EFFECTS OF MENTAL PRACTICE ON LEARNING AND PERFORMANCE OF TRACK AND FIELD SKILLS OF UPPER ELEMENTARY SCHOOL CHILDREN

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ABSTRACT

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By

Alice Marie Workinger

The purpose of this study was to determine the effects combined mental and physical practice would have upon the learning and performances of novice participants in track and field, as opposed to those having only physical practice in the same skills.

Subjects were upper elementary school students, volunteers from a parochial school. These children were completing fourth, fifth, or sixth grades. Of the forty-one original participants, thirty completed the study. Subjects met Monday through Thursday, for four weeks, a total of approximately twenty-two hours of instruction and practice.

Activities selected for the study were representative of sprints, field events, and endurance events; a 30-yard dash, from starting blocks; a high jump, using the scissors technique, and a 333-yard run. Subjects were tested in each of these events and ranked according

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to performance. Ranks were summed, ordered, and assignment of subjects was made to one of two groups; using the S-method and the ordered sums of ranks. Groups were randomly designated control (physical practice only) and experimental (mental-physical practice).

Subjects in the experimental group engaged in mental practice of one or two events daily, the fourth through the fourteenth sessions. Both groups had the same amounts of physical practice. Subjects were tested weekly on each of the three events.

Experimental and control group means were calculated after tests in each event. Graphs were plotted from the data to determine if any trends in learning could be identified. Both groups were also divided into three skill levels, based upon initial performance in each event. Means of these subgroups were calculated and the results graphed. Visual comparisons were made between the individual skill level means in each event and also between events, within the three skill levels.

Data were statistically analyzed with a t-test to determine the significance of the difference between mean changes in the experimental and control groups. The statistical tests were applied to the difference between scores on the first and third tests in each event.

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Small and variable sample size limited the conclusions which could be drawn from the data. However, the graphs would indicate that combined mental and physical practice contributes to improved performance in these three events, particularly at the lower skill level. The improvement by the experimental group was apparently obscured by greater improvements for the control group at other skill levels, therefore the mental-physical practice group as a whole demonstrated only slightly more improvement than the physical practice group.

No statistically significant differences between the mean difference scores for the physical practice and the mental-physical practice groups were found, for any of the three events.

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By

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CHAPTER I

INTRODUCTION

It is generally accepted that highly skilled performers and competitors give at least some anticipatory thought to their performances before competition. For some, this "practice" may only be an unconscious effort to concentrate on the task at hand. Others may attempt to become "psyched-up" for the performance. Still others may spend time thinking through strategies to be used in given situations.

With experienced performers, this practice is easy because past experience provides a reference point. People learning new skills do not have this experience and may not even be aware that they should think about what they are doing. Even the admonition by the instructor-coach to, "Think about what you're doing," may not produce any cognitive change, especially if the student is not quite sure what he should be thinking about.

Is it possible that students with no experience, or relatively little experience, in an activity could increase the speed with which they learn new skills, by engaging in mental practice as they are learning?

Statement of Purpose

The purpose of this study was to determine the effects combined mental and physical practice would have upon the learning and performances of novice participants in track and field, as opposed to those having only physical practice in the same skills.

Delimitations

Subjects were fourth, fifth, and sixth grade boys and girls, students at a parochial school in Lansing, Michigan. The students were asked to volunteer for the study, and a sample size of forty-one was procured. Their past learning experiences with the skills investigated were believed to be similar to others in their age range in any public school physical education class.

Definitions

Symbolic rehearsal, covert practice, visualization, imagery, introspective rehearsal, and mind rehearsal, are all terms which have been used to indicate some form of mental practice. In some studies there have been distinctions made between "mental practice" and visual

imagery, the latter referring to the controllability, by subjects, of the visual image.

Within this study, mental practice was defined as a practice session where subjects in the experimental group were engaged in the cognition of self-performance. The experimental group was directed to think completely through their performances in the activity. Two cognitive arts were stressed. Subjects were instructed to attempt to feel themselves participating, and their efforts while engaging in this practice, should have been successful.

CHAPTER II

REVIEW OF LITERATURE

Introduction

The voluminous material available concerning mental practice necessitated delimitation of the literature review to the most pertinent aspects of the complex issue. The review is organized to consider the nature of tasks involved in previous experiments, intelligence, introspective analysis, length of the experimental period, and the method of mental practice.

Nature of the Task

Clark (1) analyzed the effects of mental practice on high school boys having different levels of experience in basketball. The skill involved was the one-hand foul shot. All subjects were given the same instructions regarding the execution of the skill before the initial test. Emphasis was on knowing how to shoot, seeing how the shot was executed, and feeling the motions of the shot, eyes open and eyes closed. After an initial test, the subjects were divided into a physical practice and a

mental practice group. Practice for the physical practice group involved five warm-ups and twenty-five shots daily for a score. Statistical treatment showed there were highly significant gains from both kinds of practice. However, the mental practice was most effective for those boys who had had some competitive experience. The suggestion was made that they were able to utilize the practice because of familiarity with the skill.

Vandell and others (14) utilized basketball free-throws as one of the criterion measures of success with mental practice. The subjects who had no practice except the pre and post tests showed no improvement. Those subjects engaging in physical practice demonstrated definite improvement in the basketball free-throw skill. The group involved in daily mental practice demonstrated improvement which was almost as effective as the physical practice.

The study also included work with jr. high school youngsters and college students in dart throwing. The practice regimen was the same as for the basketball throw and mental practice was arbitrary. In both cases the results showed that the mental practice tended to produce improved performance in later stages of the activity. The authors concluded that mental and physical practice were both nearly equal in effectiveness under the

conditions of the experiment. However, due to the fact that the improvement was judged only on the basis of gain scores, it is possible that other conclusions could be reached.

Twining (13) conducted his study with college men, using a control group, a physical practice group, and a mental practice group. The selected task involved tossing rings at a target. The three groups took a pre and post test of 210 rings tossed for accuracy, on the first and twenty-second days of the experiment. The physical practice group practiced throwing seventy rings daily for each of the intervening days of the study. The mental practice groups practiced the same number of times, but with no overt participation. The results indicated that the greatest gains in performance were made by the physical and the mental practice groups; one hundred thirty-seven percent and thirty-six percent, respectively. The improvement demonstrated by the physical practice group was significantly greater than that demonstrated by the mental practice group.

Oxendine (5), in a series of studies involving seventh grade boys, used a pursuit rotor, soccer kick for accuracy, and a novel jump shot to determine the effects of varied methods and combinations of mental and physical practice on learning. Following initial tests in each

skill, four groups were formed. One group in each skill utilized only overt practice. Groups two, three, and four, utilized varying combinations of mental and overt practice such that the portion of mental practice was twenty-five percent, fifty percent, and seventy-five percent, respectively. Remaining time was devoted to overt skill practice. He found that when the task is within the capacity of the student, up to fifty percent of time spent engaging in mental practice can be as effective in producing gains in performance as one hundred percent physical practice.

Corbin completed two studies using the task of wand juggling as a criterion measure. In his first study (2), involving college men, he administered a pretest to divide subjects into three initial skill levels. Subjects of each skill level were randomly assigned to mental practice, physical practice, combined, and control groups. All practice groups were allowed the same number of practice sessions, though methods of practice were different. A post test and a retention test, after thirty days of no practice, were administered. There were significant differences between means in all groups. The physical practice and combined mental-physical practice groups showed significantly greater performance scores than the control group. Between these two groups there was little difference. This would indicate that half

physical and half mental practice is as effective as physical practice alone with this skill. Mental practice did not appear to be effective in developing the juggling skill, as it was an unfamiliar task. Corbin had divided his subjects into high, medium, and low skill groups, on the basis of pretest scores, prior to random assignment to treatment groups. The skill levels of the performers did not affect ability to benefit from a particular type of treatment and there was no apparent difference in the lasting effects of any type of practice as determined by the retention test.

In his second study (3), using high school boys, Corbin investigated the effects of mental practice on skill development after controlled physical practice. Three groups were involved; a control group, allowed no practice after the initial five day period; a mental practice group, which was allowed mental practice of the skill for the experimental period; and a physical practice group, which was allowed to continue the practice it had been engaged in during the initial learning period. After data analysis, the physical practice group showed the most improvement. The mental practice group did demonstrate some gains. The conclusion drawn, was that in order for mental practice to be effective it must be based upon real experience.

Stebbins (12) utilized four experimental groups and a control group in his efforts to determine effects of varying combinations of mental and physical practice on throwing accuracy. The physical practice group was allowed twenty-five practice throws at the target daily for the duration of the experiment. The mental practice groups watched the group involved in manual practice. The final two experimental groups had the following practice sessions; the mental-physical practice group was allowed mental practice for the first through the tenth practices, then was allowed to practice the skill manually. The physical-mental group was engaged in physical practice initially and during the final days was allowed only mental practice. Conclusions reached by analysis of the data indicated that either of the combined practice methods was superior to the physical practice, mental practice, and control groups. Experimental errors were too great to show significance between physical practice and either of the combined methods. Results may have been due to the fact that the mental practice portions of the experimental treatment involved watching another person performing the skill. As much skill development occurred through mental practice as through physical practice during the early skill learning, as indicated by skills in this study.

Egstrom (4) studied the effects on learning of practice ranging from only physical practice, combinations of mental and physical practice, mental practice, and a control group. The skill selected was a novel one which involved re-directing the flight of a ball ninety degrees to hit a target. He concluded that mental practice is an effective method for acquiring and improving gross motor skills, but that physical practice appears more effective. He suggested that this was because sensory perceptions of movement accompanying the physical practice are more vivid than those visualized. There was also an apparent advantage to alternating the manual and conceptualizing practice. The groups alternating the practice methods, were less affected by the "plateaus" at higher levels of learning. The effectiveness of the method varied with the temporal and sequential arrangement of practice, as well as with the level of achievement. The conceptualizing method of practice alone was not effective at higher levels of learning.

Shick (9) studied the effects of mental practice by college women on the acquisition of two volleyball skills. Her subjects were volunteers. In each of three substudies, a pretest on the wall-volley and underhand volleyball serve was administered. These tests were repeated as the post test, following the experimental

period. The women in the first substudy had had some instruction in volleyball. A control group had no practice of any kind for a two week period, while the experimental group engaged in mental practice three minutes daily on each skill, for the same amount of time. Analysis of data revealed no significant difference between the two groups on the wall-volley, but there was a significant difference on the scores for the serve. The other two studies compared the effects of three minutes of mental practice and one minute of mental practice on the skills, for two groups having equal amounts of physical practice. Three skill levels (high, medium, low) were determined and subjects were randomly assigned to the two groups. In the study lasting five weeks, subjects having the three minutes of mental practice were found to have significantly better scores on the serving post test than those having only one minute of mental practice daily. Further investigation revealed that most of the difference was caused by improvement in the low skill group. Another study of the same design, lasting only three weeks, demonstrated no significant differences between the groups, for any of the three skill levels. No single variable was considered the key factor in determining an individual's score.

Phipps and Morehouse (6) completed a study to determine the relative effects of mental practice, for subjects with no prior physical practice, on the learning of three skills of increasing difficulty; the hock-swing on a horizontal bar, jump-foot (part of the Brace Test of Motor Ability), and the soccer hitch-kick. Subjects participated in the experiment for three weeks; one week was spent on each skill. The control group watched a demonstration of each skill and was then allowed a maximum of ten trials to satisfy the passing criterion of two successive completions of the skill. The trial during which the subject was successful in meeting the criterion was recorded. Subjects in the mental practice group saw the selected skill demonstrated on the Monday of each of the three phases of the experiment. Subjects were then given written instructions for the skill. During the mental practice period, the instructor also read the instructions aloud. On the fifth day subjects in the experimental group were tested individually. Passing criteria were the same for both groups. Comparisons were made between mean scores of the control and experimental groups for each activity. Only with the hock-swing were there significantly better scores for the mental practice group. Mental practice without prior physical practice did not appear to be effective in

learning either of the other two skills. The authors hypothesized that the value of mental practice depends upon the difficulty of the skill and also might be specific for simple skills.

