LEVEL OF CONFIDENCE
Massed - Group I	14			
		-.85	-.205	
Distributed - Group II	14			

The criterion value was 2.05 for .05 level of confidence.

TABLE II

SIGNIFICANCE OF DIFFERENCE BETWEEN MASSED AND DISTRIBUTED CONDITION GROUPS IN IN PERFORMANCE OF THE BACKHAND DRIVE

CLASSES	N	DIFFERENCE	"t"	LEVEL OF CONFIDENCE
Massed - Group II	14			
		-9.07	-2.94	1%
Distributed - Group I	14			

The criterion value was 2.76 for .01 level of confidence

skill. Inspection of the daily scores indicated that the backhand drive was more difficult to master for the students. Therefore, the subjects practicing under massed conditions possibly became more frustrated or fatigued because of no rest, and consequently did not perform as well as the distributed condition group. Several comments made about the backhand drive by students led the investigator to believe they were frustrated and fatigued.

Combined Forehand and Backhand Drives

Fisher's "t" test for the significance of difference among small uncorrelated groups was employed to determine if there was a significant difference between the sequence of massed-distributed or distributed-massed condition groups in performance of the combined forehand and backhand drives. The test revealed a t-value of .753--which was less than the criterion value of 2.05. (See Table III, page 57.) Therefore, there was no difference between groups in terms of performance on the Scott-French Revision of the Dyer Wall Test, regardless of the sequence of practice conditions.

It was observed that the students used the forehand drive, which was apparently the easier stroke, much more frequently than the backhand drive when they took the Scott-French Revision of the Dyer Wall Test. Since it was already

TABLE III

SIGNIFICANCE OF DIFFERENCE BETWEEN THE SEQUENCE OF MASSED-DISTRIBUTED AND DISTRIBUTED-MASSED CONDITION GROUPS IN PERFORMANCE OF THE COMBINED FOREHAND AND BACKHAND DRIVES

CLASSES	N	MEAN DIFFERENCE	"t"	LEVEL OF CONFIDENCE
Massed-Distributed Group I	14			
		-1.93	-.753	
Distributed-Massed Group II	14			

The criterion value was 2.05 for .05 level of confidence

revealed that there was no significant difference between the groups in the performance of the forehand drive, this outcome was not surprising.

Raw scores for all three tests may be found in the Appendix.

CHAPTER VI

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

Summary

The purpose of the experiment was to compare the effects of massed and distributed practice on the learning of the forehand and backhand drives in tennis.

The study was conducted at the University of North Carolina at Greensboro, during the spring term of 1968. The subjects were undergraduate women students in two beginning physical education tennis service classes. The twenty-eight subjects were matched in pairs according to their Scott Motor Ability Test scores and according to their past tennis experience. The entire experiment was conducted indoors as in a typical winter class situation. One class practiced the forehand drive against the wall for fifteen minutes twice a week for three weeks under massed conditions, while the other class practiced the forehand drive against the wall for fifteen minutes twice a week for three weeks under distributed conditions. The same procedure was followed for the backhand drive sessions except the two groups reversed conditions of practice.

The Broer-Miller Forehand Drive Test was administered to both classes after completion of the forehand drive practice sessions and the Broer-Miller Backhand Drive Test was given to both classes after completion of the backhand practice sessions. At the third period after the backhand drive test was given, the Scott-French Revision of the Dyer Wall Test was administered to determine the combined forehand and backhand drive performance of the sequential massed-distributed condition class and the distributed-massed condition class.

The statistic employed for all three comparisons was the Fisher's "t" test for the significance of difference among small uncorrelated groups. This was used to determine if there was a significant difference between the massed and distributed condition classes and the sequential massed-distributed, distributed-massed condition classes in forehand and backhand drive performance.

Results revealed that there was no significant difference between the performance of the massed and distributed condition groups in the forehand drive.