Intelligence and the Ability to Engage in Mental Practice

Start (10) investigated the relationship of intelligence to the ability of twelve-year-old boys to mentally practice an underhand basketball free-throw. All subjects had an initial pretest of ten throws to determine their skill in the task. Students had already been assigned to academic "streams" in English secondary schools. Subjects from adjacent streams were compared and the upper six streams were considered. All subjects were given nine daily sessions of five minutes each to practice the skill mentally. A post test of ten throws was administered. Significant differences between initial and final scores were demonstrated by all six groups. There was no significance between the gains made by the higher intelligence groups and the lower intelligence groups, as measured by this skill. The author indicated that perhaps motivation played a great part in the performance. The skill was difficult to acquire and there was not a wide score range. Performance scores were negatively skewed, in that those initially demonstrating poor performance could not regress and tended to improve by chance.

In a previously cited study, Oxendine (5) compared IQ scores of the subjects and their performance scores at each stage of the experiment. Correlations were low (only seven of forty-eight were above .40) and there were no consistent trends demonstrated among the highest correlations. Subjects in both these groups were approximately twelve to thirteen years of age.

In Clark's study (1), intelligence was the only factor exerting no statistically significant influence on free-throw scores of the subjects.

Introspective Analysis

Attitude of the subjects must be considered when asking their co-operation in mental practice. The reactions of the participants to the practice sessions can provide information about appeal of the method. Most investigators recognized this.

Twining (13) found that five minutes was all the practice time which seemed effective for the subjects. Efforts beyond that point were non-rewarding, as concentration became more difficult. His mental practice group had been asked to practice daily for fifteen minutes.

Egstrom (4) asked his subjects to describe their particular practice techniques into a tape recorder. Some indicated they became distracted at times during their practice.

Start and Richardson (11) were interested in the efficiency of imagery as a factor in the ability of a person to improve motor performance after mental practice. Subjects rated themselves on the vividness of images they could develop in response to sentences descriptive of body senses. Subjects, all novices, were given a detailed instruction sheet providing analysis of a gymnastic move on the high bar. They were allowed six daily practice sessions of five minutes each to mentally practice the skill. On the seventh day of the experiment, subjects were asked to perform the skill for the first time. The vividness of imagery test was not found to be significantly correlated with efficiency of mental practice, as measured by performance of the gymnastic skill. There was an interaction of vividness and controllability of imagery and relationship to performance scores. "It would seem that neither vividness nor controllability of imagery separately predicts performance scores of a physical skill which has been learned by mental practice" (11:38).

In Corbin's study (2) with college students, questionnaires completed indicated that subjects experienced as much success in the covert practice as they had overtly. Some indicated they had difficulty visualizing their performances. The general opinion of these subjects

was that the covert rehearsal periods improved their abilities to relax, helped them concentrate, and helped them analyze the task.

Subjects in Corbin's other study (3) were high school students and their questionnaire analysis showed the mental practice group had more success during the practice session than while actually performing. Nearly all subjects reported they had confidence in the mental practice as a factor in improving skill.

In Shick's experiments (9), questionnaires were administered to the subjects to determine the type and clarity of images they had while engaging in mental practice of the volleyball skills. Responses on these questionnaires revealed that subjects had clear images of the activities, but the majority reported they were watching performances separate from their own bodies. Further questioning indicated the images were often of those people for whom they had counted volley scores or watched serve during the pretest.

Length of the Experimental Period

The length of the experimental periods varied, but most of the studies were relatively short. Clark's (1) subjects were given pre and post tests, and the intervening experimental period lasted fourteen days. Start and Richardson (11) and Oxendine (5) completed their

studies and obtained significant differences in seven days. Start (10) completed his experiment in ten days. Stebbins' (12) investigation involved twenty class meetings, but these were distributed over a six week period. Shick's experiment (9) consisted of three separate substudies. The first of which lasted fourteen days. The second was ongoing for five weeks, while the final study lasted three weeks. Phipps and Morehouse investigation (6) was also completed in three consecutive weeks, though each of the three phases required only one week apiece. The remaining studies reviewed; (2), (3), (4), (13), (14), were completed in between twenty and twenty-three days.

As indicated here, a relatively short experimental period can produce significant changes in performance of a new skill or demonstrate differences between practice methods of experimental groups.

Method of Mental Practice

In the studies cited, most of the practice was directed. Subjects were given printed instructions and asked to read them before the mental practice; (1), (2), (3), (6), (11), (13). Specific oral directions were given to the participants of these experiments; (5), (6), (10). Subjects were given the freedom to practice as they wished in the studies conducted by Egstrom (4),

Vandell (14), and Shick (9), though in the latter study, the amount of time for practice was specified and engaged in apart from the experimental situation. Participants in Stebbins' experiment (12) watched the subjects who were practicing manually.

Summary

Collectively the studies reviewed here suggest that:

1. Mental practice alone does not seem to produce the same success or improvement as does physical practice alone.

2. Combinations of mental and physical practice do seem to produce success in performance or rate of learning.

3. Some experience with the task appears necessary for subjects to benefit from mental practice. At least those with experience seem to demonstrate more improvement.

4. Relatively short experimental periods can demonstrate differences in the effectiveness of mental, physical, or combined practice methods.

5. Visualizing a task or imagining a practice situation seems to be a problem for some people.

6. Individuals may differ in their respective abilities and methods to practice mentally.

7. Within the IQ ranges considered in these studies, intelligence does not appear to be a factor in the ability of subjects to engage in mental practice.

CHAPTER III

DESIGN AND METHODOLOGY

Introduction

Previous experiments have investigated the effects of mental practice on the learning of discrete skills. There have been no attempts made to determine if the practice methods devised for these tasks can effectively contribute to learning continuous movements. The purpose of this study was to investigate the affects of combined mental and physical practice on the learning of continuous gross movement patterns, specifically three track and field skills.

Sample

Subjects were upper elementary school students, volunteers from a parochial school in Lansing, Michigan. These children ranged in age from ten to twelve years and were completing fourth, fifth, or sixth grades. Of the forty-one original participants, only thirty completed the study. The final group was composed of twenty-four boys and six girls.

Evidence seems to indicate that within "normal" limits, intelligence is not a factor in determining the effects of mental practice (1), (5), (10). Therefore, subjects were not matched on the basis of intelligence.

Length of the Experiment

Subjects met Monday through Thursday, from 4:00 to 5:30 in the afternoon, for four weeks. Due to inclement weather, no meeting was held on the last Wednesday of the experimental period; thus there were fifteen sessions or a total of approximately twenty-two hours of instruction and practice.

Criterion Measures

The author selected activities which were representative of sprints, field events, and endurance events.

A 30-yard dash from starting blocks was selected as the sprint event instead of a more "standard" 50-yard dash, because even a distance of fifty yards may be an endurance event for some subjects at this age. A measure was desired which was indicative of speed, not staying power.

The high jump, using a scissors jump, was selected as the field event. There was no satisfactory foam landing area available, therefore it was not possible to present

one of the competitive high jumping techniques. Lack of proper facilities prohibited selection of the running long jump. Other possible events were ruled out because of the lack of facilities and insufficient equipment.

A distance between two hundred twenty and four hundred forty yards was determined satisfactory for an endurance event. The park where the experiment was conducted was adjacent to an oval parking area; the surface of which was packed dirt. The straight portion of this "track" was two hundred ninety-five feet long, the curves measured two hundred five feet. This distance, three hundred thirty-three yards, was established as the distance for the endurance event. While this distance, for adult competitors, would be considered a sprint; for untrained youngsters it is an endurance run.

Collection of Data

Measures on the selected events were obtained weekly. Before the initial test on the 30-yard dash, the sprint start from starting blocks was explained and demonstrated. All subjects than had two non-consecutive practice starts to determine preferred drive leg. Subjects had one timed trial for the 30-yard dash during any test session. Times were recorded to the nearest slower tenth of a second.

The initial measure for the high jump was obtained the same way for all participants. Each subject had three attempts to clear any height. A record of attempts and misses was maintained in the initial test, in order to rank subjects on their performances in this event. The beginning height was eighteen inches, the next height was twenty-four inches. Further increases of two inches were made up to the height of thirty-two inches and thereafter, increases were in one inch increments. When a subject failed to clear a height after three attempts, his best jump up to that point was recorded.

After the first tests, the two running events continued to be measured in the manner described. In the high jump, subjects were grouped roughly according to ability. They began jumping at a height approximately two inches below their previous best jump. Three attempts were allowed at any given height.

Assignment to Groups

With the exception of the mental practice sessions, all subjects had the same activities and instruction. (Specific activities are included as Appendix A). Pretests in each of the events were completed by the end of the first three meetings. Subjects were ranked in each event on the basis of performance. Ranks were summed, ordered,

and assignment of subjects was made to one of two groups; using the S-method and the ordered sums of ranks. Groups were randomly designated control (physical practice only) and experimental (mental-physical practice). Four subjects volunteered at the beginning of the second week of the experimental period. They were assigned to one or the other of the two groups with the use of a table of random numbers.

Experimental Treatment

Subjects in the experimental group engaged in mental practice of one or two events daily, the fourth through the fourteenth sessions. In all cases, the mental practice for one event occurred almost immediately before actual practice or testing of that event. An order was established for the imaginary practice of the events (30-yard dash, high jump, 333-yard run) to prevent possible interference of mental practice of one of the running events with mental practice of the other. Mental practice sessions were always separated by activity.

All subjects knew they were participants in an experiment. Each group was asked to refrain from discussing with anyone, their "special" practice in class. Only if procedures remained secret would the treatment work to their advantage. A placebo treatment for the control group (discussion of baseball statistics) was eliminated after

two days because it seemed to promote the kinds of activities and questions which were desirable to avoid.

Subjects were often grouped to practice skills, so it was possible to meet with the experimental group apart from the control group. Subjects in this group were asked to sit alone and practice with eyes closed. Verbal directions were given at the beginning of each mental practice session. (Specific directions and cues are included as Appendix B). No time interval was designated for practice of the sprint or high jump. Emphasis in both cases was upon completion of events an exact number of times. Five was the number selected because it was believed this many repetitions would not exceed two or three minutes.

Mental practice of the endurance event was conducted in a slightly different way. There was no evidence in the available literature of attempts to engage in the mental practice of an endurance event, and therefore no guide as to how this might most effectively be accomplished. The mental practice time for one repetition of the endurance run was established as seventy-five seconds. This value was obtained by subtracting ten seconds from the experimental group's mean 333-yard run time; a procedure roughly similar to determining an ideal pace time for a training program.

It became apparent during the first mental practice session for this event, that seventy-five seconds was too long for most of these children to concentrate. Subjects were allowed to "finish the race" at their own speeds and asked to indicate the finish by raising their hands. There were only three repetitions of this event during one mental practice session.

Six mental practice sessions were conducted for each event; thirty repetitions each for the 30-yard dash and high jump, and eighteen repetitions for the 333-yard run. The range of elapsed time was recorded for the subjects during each practice session of the endurance event. Toward the latter part of the experiment, approximate times for completion of each of the other two events were noted. This information is included in Table 1.

Statistical Treatment

Experimental and control group means were calculated after tests in each event. Graphs were plotted from the data to determine if any trends in learning could be identified. Both groups were also divided into three skill levels, based upon initial performance in each event. Means of these subgroups were calculated and the results graphed. Visual comparisons were made

Table 1. Mental Practice Schedule

Date	333-Yard Run	30-Yard Dash	High Jump
June 10	50-60[ab]	. .	*[c]
June 14	. .	6	*
June 15	. .	*	*
June 16	50-60	. .	. .
June 17	. .	7	. .
June 21	47-63	. .	*
June 22	43-62	5-6	. .
June 23	. .	. .	3-4
June 24	37-65	5-6	. .
June 28	. .	5	4-5
June 29	63-65 49-67 46-61	. .	. .

[a]Expressed in seconds.

[b]Time indicated is for one repetition.

[c]Mental practice was conducted, but elapsed time was not recorded.

between the individual skill level means in each event and also between events, within the three skill levels.

Data were statistically analyzed with a t-test to determine the significance of the difference between mean changes in the experimental and control groups. The statistical tests were applied to the difference between scores on the first and third tests in each event.

Introspective Analysis

Subjective reactions of the subjects to the practice method were of interest. At the conclusion of the study, participants in the experimental group were asked to respond individually to some questions about their experiences during mental practice. They were first given opportunities to describe what they saw and felt, then more specific questions were asked. (Questions asked in the interviews are included as Appendix C).

Limitations

Because subjects were volunteers, regular attendance at the activity sessions was not consistent. Consequently the data must be limited in its generalizability.

Difficulty in securing a sufficient sample size of sixth grade students, made it necessary to accept volunteers from several grade levels. Chronological age differences were compounded by a sample which was composed of both boys and girls.

There was no guarantee that the subjects involved in the "physical" practice schedule would not, of their own volition, think about their performances. There was no way to effectively control this variable. It was also impossible to accurately determine whether those subjects involved in mental practice, were actually engaging in the mental practice. However, it was believed that the children were sufficiently motivated to co-operate.

CHAPTER IV

PRESENTATION OF DATA

Introduction

The purpose of this study was to determine whether or not mental practice in combination with physical practice can bring about faster learning of gross motor skills, than can physical practice alone. Subjects volunteering for the experiment were upper elementary school students (N = 41). Skills which were utilized to measure the effects of the two practice methods were three track and field events; 30-yard dash, 333-yard run, and a high jump.

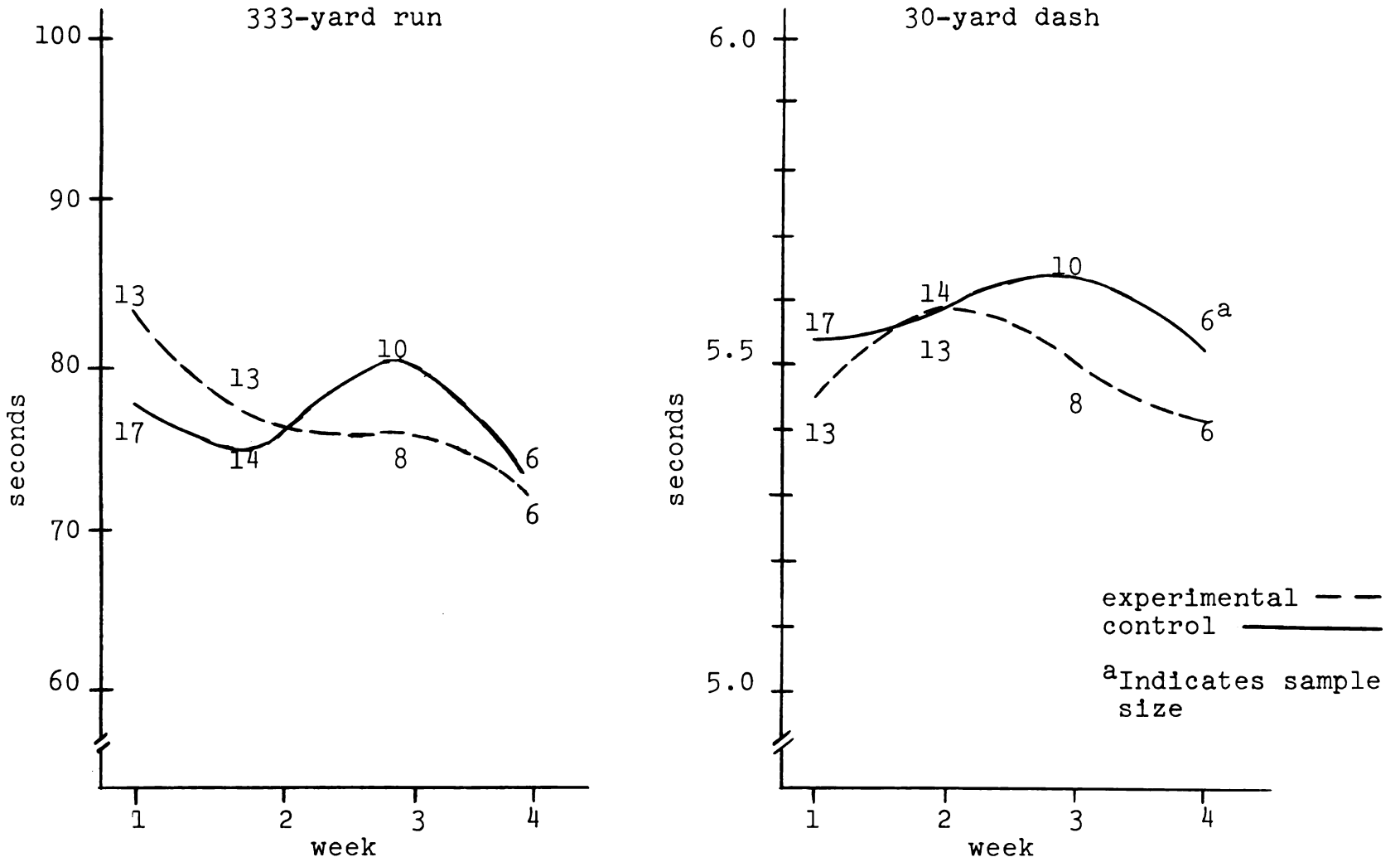
Subjects were initially tested in each of the three events, ranked according to scores obtained, and assigned to one of two groups on the basis of sums of ranks. This procedure roughly matched subjects on the basis of general ability. The two groups were randomly designated experimental and control. Subjects in the control group had only physical practice of the skills. Those in the experimental group had approximately the

same amounts of physical practice, but in addition, engaged in the mental practice of the events. Subjects were tested weekly, for four weeks, in each of the events. Following the experimental period, participants in the mental-physical practice group were individually asked to comment upon their thoughts during the mental practice sessions. Specific questions were asked regarding the nature of images they had while engaging in mental practice.

Discussion of Data

Sample size necessarily restricts the nature of generalizations which can be drawn from the data secured. (Raw data are included as Appendix D). While visual comparisons of group results have no statistical significance, they may illustrate trends in performance which occurred during the experimental period and thus give direction to future research. Means and standard deviations were calculated for the scores obtained by the physical practice and mental-physical practice groups, each week, for each event. The values obtained are depicted in Figures 1. through 3.

Despite the diminishing and variable sample sizes, graphs of the groups' mean scores seem to point toward slighly improved performance on the part of the



Figures 1. and 2. Mean Times For Experimental and Control Groups

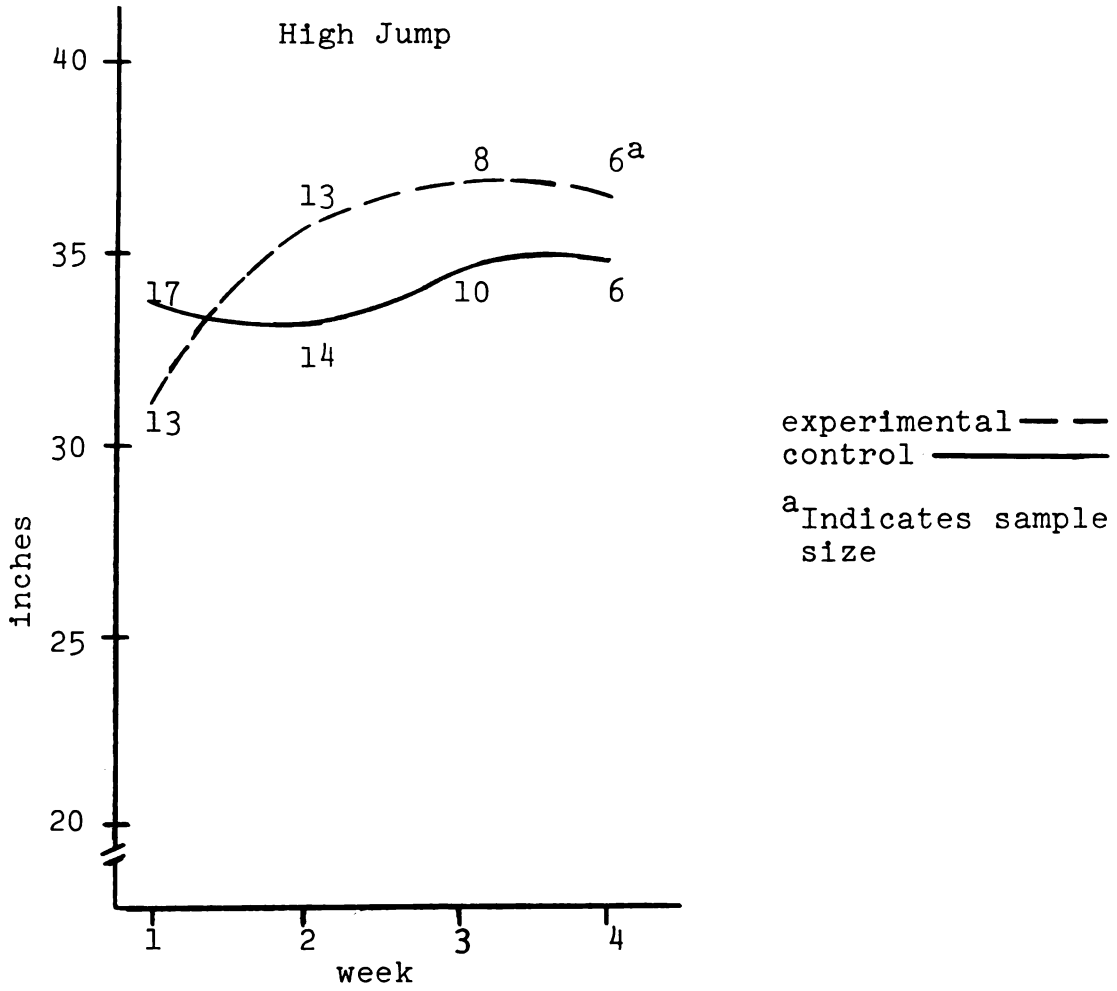
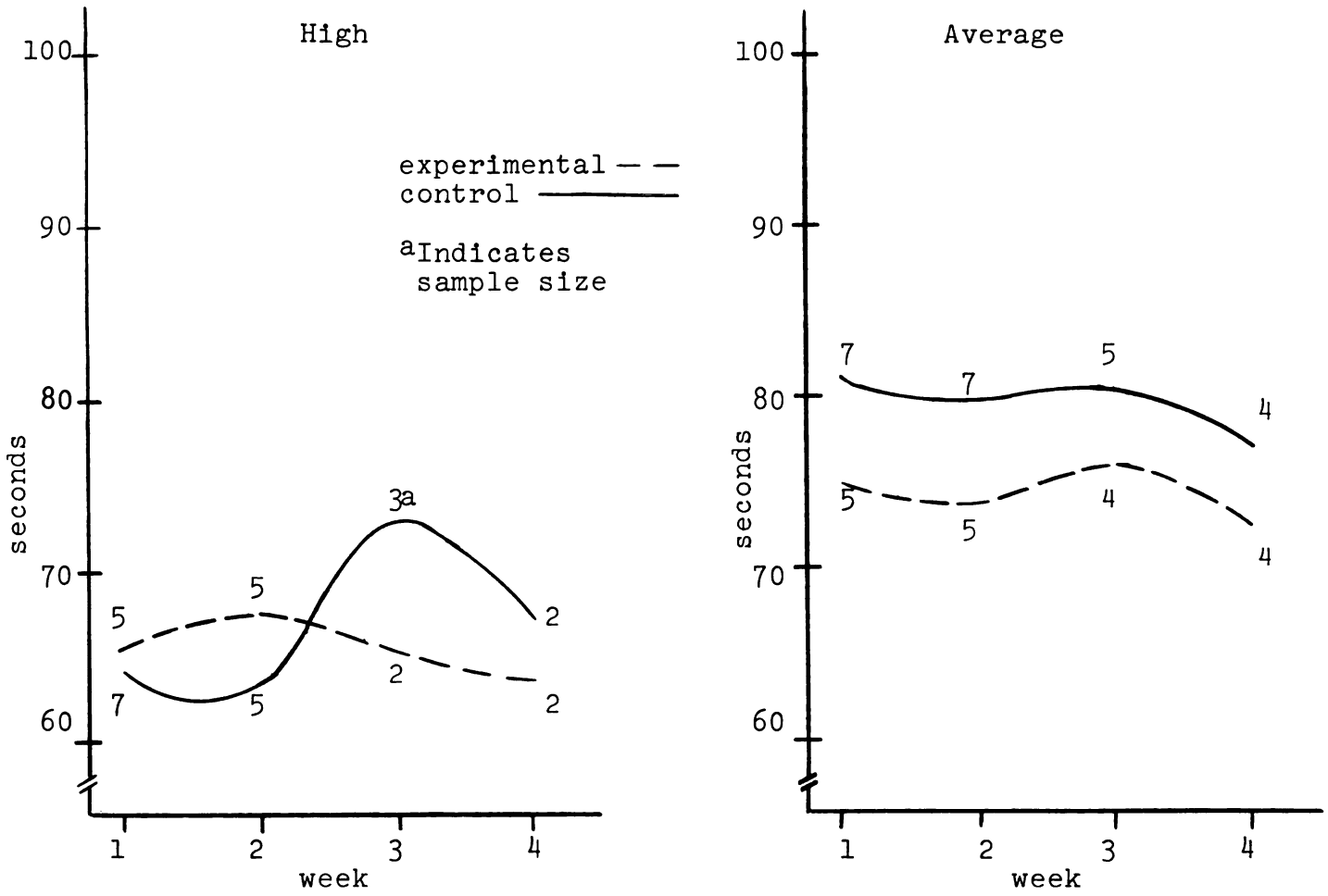


Figure 3. Mean Heights For Experimental and Control Groups

experimental group, in terms of decreased time in both running events and greater height attained in the high jump. The only other comment of importance which can justifiably be made is that the scores of the experimental group seem to be less variable than those of the control group. The control group reached a peak in performance during the second week, for all three skills, while the experimental group demonstrated CONTINUING improvement, i.e. learning.