In the backhand drive performance by both groups, the distributed condition group was superior to the massed condition group at the one per cent level of confidence.

There was no significant difference between the performance of the sequential massed-distributed condition group

and that of the distributed-massed condition group in the combined forehand and backhand drives.

Conclusions

Under the conditions of this study the following conclusions were drawn:

1. Fifteen continuous minutes of practice on the forehand drive each period twice a week is just as effective as having fifteen minutes of practice with a change of activity spaced between every five minutes of practice.

2. Distributed practice of fifteen minutes with a change of activity spaced between each five minutes of practice is more beneficial than massed practice of fifteen continuous minutes in learning the backhand drive.

3. The sequence of learning the forehand drive under massed conditions, the backhand drive under distributed conditions, and vice versa does not seem to affect performance.

Suggestions for Further Study

1. By conducting a study similar to this one, without reversing the conditions of practice in the middle of the experiment, it would be possible to use the Scott-French Revision of the Dyer Wall Test to compare the effects of massed and distributed condition groups on the combined forehand and backhand drives.

2. An experiment similar to this one, but teaching the backhand drive first might reveal different results.

3. An experiment could be conducted in which the forehand and backhand drives are practiced at the same time. Perhaps the learning of one of the strokes first, hinders the learning of the other stroke.

4. A similar experiment could be conducted with male college subjects or with a junior high school group of subjects. It was observed in this study that the two male subjects before they were dropped from the study, were the best performers of the two classes possibly because of their competitive spirits. A younger age group would possibly be more enthusiastic.

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APPENDIX A

TENNIS QUESTIONNAIRE

1. Have you ever held a tennis racket before?
2. Do you know what forehand and backhand are?
3. Can you execute an overhead tennis serve?
4. Do you know how to score a game of tennis?
5. Do you know how to play the game of tennis?
6. Have you ever played a game?
7. Have you ever played at the net?
8. Have you ever watched a tennis game?
9. Have you had any tennis instruction? If so, by whom and how many lessons?
10. If No to number 9, have you ever hit the ball back and forth across the net? Approximately how many times did you keep the ball going?

APPENDIX B

LESSON PLANS

Both 10:00 and 3:00 Classes - Introductory

Racket grip for forehand drive
Ball bouncing with grip
Naming of the parts of the racket
Basics of the forehand drive
    a) Stance
    b) Swing
    c) Rhythm
Demonstration of the stroke against the wall
Practice by class of the swing with corrections
Practice of the stroke against the wall

Review of the basics of the forehand drive
Ball bouncing with forehand grip
Practice of the forehand drive against the wall
Practice bouncing balls to self and hitting to a partner across the gym
Explanation of the experiment

LESSON 3

10:00 Class

10:15-10:20 -- First group of thirteen hit forehand drive against the wall
Second group of thirteen practiced the overhand throw in the center as a lead-up to the serve

10:21-10:26 -- The two groups reversed positions

10:27-10:32 -- First group hit forehand drive against the wall
Second group listened to the explanation of the serve and its parts, saw the demonstration, and practiced the entire swing with corrections

10:33-10:38 -- The two groups again reversed stations

10:39-10:44 -- The first group hit forehand drive against the wall
Second group practiced the toss and total coordination of the serve

10:45-10:50 -- The two groups reversed positions

3:00 Class

3:15-3:30 -- First group of thirteen hit forehand drive against the wall
Second group of thirteen practiced the overhand throw, listened to the explanation of the serve, saw the demonstration, practiced the swing, toss, and total coordination of the serve with corrections

3:31-3:46 -- The two groups reversed stations

LESSON 4

10:00 Class

10:15-10:30 -- First group hit forehand drive against the wall
Second group reviewed the entire serve and practiced the toss

10:21-10:26 -- The two groups reversed positions

LESSON 4 (cont.)