In order to consider the function of ability level, subjects were divided into three skill levels, for each skill based on initial performance scores. Classification into the high skill level in one event did not necessarily mean automatic assignment to the same level for the other two events. Means and standard deviations were calculated for each of the three skill levels in each event. As with the total group means, the values calculated were graphed.

At all three skill levels the experimental group demonstrated the best time on the final 333-yard run test (Figures 4.-6.). There was more consistent improvement demonstrated by the experimental group than the control group throughout the experimental period. This is most dramatically illustrated by the decrease in mean time of fifty seconds made by the low skill



Figures 4. and 5. Mean Times For The High and Average Skill Groups In The 333-Yard Run

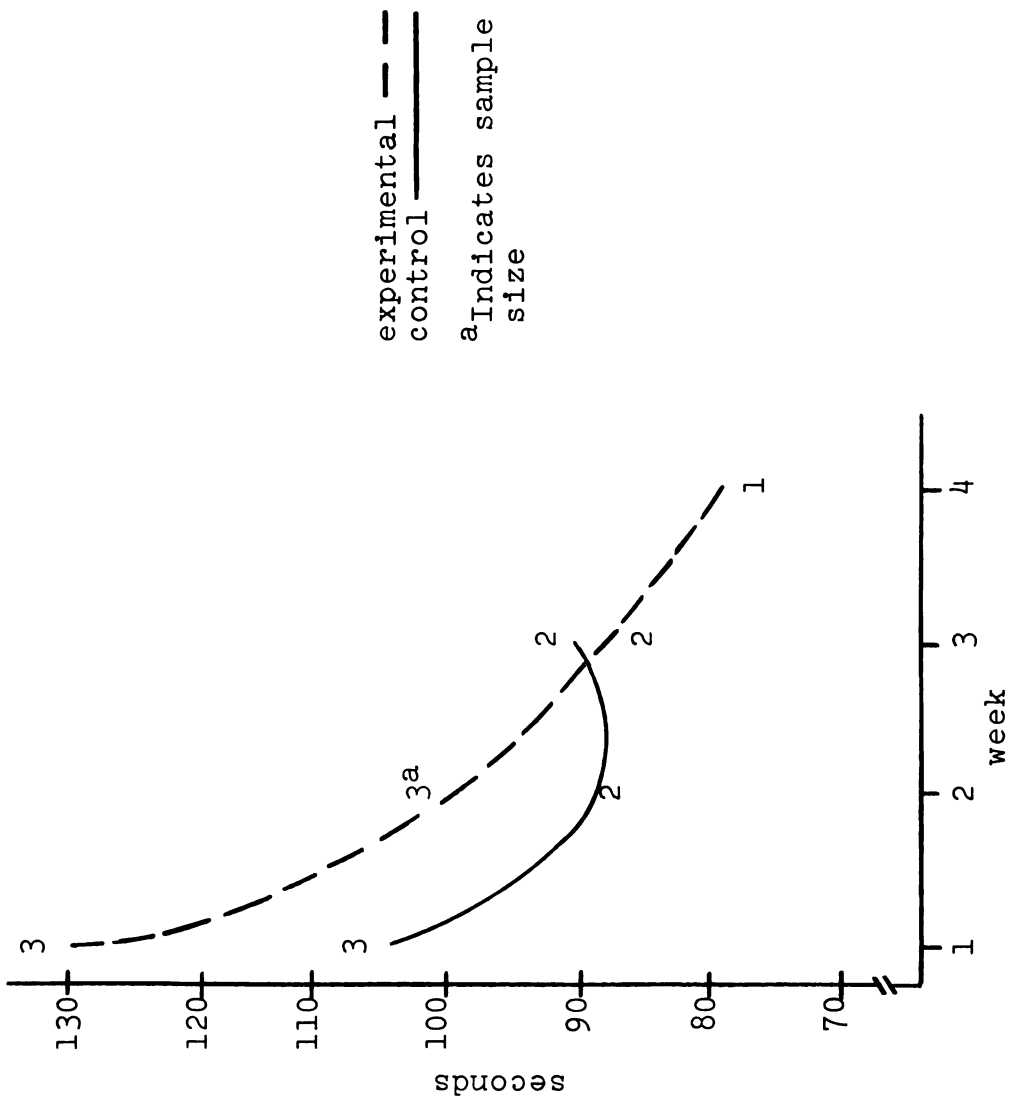


Figure 6. Mean Times For Low Skill Groups In The 333-Yard Run

group in this event. The control group demonstrated more week to week variations in performance than did the experimental group. Consistent improvement appeared to have been aided by the mental-physical practice.

Changes exhibited by "average" skilled subjects were of nearly the same magnitude (Figure 5.), except that the experimental subjects had initially lower times than the control subjects, so though decreases are the same in absolute time, proportionately their improvements were greater. Improvement for both groups at this skill level was gradual and comparisons may have the most significance because the sample size was larger and remained so throughout the experiment.

The most dramatic improvement was made by the low skill subgroup. Even if comparisons were to be made only through the third test, decreases in mean times made by both groups were large. It must be noted, however, that the experimental group mean was some twenty-five seconds higher at the first trial, which emphasizes the improvement made by this group.

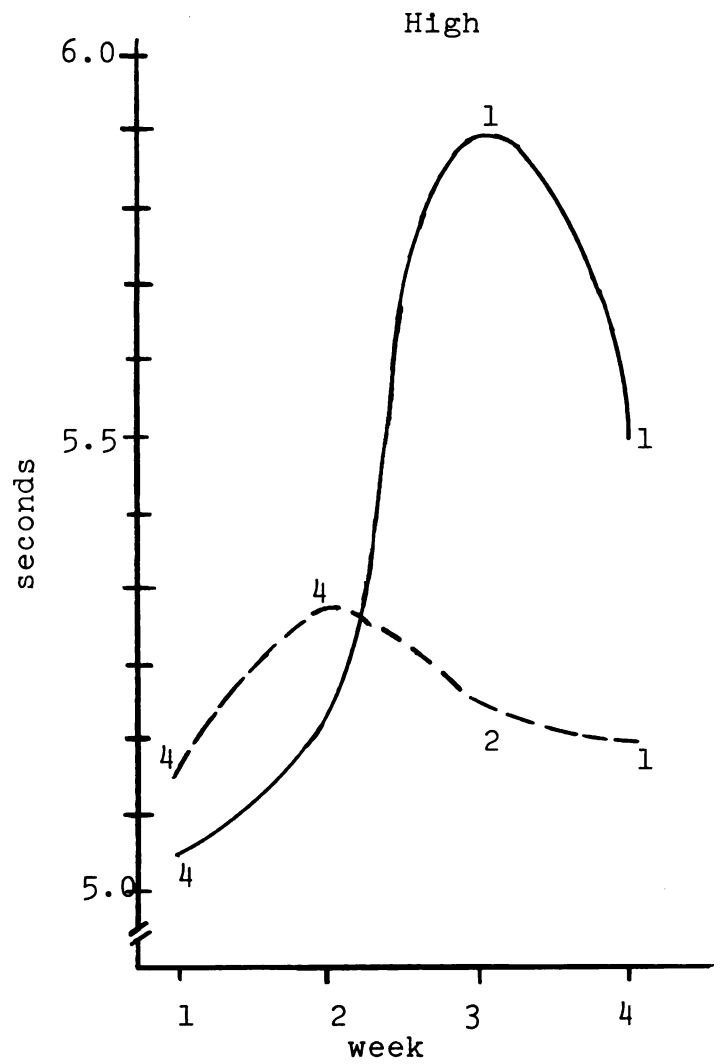
The high and low control groups demonstrated their best performances at the second test, after which, their mean values increased. Small sample size may have bearing on the fluctuations at these skill levels. It might

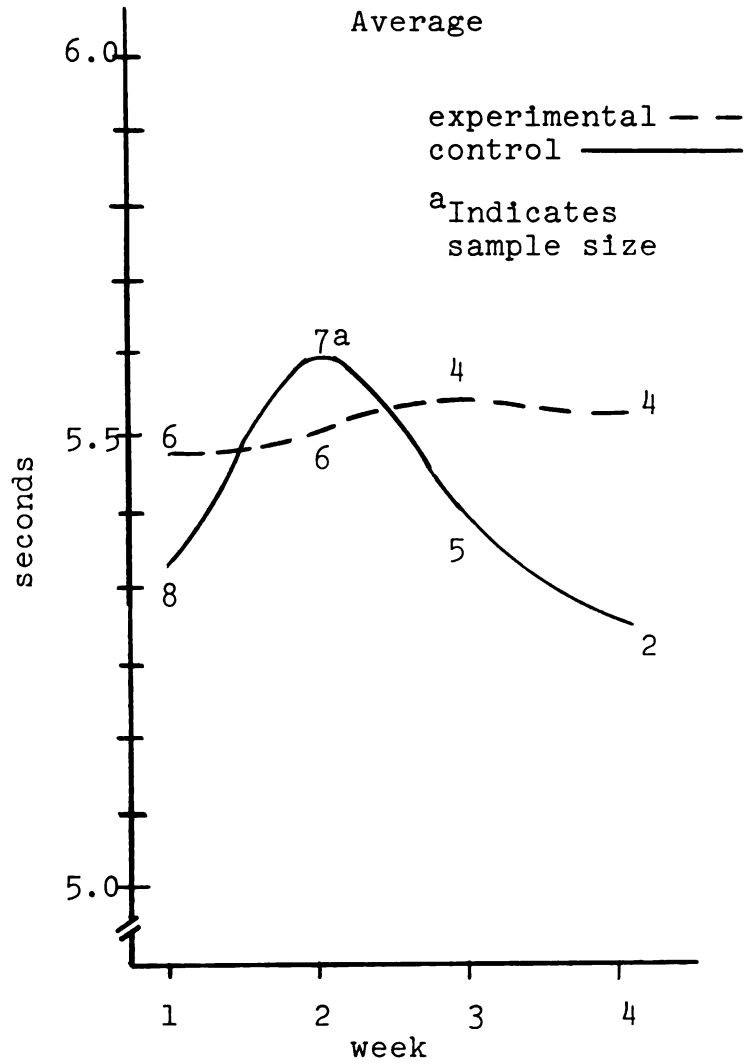
be expected that the learning curves for the two groups would level off and approach each other if the experimental period were extended.

Figures 7. through 9. depict the performances of high, average, and low skill groups on the 30-yard dash. The control group demonstrated greater fluctuations at all three levels when compared with the experimental group. It may be that the mental practice had a beneficial affect on achieving consistency in this event.

Mental practice appears to have been effective at the extreme skill levels. The size of the sample may be an important factor in results within both the groups. The high skill level of the control group demonstrated increased time in the 30-yard dash between the first and second tests. There were also initial increases in time for the experimental group at the same skill level. This may suggest that mental practice is not beneficial at this level.

The magnitude of change was greatest, in a positive direction, for subjects in the low experimental group. The best performance for the low control group was seen during the second week, then mean times increased again, nearly to the point of the initial test.





Figures 7. and 8. **Mean Times For The High and Average Skill Groups In The 30-Yard Dash**

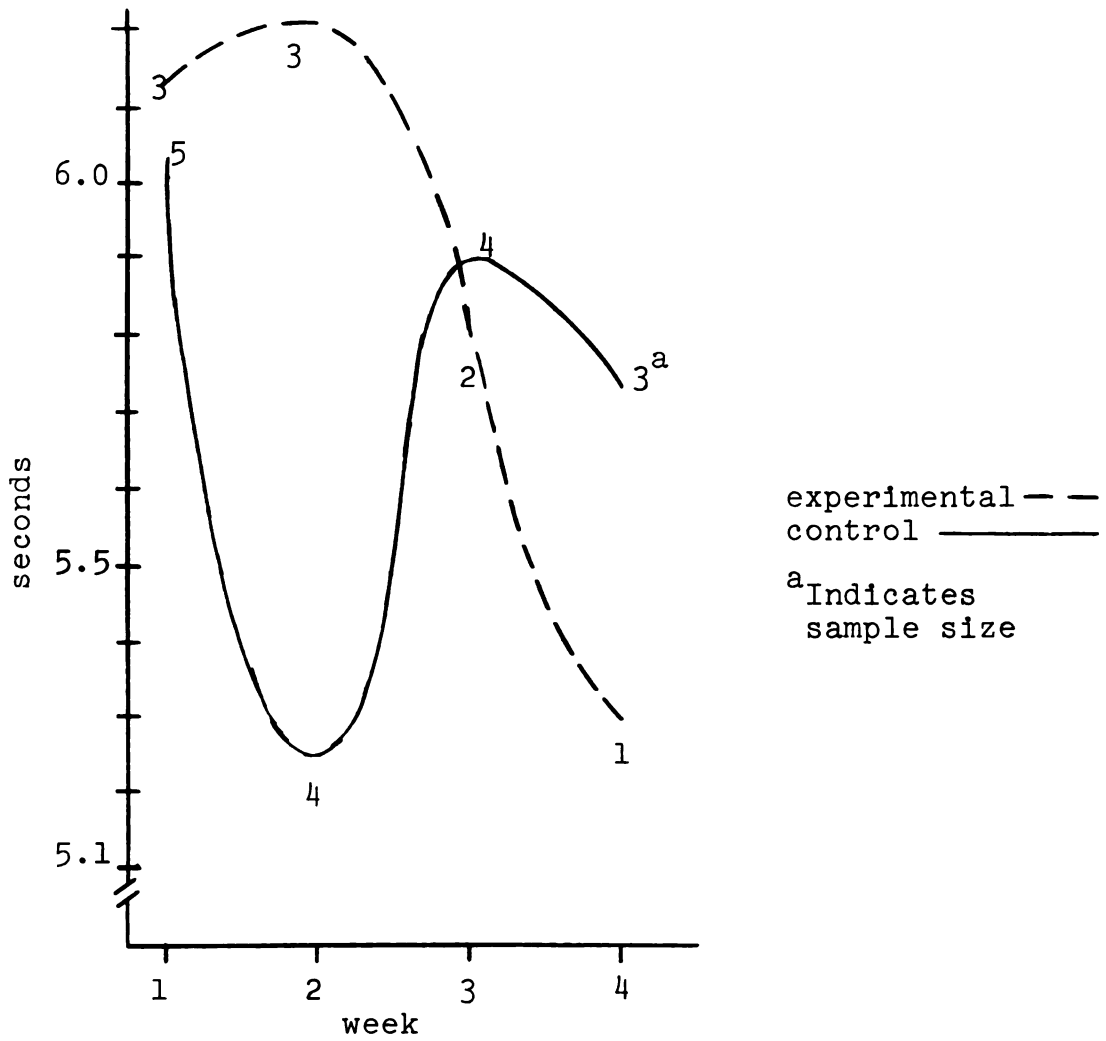
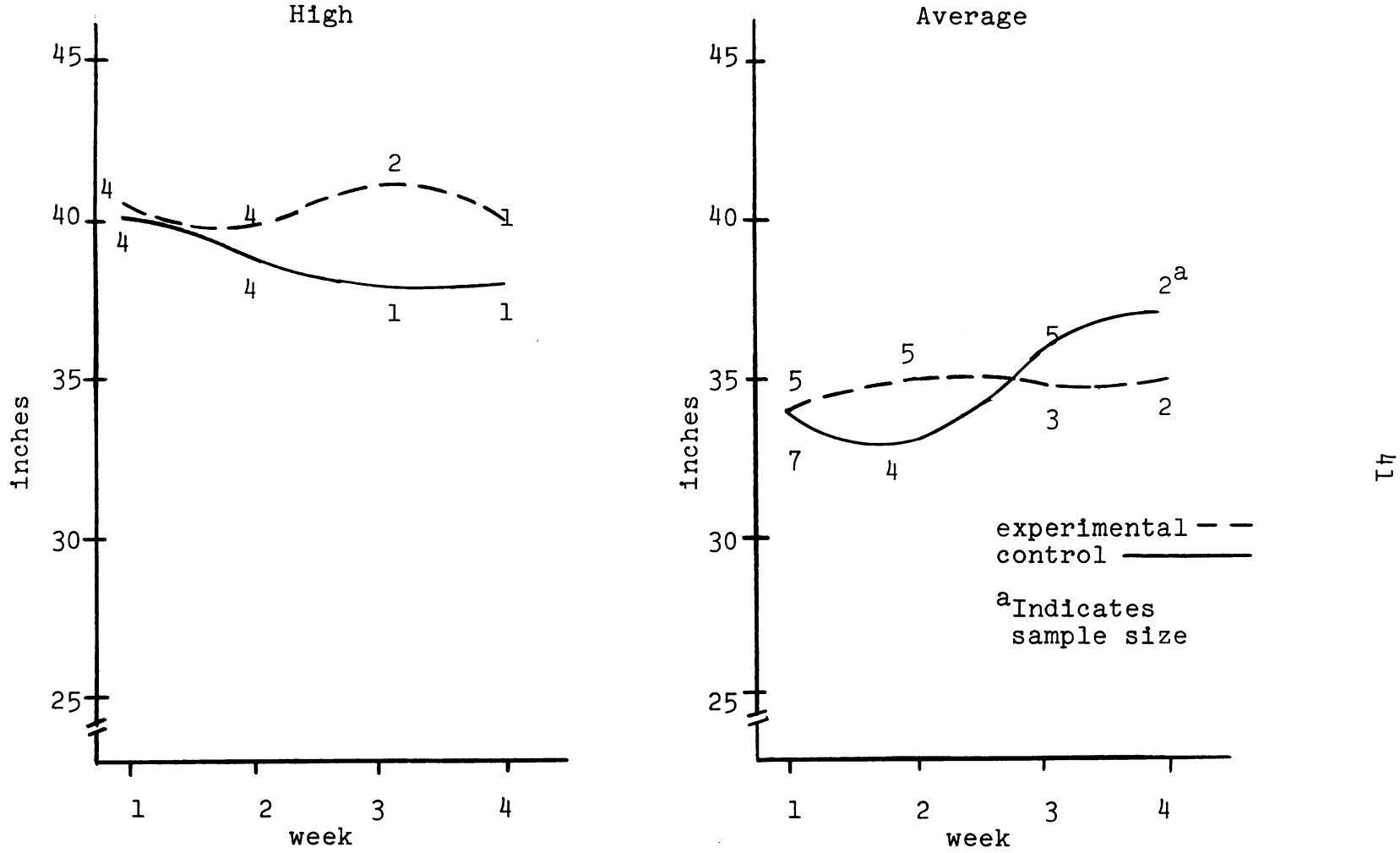


Figure 9. Mean Times For Low Skill Groups In The 30-Yard Dash

The control group demonstrated more stable performance in the high jump (Figures 10.-12.) than in either of the running events. With the exception of the subjects in the high skill subgroup, the control group made slight but constant improvement.

Mental practice again, appeared most effective with the extreme skill groups. The "average" subjects in the experimental group made no net gains in performance. Those in the high group, while not demonstrating large increases in heights attained, did not have poorer performances, but stayed at a relatively constant level. The low skill level improved approximately thirteen inches from the beginning to the end of the experimental period. The corresponding control subgroup, with an initial mean height nearly seven inches greater than the experimental group, failed to reach even the same level as the experiemntal group. Sample size would indicate that the great differences between the two groups was probably not due to extreme variations in individual performance, but might be a result of the difference in practice methods.

Subjects in the low skill group appeared to benefit most from the mental-physical practice. It may be that the mental practice affords them the opportunity to understand what they must do to execute the skill.



Figures 10. and 11. Mean Heights For The High and Average Skill Groups In The High Jump