10:27-10:32 -- First group hit forehand drive against the wall
Second group practiced hitting the serve over the portable net and into the court diagonally across from them

10:33-10:38 -- The two groups again reversed stations

10:39-10:44 -- First group hit forehand drive against the wall
Second group practiced serving over the net

10:45-10:50 -- The two groups reversed stations

3:00 Class

3:15-3:30 -- First group hit forehand drive against the wall
Second group reviewed the entire serve, practiced the toss, and practiced serving over the net and into the diagonal court

3:31-3:46 -- The two groups reversed positions

LESSON 5

10:00 Class

10:15-10:20 -- First group of thirteen hit forehand drive against the wall
Second group of thirteen listened to an explanation of serving in relation to the actual game

10:21-10:26 -- The two groups interchanged

10:27-10:32 -- First group hit forehand drive against the wall
Second group practiced serving over the net and into the proper court

10:33-10:38 -- The two groups interchanged

10:39-10:44 -- First group hit forehand drive against the wall
Second group practiced serving over the net and into the proper court

10:45-10:50 -- The two groups switched stations

LESSON 5 (cont.)

3:00 Class

3:15-3:30 -- First group of thirteen hit forehand drive against the wall
Second group listened to an explanation of serving in relation to the actual game and practiced serving over the net into the proper court

3:31-3:46 -- The two groups switched places

LESSON 6

10:00 Class

10:15-10:20 -- First group of thirteen hit forehand drive against the wall
Second group practiced serving over the net

10:21-10:26 -- The two groups reversed positions

10:27-10:32 -- First group hit forehand drive against the wall
Second group practiced serving over the net

10:33-10:38 -- The two groups reversed stations

10:39-10:44 -- First group hit forehand drive against the wall
Second group listened to a brief introduction into net play

10:45-10:50 -- The two groups interchanged

3:00 Class

3:15-3:30 -- First group of thirteen hit forehand drive against the wall
Second group practiced serving over the net and listened to a brief introduction into net play

3:31-3:46 -- The two groups interchanged

LESSON 7

10:00 Class

10:15-10:20 -- First group of thirteen hit forehand drive against the wall
Second group saw a demonstration of net play and practiced just meeting the ball at the net

10:21-10:26 -- The two groups exchanged places

10:27-10:32 -- First group hit forehand drive against the wall
Second group practiced net play with a partner tossing the ball

10:33-10:38 -- The two groups switched stations

10:39-10:44 -- First group hit forehand drive against the wall
Second group practiced net play with partners

10:45-10:50 -- The two groups interchanged

3:00 Class

3:15-3:30 -- First group of thirteen hit forehand drive against the wall
Second group watched a demonstration of net play, and then practiced at the net with partners

3:31-3:46 -- The two groups exchanged places

LESSON 8

10:00 Class

10:15-10:20 -- First group of thirteen hit forehand drive against the wall
Second group practiced hitting forehand drives with the Ball-boy tossing the balls

10:21-10:26 -- The two groups switched places

10:27-10:32 -- First group hit forehand drive against the wall
Second group practiced hitting forehand drives with the Ball-boy tossing the balls

10:33-10:38 -- The two groups interchanged

LESSON 8 (cont.)

10:39-10:44 -- First group hit forehand drive against the wall
Second group practiced hitting forehand drives with the Ball-boy tossing the balls

10:45-10:50 -- The two groups exchanged places

3:00 Class

3:15-3:30 -- First group of thirteen hit forehand drive against the wall
Second group practiced hitting forehand drives with the Ball-boy tossing the balls

3:31-3:46 -- The two groups switched places

LESSON 9

Both 10:00 and 3:00 Classes

10:15-10:50 -- Both groups took the Broer-Miller Forehand Drive Test

3:15-3:50 -- Both groups took the Broer-Miller Forehand Drive Test

LESSON 10

Both 10:00 and 3:00 Classes

Racket grip for backhand drive
Ball bouncing on top of racket with forehand grip
Basics of the backhand drive
a) Stance
b) Swing
c) Rhythm
Demonstration of the stroke against the wall
Practice by class of the swing with corrections
Practice of the stroke against the wall