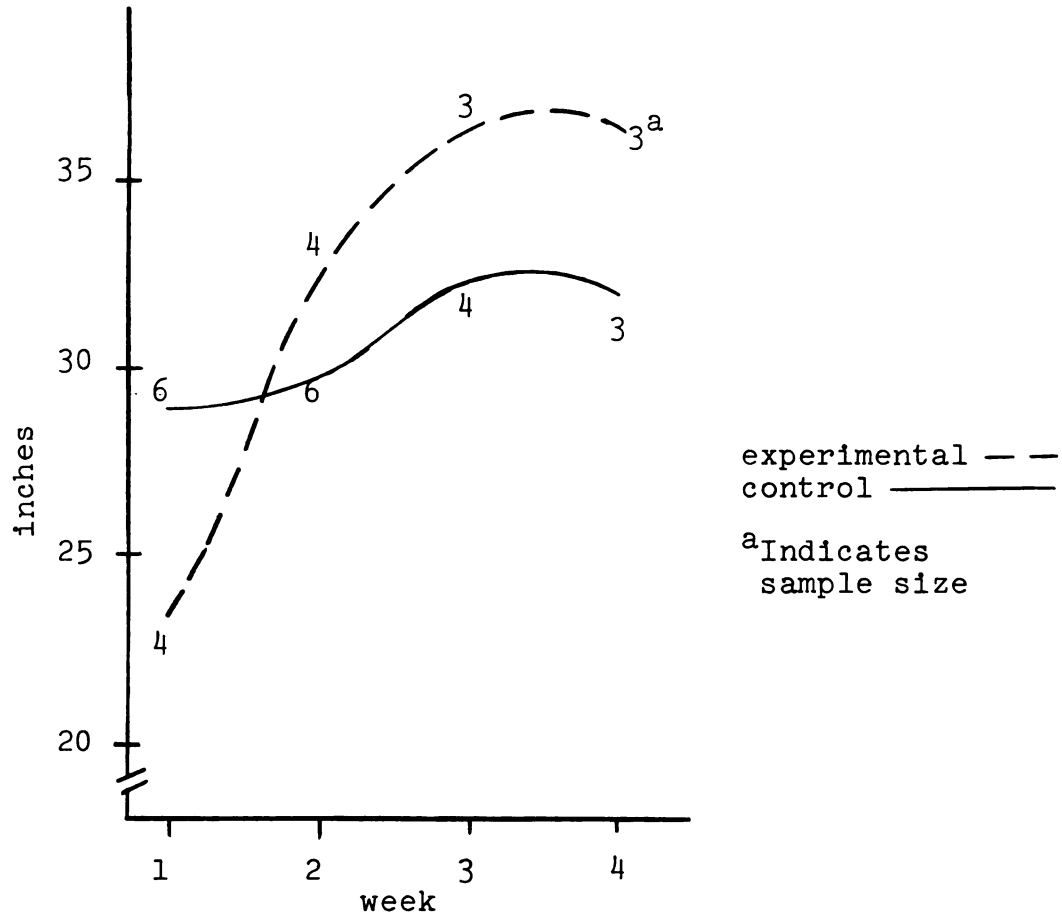
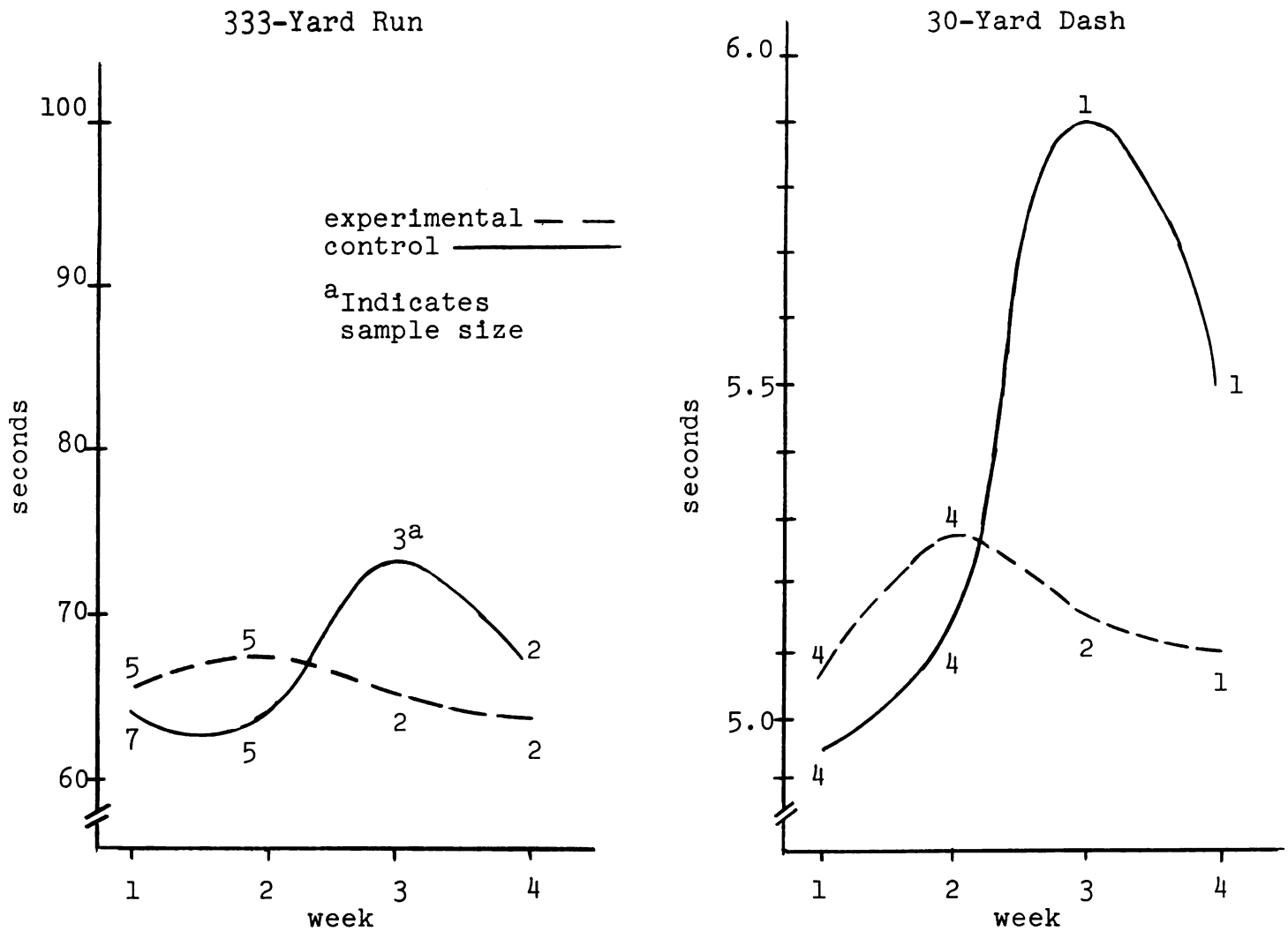


Figure 12. Mean Heights For The Low Skill Groups In The High Jump

Another way to examine the learning curves is to consider performances by subjects at each skill level on all three tasks. There were differences demonstrated between the two groups at the high skill level in the running events (Figures 13. and 14.). The experimental group had mean times which definitely, though gradually, tended to decrease. There is no explanation which can be offered for the extreme fluctuations in the control group's curve for either of these events unless mental practice facilitates consistency. The decrease for the experimental group was not large, but it was constant. Variations in time for the 30-yard dash have been magnified due to the scale of the graph. The difference in time of one or two tenths of a second is small, but again, there is no entirely satisfactory explanation for such extreme fluctuations of the control group's times when the values for the experimental group were much more constant.

Subjects in the "high" skill level for both the experimental and control groups, maintained relatively stable performances in the high jump (Figure 15.). Some of the subjects in this group had their best scores on the initial test and attained the same or slightly lower heights on subsequent tests. It may be that subjects had reached a ceiling of performance when jumping with the particular technique they were asked to use.



Figures 13. and 14. Mean Times For The High Skill Groups

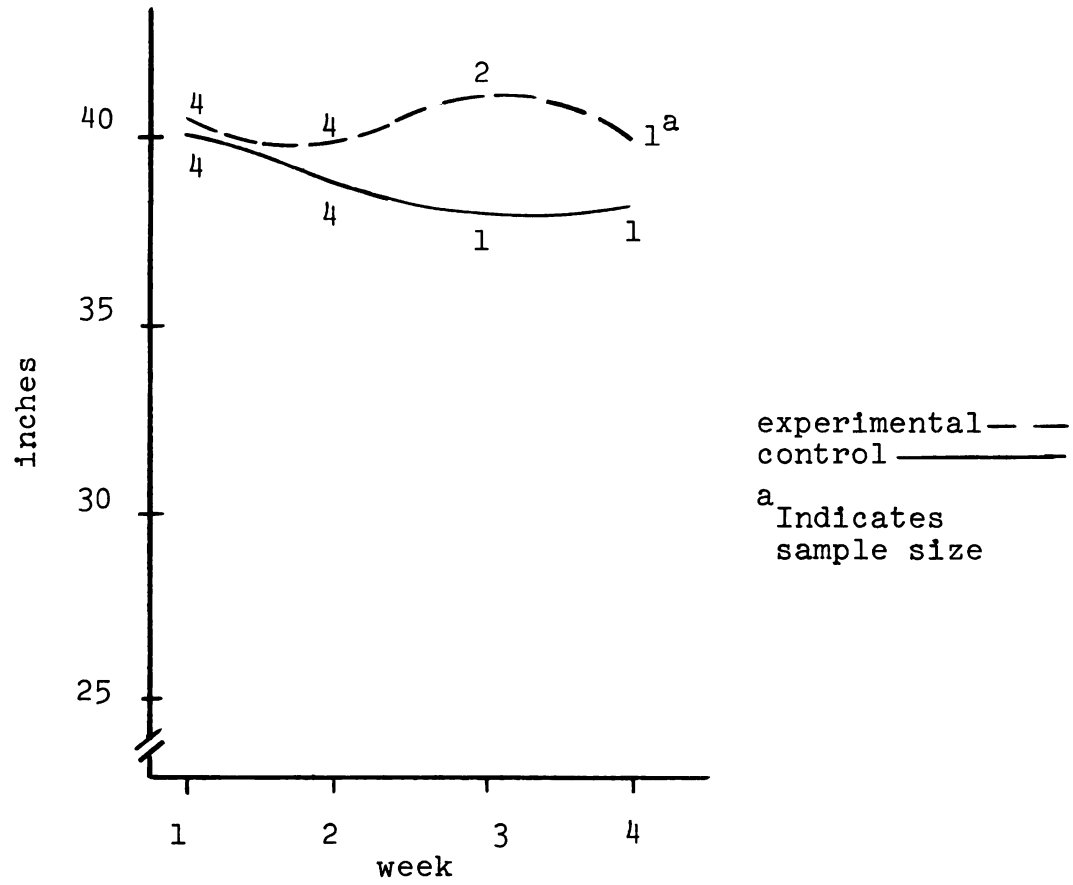
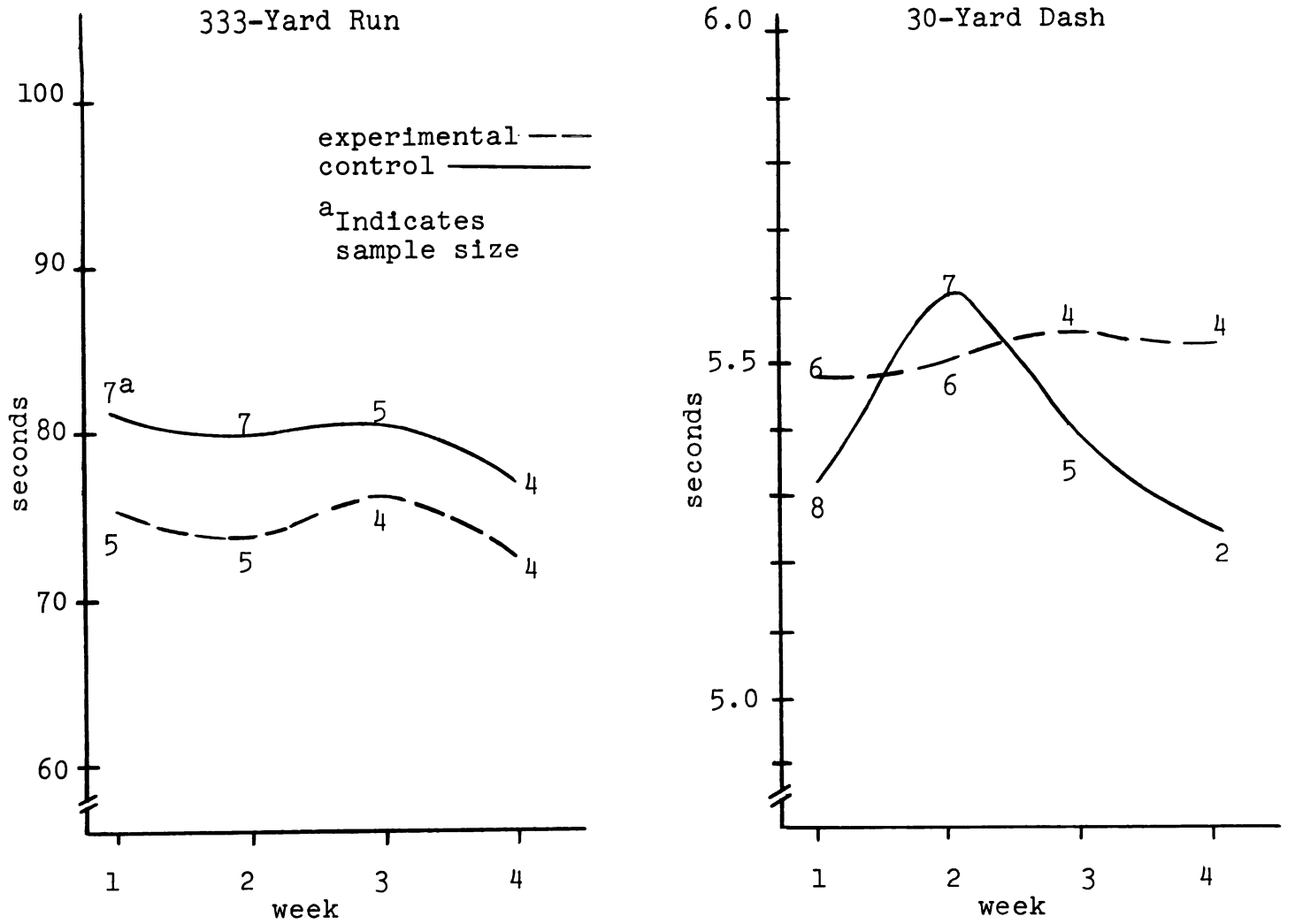


Figure 15. Mean Heights For The High Skill Groups In The High Jump

The sample sizes for the "average" skill groups (Figures 16.-18.) were generally larger and remained more constant. The experimental group had an initially lower mean time in the 333-yard run than the control group. Neither group demonstrated more than approximately three seconds decrease in total run time. If one group had had a much lower first trial mean, the same absolute improvement could indicate proportionately greater improvement for the group with the initial low mean. The control group exhibited more variation in scores, but also demonstrated greater improvement in all events than the mental-physical practice group. High jump scores for the experimental group in this skill division exhibited little change, while the control group showed gradual, but definite improvement. There was little change in performance in the events for the experimental group over the four week period.