LESSON 11

Both 10:00 and 3:00 Classes

Review of the basics of the backhand drive
Ball bouncing on top of the racket with forehand grip
Practice of the backhand drive against the wall
Practice bouncing balls to self and hitting to a partner across the gym
Explanation of the change in length of practice periods for both classes

LESSON 12

10:00 Class

10:15-10:30 -- First group of thirteen hit backhand drive against the wall
Second group practiced net with balls being tossed at them and to both sides
10:31-10:46 -- The two groups switched places

3:00 Class

3:15-3:20 -- First group of thirteen hit backhand drive against the wall
Second group practiced net with balls being tossed at them
3:21-3:26 -- The two groups interchanged
3:27-3:32 -- First group hit backhand drive against the wall
Second group practiced at net with balls being tossed to their forehand side
3:33-3:38 -- The two groups exchanged places
3:39-3:44 -- First group hit backhand drive against the wall
Second group practiced at net with balls being tossed to their backhand side
3:45-3:50 -- The two groups switched stations

LESSON 13

10:00 Class

10:15-10:30 -- First group of thirteen hit backhand drive against the wall
Second group practiced volleying back and forth with partners

10:31-10:46 -- The two groups exchanged places

3:00 Class

3:15-3:20 -- First group of thirteen hit backhand drive against the wall
Second group practiced volleying back and forth with partners

3:21-3:26 -- The two groups interchanged

3:27-3:32 -- First group hit backhand drive against the wall
Second group practiced volleying back and forth with partners

3:33-3:38 -- The two groups interchanged

3:39-3:44 -- First group hit backhand drive against the wall
Second group practiced volleying back and forth with partners

3:45-3:50 -- The two groups switched places

LESSON 14

10:00 Class

10:15-10:30 -- First group of thirteen hit backhand drive against the wall
Second group practiced volleying in partners and playing at net with the Ball-boy tossing the balls

10:31-10:46 -- The two groups exchanged places

3:00 Class

3:15-3:20 -- First group of thirteen hit backhand drive against the wall
Second group practiced volleying in partners

LESSON 14 (cont.)

3:21-3:26 -- The two groups switched stations
3:27-3:32 -- First group hit backhand drive against the wall
Second group practiced playing at net with the Ball-boy tossing the balls
3:33-3:38 -- The two groups exchanged places
3:39-3:44 -- First group hit backhand drive against the wall
Second group practiced playing at net with the Ball-boy tossing the balls
3:45-3:50 -- The two groups switched places

LESSON 15

10:00 Class

10:15-10:30 -- First group of thirteen hit backhand drive against the wall
Second group practiced serving and learned how to score a game
10:31-10:46 -- The two groups exchanged places

3:00 Class

3:15-3:20 -- First group of thirteen hit backhand drive against the wall
Second group practiced serving
3:21-3:26 -- The two groups exchanged places
3:27-3:32 -- First group hit backhand drive against the wall
Second group practiced serving
3:33-3:38 -- The two groups interchanged
3:39-3:44 -- First group hit backhand drive against the wall
Second group learned how to score a game
3:45-3:50 -- The two groups exchanged stations

LESSON 16

10:00 Class

10:15-10:30 -- First group of thirteen hit backhand drive against the wall

LESSON 16 (cont.)