The greatest changes in performance were evident with the "low" skill subjects (Figures 19.-21.). This may be simply because there was more room for the improvement. The experimental group demonstrated a mean improvement of forty-five seconds from the first to the fourth tests, while the control group only improved its mean time approximately ten seconds. The great change between the first and second tests for the



Figures 16. and 17. Mean Times For The Average Skill Groups

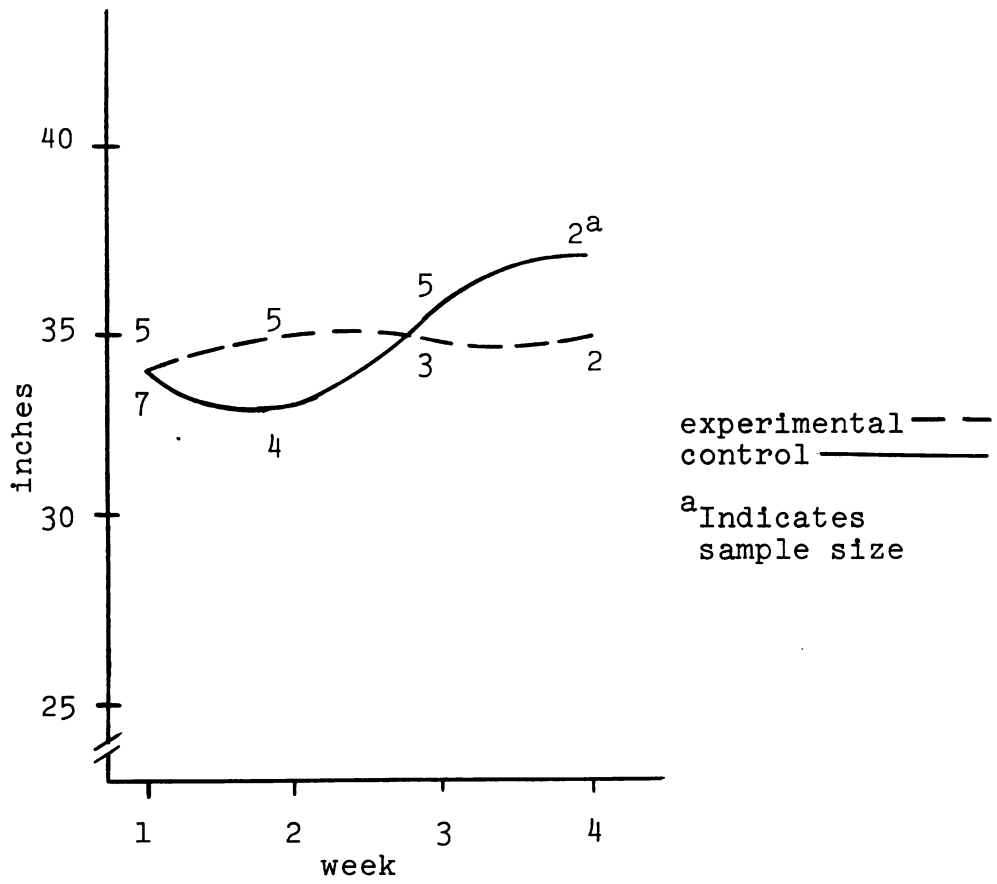
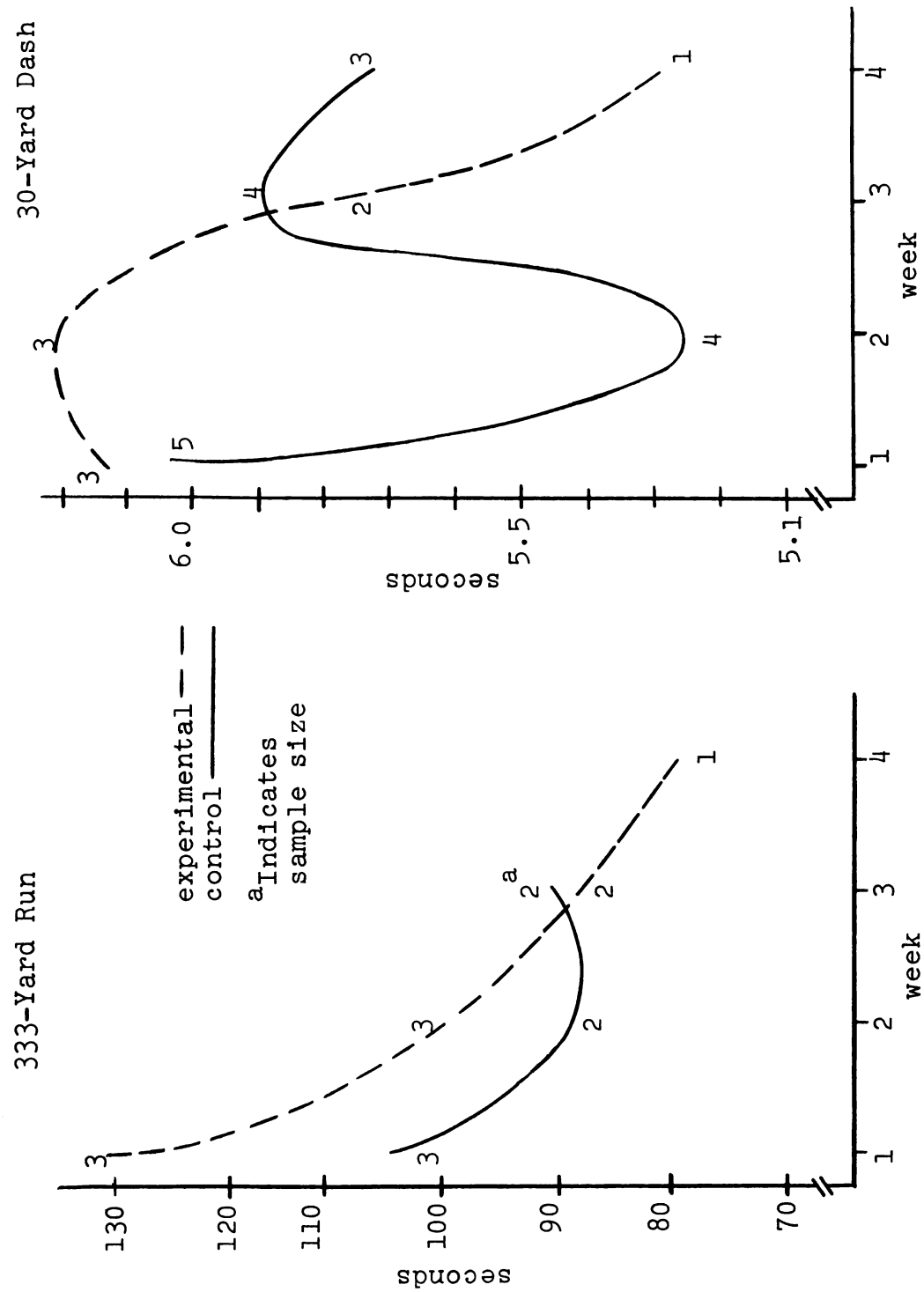


Figure 18. Mean Heights For The Average Skill Groups In The High Jump



Figures 19. and 20. Mean Times For The Low Skill Groups

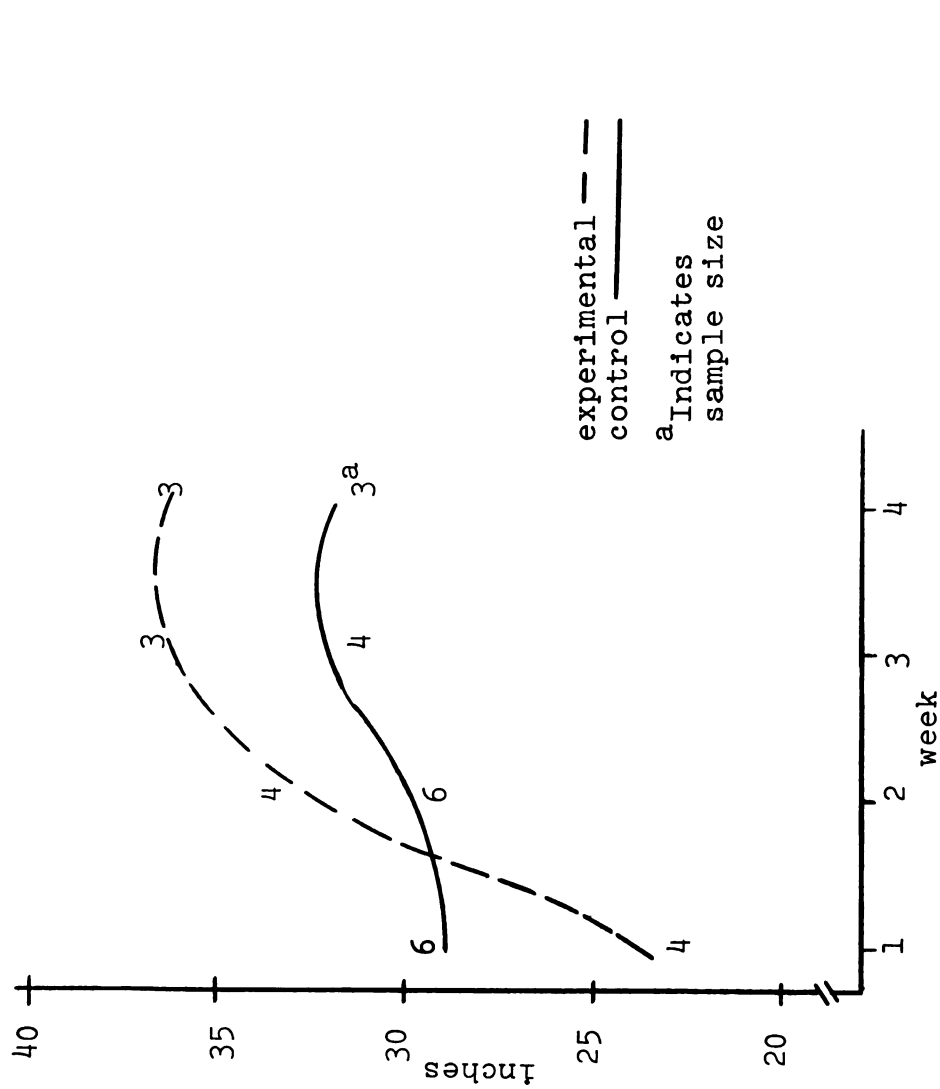


Figure 21. Mean Heights For The Low Skill Groups In The High Jump

mental-physical practice group can, in part, be attributed to the improvement of one subject who had an extremely slow time during the first test. This group also had faster mean times in the 30-yard dash when compared to the improvement and final mean times of the physical practice group. Improvement by the experimental group was more constant than that of the control group. It should be noted that in the two running events, the final "means" were either single scores or the average of only two scores. Subjects in the experimental group demonstrated improvement of approximately thirteen inches in the high jump. Initial performance by this group was much lower than the control group. The physical practice group during the same time period improved only three inches.

The graphs would indicate that combined mental and physical practice contributes to improved performance in these three events, particularly at the lower skill level. However, improvement made by the experimental group at any level has apparently been obscured by greater improvements for the control group at other skill levels. Generally there appears to be only a slight improvement for the mental-physical practice group.

Statistical Treatment

Data were statistically analyzed using the Cochran-Cox t-test to determine the significance of the difference between mean changes in the experimental and control groups. It was noted that the measures obtained during the fourth test closely approximated those obtained on the third test, that is, most of the learning appeared to have occurred by the end of the third week of the experimental period. Therefore, the statistical tests were applied to the difference between scores on the first and third tests in each event. This also made possible the inclusion of more subjects' scores in the analysis. The control group contained ten subjects, the experimental contained eight.

The hypothesis tested for the high jump was that the difference between the mean change of the control group, minus the mean change of the experimental group would be GREATER than or equal to zero. The hypotheses for the 333-yard run and the 30-yard dash were that the difference between the mean change of the experimental group would be LESS than or equal to zero. For each test, alpha was set at .10.