Second group reviewed scoring, practiced volleying, and practiced serving

10:31-10:46 -- The two groups switched places

3:00 Class

3:15-3:20 -- First group of thirteen hit backhand drive against the wall

Second group reviewed scoring

3:21-3:26 -- The two groups exchanged stations

3:27-3:32 -- First group hit backhand drive against the wall

Second group practiced volleying

3:33-3:38 -- The two groups interchanged

3:39-3:44 -- First group hit backhand drive against the wall

Second group practiced serving

3:45-3:50 -- The two groups switched places

LESSON 17

10:00 Class

10:15-10:30 -- First group of thirteen hit backhand drive against the wall

Second group practiced hitting backhand drives with balls being tossed by the Ball-boy

10:31-10:46 -- The two groups switched places

3:00 Class

3:15-3:20 -- First group of thirteen hit backhand drive against the wall

Second group practiced hitting backhand drives with balls being tossed by the Ball-boy

3:21-3:26 -- The two groups exchanged stations

3:27-3:32 -- First group hit backhand drive against the wall

Second group practiced hitting backhand drives with balls being tossed by the Ball-boy

LESSON 17 (cont.)

3:33-3:38 -- The two groups interchanged

3:39-3:44 -- First group hit backhand drive against the wall

Second group practiced hitting backhand drives with balls being tossed by the Ball-boy

3:45-3:50 -- The two groups exchanged places

LESSON 18

Both 10:00 and 3:00 Classes

10:15-10:50 -- Both groups took the Broer-Miller Backhand Drive Test

3:15-3:50 -- Both groups took the Broer-Miller Backhand Drive Test

LESSON 19

Both 10:00 and 3:00 Classes--Outside

Rally practice with partners on other side of the court
Correction of errors in form
Correction of errors in court positioning

LESSON 20

Both 10:00 and 3:00 Classes--Outside

Rally practice with partners on other side of the court
Game Strategy
Practice of games with partner

LESSON 21

Both 10:00 and 3:00 Classes

10:15-10:50 -- Both groups took the Scott-French Revision of the Dyer Wall Test

3:15-3:50 -- Both groups took the Scott-French Revision of the Dyer Wall Test

APPENDIX C

THE BROER-MILLER FOREHAND-BACKHAND DRIVE TEST (12)

Equipment

One regulation court, with a regulation net with a rope stretched four feet above the net, one racket, fifteen to twenty balls in good condition, and a Ball-boy.

Test Directions

1. The player taking the test stands behind the base-line facing the net.

2. As the ball comes from the Ball-boy, she turns her side to the net and strokes the ball on one bounce attempting to place it in the back nine feet of the opposite court.

3. Each player is allowed fourteen trials on the fore-hand and fourteen trials on the backhand.

4. In order to score the values marked in Figure I, page 88, the balls must go between the top of the net and the rope and land in the designated area or on lines bounding the area. (Balls hitting the lines receive the score of the higher space.)

5. Balls which go over the rope score one-half the value of that area in which they land.

6. If a player misses the ball in attempting to strike it, it is considered a trial.

7. Let balls are taken over.

Scoring

1. The number of each trial is marked on the score card.

2. Each ball hit is scored 2-4-6-8-6-4-2 depending upon the area in which it lands (see Figure I, page 88). Each ball going over the rope is scored one-half the value of the area in which it lands. (Scorer may circle the ball number on the score card to facilitate the scoring.)

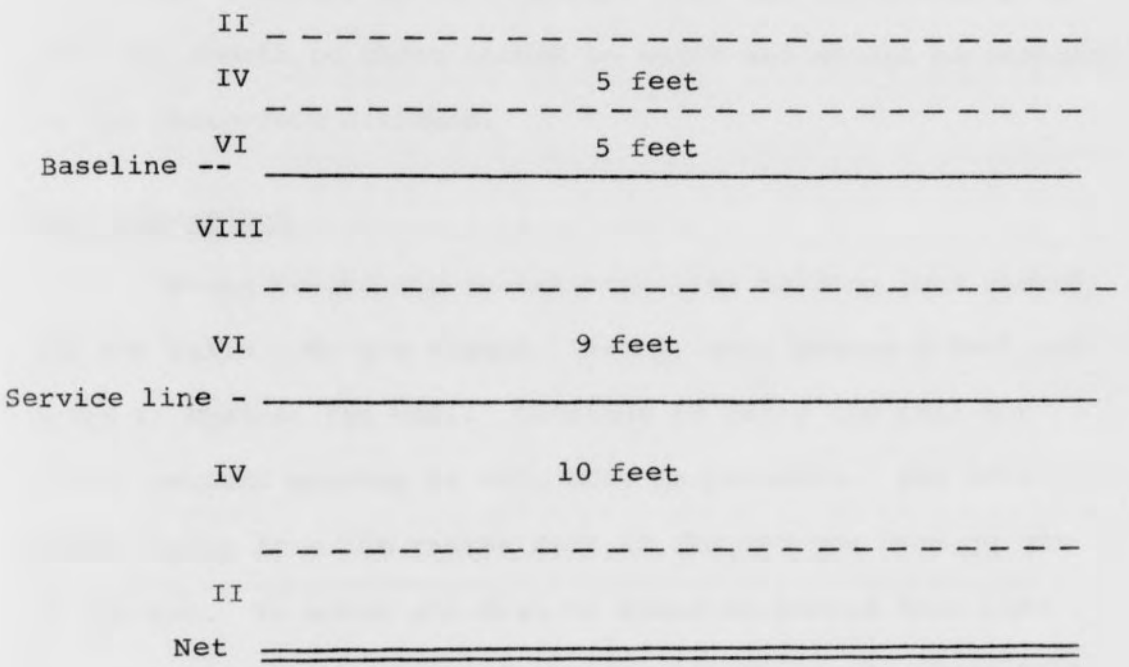
3. The total score equals the sum of fourteen balls on the forehand and fourteen balls on the backhand.

THE BROER-MILLER TEST SCORE CARD

NAME	T_1	T_2	T_3	T_4	T_5	T_6	T_7	T_8	T_9	T_{10}	T_{11}	T_{12}	T_{13}	T_{14}
1														
2														
3														
4														
5														
6														
7														
8														
9														
10														

FIGURE I

COURT MARKINGS FOR THE ADMINISTRATION OF THE BROER-MILLER FOREHAND-BACKHAND DRIVE TEST



Court Markings - 2 chalk lines are drawn parallel to the service line, one ten feet nearer the net than the service line and one nine feet nearer the baseline than the service line. Two lines are drawn parallel to the baseline, one five feet behind the baseline and one ten feet behind the baseline.

SCOTT-FRENCH REVISION OF THE DYER WALL TEST (1)

Facilities and Equipment

Two rackets, 10 to 12 balls, wall and floor space, the net line should be three inches in width and should be included in the three-foot distance.

Test Directions

"Stand behind the restraining line holding your racket and two balls. On the signal, 'Ready, Go!' bounce a ball and drive it against the wall. Continue to rally the ball for thirty seconds getting as many hits as possible. Get additional balls from the racket face if the two you have go out of control. To score you must be standing behind this line when you stroke the ball and it must hit above the three-foot line. It is permissible to go ahead of the line to keep the rally going but balls hit from this area do not score. You may hit the ball on the volley or after any number of bounces. Your score will be the total number of hits you make in three thirty-second trials."

Scoring

Three thirty-second trials are given. The score is the total hits for all three trials. A legal hit must land above

the three-foot line on the wall and must be contacted from behind the twenty-seven and a half foot restraining line. (See Figure II, page 91.)

THE SCOTT-FRENCH REVISION OF THE DYER WALL TEST SCORE CARD

Name _____

Wall Test Scores:

1. _____

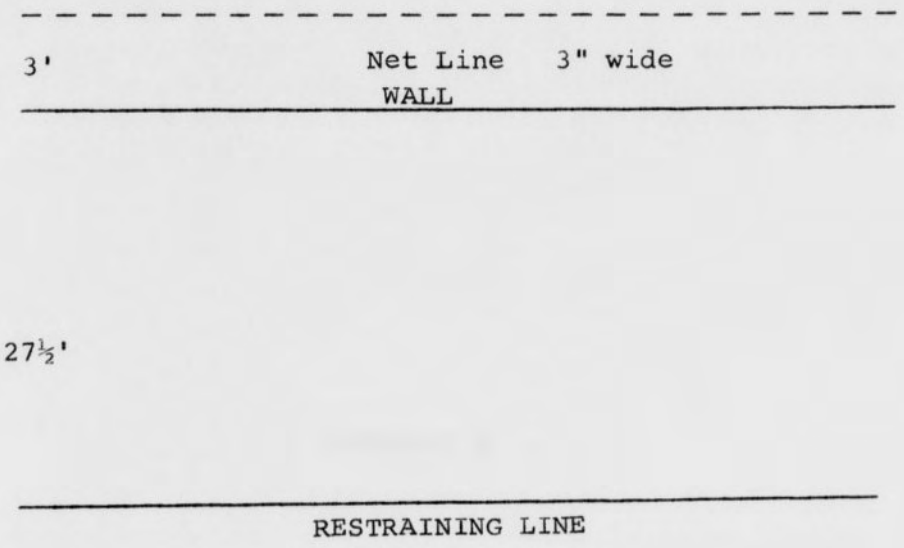
2. _____

3. _____

TOTAL _____

FIGURE II

MARKINGS FOR THE ADMINISTRATION OF THE
SCOTT-FRENCH REVISION OF THE
DYER WALL TEST



APPENDIX D

RAW SCORES OF CLASS I AND CLASS II
ON THE BROER-MILLER FOREHAND
DRIVE TEST

CLASS I - MASSED CONDITIONS		CLASS II - DISTRIBUTED CONDITIONS	
1.	8	1.	21
2.	18	2.	19
3.	23	3.	20
4.	24	4.	8
5.	8	5.	23
6.	9	6.	1
7.	29	7.	15
8.	24	8.	22
9.	35	9.	35
10.	19	10.	10
11.	18	11.	39
12.	23	12.	12
13.	39	13.	32
14.	33	14.	41
	310		298

RAW SCORES OF CLASS I AND CLASS II
ON THE BROER-MILLER BACKHAND
DRIVE TEST

CLASS I - DISTRIBUTED CONDITIONS		CLASS II - MASSED CONDITIONS	
1.	29	1.	9
2.	35	2.	13
3.	12	3.	20
4.	26	4.	9
5.	14	5.	16
6.	19	6.	22
7.	34	7.	8
8.	11	8.	11
9.	17	9.	18
10.	12	10.	8
11.	24	11.	2
12.	5	12.	2
13.	27	13.	21
14.	30	14.	9
	295		168

RAW SCORES OF THE THREE TRIALS OF CLASS I AND CLASS II ON THE SCOTT-FRENCH REVISION OF THE DYER WALL TEST

CLASS I - MASSED-DISTRIBUTED					CLASS II - DISTRIBUTED-MASSED				
	T_1	T_2	T_3	Total		T_1	T_2	T_3	Total
1.	7	7	7	21	1.	8	6	8	22
2.	3	2	5	10	2.	5	10	9	24
3.	8	4	5	17	3.	4	5	8	17
4.	3	10	6	19	4.	9	3	3	15
5.	6	5	9	20	5.	6	7	8	21
6.	5	12	7	24	6.	3	7	8	18
7.	6	10	10	26	7.	5	11	5	21
8.	5	9	8	22	8.	7	4	6	17
9.	9	10	6	25	9.	11	9	10	30
10.	9	7	9	25	10.	9	10	13	32
11.	5	8	10	23	11.	4	5	4	13
12.	12	14	11	37	12.	5	10	6	21
13.	10	12	13	35	13.	10	11	10	31
14.	13	10	11	34	14.	10	7	12	19
	101	120	117	338		96	105	110	311