Table 2. reports the obtained t-values and the critical values for each of the three events. It can

Table 2. t-Values and Critical Values For All Three Events

Event	df	t	Reject H_o for
333-yard run	7	1.0389	$t \geq 1.4149$
30-yard dash	18	-0.4484	$t \geq 1.3304$
high jump	9	-0.6898	$t \leq -1.3830$

be seen that none of the null hypotheses were rejected which indicates there were no statistically significant differences between the mean difference scores for the physical practice and the mental-physical practice groups, for any of the three events.

It is interesting to note that the t-value for the endurance events shows the greatest possibility for rejection and one might speculate that it is worthy of further research with increased sample size, under more controlled conditions. At the same time, the t-values obtained for the high jump and the dash fail to suggest that additional research may be warranted.

Introspective Analysis

At the end of the experiment, subjects in the experimental group were individually invited to comment

about their reactions to mental practice. Without exception, subjects indicated that "they" were participating in the activities during the mental practice. The guidelines given for the practice sessions may be the cause of the particular responses of these children since they were asked to imagine themselves running or jumping.

There were some specific questions asked about each of the events. In the longer running event, subjects reported they could see the track, grass, and other people, just as they did when running for time. Some subjects could identify those running with them. Reactions toward the cues (indicated in Appendix B) were mixed. Some of the participants indicated they "went faster" or were ahead of the cues when they were practicing. One boy reported he felt himself speed up when he heard the cues, in order to catch up with the others. One of those who was ahead of the cues in him imaginary race, indicated they confused him.

Most felt they were able to run faster while thinking about the race than when actually running, "because you can think faster than you can do it." Those who enjoyed running, reported more success during the mental practice than those who did not like to run or who were not particularly successful runners.

Some said they felt tired after the imaginary race, but as soon as they opened their eyes, the feeling vanished and did not interfere with subsequent imagined practice of the event.

Responses regarding the practice of the 30-yard dash were much the same as for the longer running event. The most frequent comment was being able to run the same speed or faster during mental practice than when actually being timed.

When questioned about the high jump, most subjects said they were able to clear the bar each attempt, but two said on the occasions they missed their first attempt, they were able to clear the bar on a second or third try. Subjects reported that during mental practice the height of the bar while they jumped, was near the height where they had had the most trouble when actually attempting a jump. Some were even able to specify the height of the crossbar. All subjects reported that during mental practice, they were able to jump higher than when they were actually jumping. One boy said that when he actually jumped he would sometimes get mixed up because he was concentrating so much on the jump. He was one of those in the high skill group.

Generally subjects reported they were able to concentrate on the task best when their eyes were closed

and when there was no distracting conversation. When asked if they thought mental practice helped their performances, most said it gave them more confidence, particularly in the high jump.

Discussion of Results

Analysis of the data, obtained within the limits of this study, failed to show improvements in performance of the selected tasks, which were significantly greater than those which might be expected to occur by chance. Recognizing this, and in spite of the fact that the sample size was small, there are some comments which can be made.

It would be a mistake to ignore the absolute gains in mean scores made by the experimental group. Though these gains were not statistically supportable, they suggest a possible contribution of mental practice to performance in the three events. Subjects from both groups had varying amounts of physical practice because of irregular attendance. Variability in the amounts of physical practice had probably as great an affect upon scores obtained by subjects as variability in the amounts of mental practice. Mental practice for the experimental group cannot compensate for those times subjects had no physical practice. These variable are important to consider when looking at the results of the t-tests.

Responses from subjects indicate that upper elementary school children can adequately visualize themselves participating in the activities, if they have had some exposure to them. Unsolicited remarks and questions throughout the experimental period and responses after the treatment, suggest that subjects had vivid pictures of their participation during the mental practice sessions.

CHAPTER V

SUMMARY, CONCLUSIONS, AND RECOMMENDATION

SUMMARY

The purpose of this study was to determine if differences in the rates of learning of elementary school youngsters might be demonstrated by two groups employing different practice methods. One group utilized only physical practice in learning three track and field skills. A second group engaged in mental practice of the events, in addition to the physical practice. Skills which were selected were the 333-yard run, 30-yard dash, and a high jump.

CONCLUSIONS

Experimental and control means were calculated after tests in each event. Graphs were plotted from the data to determine if any trends in learning could be identified. Both groups were also divided into three skill levels, based upon initial performance in each event. Means of these subgroups were calculated

and the results graphed. Visual comparisons were made between the individual skill level means in each event and also between events, within the three skill levels.

Group Mean Comparisons

1. The groups' mean scores seem to point toward improvements in performance on the part of the experimental group which are slightly better than improvements made by the control group.

2. Scores of the experimental group seem to be less variable than those of the control group.

3. The control group reached peaks in performance during the second week.

4. The experimental group demonstrated continuing improvement throughout the experiment, in all three events.

Event Comparisons

1. 333-yard run

   a. The experimental group demonstrated the best time on the final test at all three skill levels.

   b. The experimental group demonstrated more consistent improvement than the control group.

   c. The control demonstrated more week to week fluctuations in performance than did the experimental group.

   d. Consistent improvement in this event appeared to have been aided by the mental-physical practice.

   e. Improvement for both average skill groups was gradual.

f. Subjects in the low skill subgroups made the greatest gains.

g. The most dramatic improvement was demonstrated by the low skill experimental group.

h. The high skill and low skill control groups had their best performances at the second test.

2. 30-yard dash

a. The control group demonstrated greater fluctuations in performance at all three skill levels.

b. Mental practice appears to have been most effective at the extreme skill levels.

c. The greatest improvement was made by subjects in the low skill experimental group.

d. The low skill control group demonstrated its best performance during the second week.

e. The high control group demonstrated increased time between the first and second tests.

3. High jump

a. The control subjects demonstrated more stable performances in the high jump than in either of the running events.

b. Mental practice appeared most effective with the extreme skill groups.

c. The high skill experimental group stayed at a nearly constant level of performance.

d. Subjects in the low skill group appeared to benefit most from the mental-physical practice.

Skill Level Comparisons

1. High skill

a. Subjects in the experimental group had gradually decreasing times in both running events.

b. The control group demonstrated extremely variable performance in both running events.

c. Subjects in both groups maintained relatively stable performance levels in the high jump.

2. Average skill

a. The experimental group had an initially lower mean time in the 333-yard run than the control group. Both groups made the same absolute improvement in the event.

b. The control group exhibited more variation in scores than the experimental group.

c. High jump scores for the experimental group exhibited little change.

d. The control group showed gradual improvement in the high jump.

e. The control group demonstrated greater improvement in all events than the experimental group.

3. Low skill

a. Subjects in both groups demonstrated more improvement than subjects at the other skill levels, for all the events.

b. Improvements made by the mental-physical practice group in the running events were more constant than those made by the control group.

c. Subjects in the experimental group had an initial mean height much lower than the control subjects, but made gains nearly twice those achieved by the controls.

d. Graphs indicate that combined mental and physical practice contributes to improved performance in all three events, particularly at the low skill levels.

Data were statistically analyzed with a t-test to determine the significance of the difference between mean changes in the experimental and control groups. The statistical tests were applied to the difference between scores on the first and third tests in each event.

No statistically significant differences between the mean difference scores for the physical practice and the mental-physical practice groups were found, for any of the three events.

Interpretation of Results

It appears that combined mental-physical practice made no statistically greater contribution to improved times in the running events, or heights attained in the high jump for the experimental group. Within the limits of the experiment, there are some observations which can be made about the results.

Of the two groups involved in the experiment, the mental-physical practice group appeared to achieve the most absolute improvement and reach better performance levels than the other group. The difference between group performances was most noticeable in the 333-yard run. In an endurance activity for youngsters the potential for improvement is great and not yet at

a level where additional practice results in diminishing returns, in terms of improved performance. It may be that differences observed were more a result of physical practice.

If mental practice did contribute to the differences in time between the two groups, perhaps it was more evident because subjects in the experimental group engaged in mental practice longer in this event than in either of the other two events. Imagined practice of the 333-yard run was thought to occur at a constant speed, approximating that of the actual timed event. There was no way to separate the influence of mental practice and physical practice in this event.

Improvement in the high jump and the 30-yard dash was not as great for either group. In both these events some of the subjects may have performed on the initial test, close to their maximum not leaving the opportunities for improvement as there were with the running event. Neither of these activities took much time to complete in a physical setting. The changes in the performance of the mental-physical practice group may have been obscured by physical performance differences. The daily fluctuations in performance could cause equal or greater differences in the events and perhaps exert more influence than the mental practice, on any results.

The verbal cues for the endurance run and events are believed to have been more effective for this group than written instructions would have been. It was sometimes difficult for subjects to concentrate on the mental practice and written instructions would have been even more difficult to understand, particularly at the beginning of the experiment. Subjects in the experimental group, while at first a bit skeptical about the practice method, did co-operate and seemed able to successfully engage in mental practice.

RECOMMENDATION

The information which was originally desired was not obtained in uncontaminated form because of several uncontrollable factors. This investigation should be conducted again with alterations in design and improved control of variables. A larger sample size should be secured, one which could remain more consistent in size than this one and whose subjects would be more regular in attendance. Additional strength would be gained by selecting subjects of the same sex and the same chronological age, though subjects of the same skeletal age would be preferable.

Mental practice should occur at more regular intervals, rather than every second or third day as was the case in this experiment. Multiple events may interact with one another. Perhaps only one event should be investigated at a time.

Several subjects in the experimental group indicated they finished the 333-yard run more quickly if allowed to imagine the race at their own speeds. It would be interesting to compare the results of three groups in an experiment like this one; one group being allowed only physical practice and two other groups also having physical practice, but one whose mental practice was directed by the investigator and the other whose mental practice was self-directed.

Responses from the subjects in the experimental group suggest that mental practice can be utilized by children the ages of those in this study. Their comments suggest that mental practice made them more confident about their performances. Perhaps this is where the effectiveness of the method lies, in increasing the self-confidence of the subjects.

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APPENDICES

APPENDIX A

PHYSICAL ACTIVITIES--WEEK 1

Monday	Tuesday
Sprint start introduced. Test 1--30-yard dash Test 1--high jump Test 1--333-yard run	Completed tests for all subjects. Practice on all events in smaller groups.
Wednesday	**Thursday**
Shuttle relays Form for the sprints and the starts discussed. Explanation of pace and pace times determined for 85 and 170 yards based on results of Test 1. Four repetitions of 85 yards, one repetition of 170 yards, at determined pace.	Control and experimental groups designated. Began mental practice. Two repetitions of 85 yards, two repetitions of 170 yards, and two repetitions of 85 yards, at pace. Practiced high jump Kick ball.

APPENDIX A

PHYSICAL ACTIVITIES --WEEK 2

Monday	Tuesday
New participants assigned to groups Test 2--30-yard dash Test 2--high jump Groups switched to be tested in other event. Test 2--333-yard run	Worked in two groups. Baton pass introduced from a stand, walking, jogging. Practiced sprint starts, individual help. Groups switched activities. Kick ball.
Wednesday	**Thursday**
Practice in two groups Practiced baton pass from jog, then running. Organized the rest of the subjects into teams. Groups switched. Continuation relay, five to a team, each participant ran four 85 yard sprints. Softball	Practice on the high jump. Short "cross-country" race, approximately 600 yards. Softball

APPENDIX A

PHYSICAL ACTIVITIES--WEEK 3

Monday	Tuesday
Worked with two groups for the first test. Test 3--333-yard run Test 3--high jump Test 3--30-yard dash Kick ball	Division of subjects into teams. Shuttle **relay** from sprint start, two 90 yard legs. Rest Two 30 yard sprints. Two groups High jump practice Discus event explained, subjects learned to hold the implement, roll it along the ground. Groups switched
Wednesday	**Thursday**
Teams, shuttle relay from sprint start, four 75 yard legs. Rest Two groups High jump practice Long jump, standing and running. Groups switch	Team race, three people to a team (at least one girl and/or one fourth grader to a team) Team members could only run as fast as the slowest person on the team. Rest Two groups again; one working with standing and running long jump, the other with the discus. Groups switched.

APPENDIX A

PHYSICAL ACTIVITIES--WEEK 4

Monday	Tuesday
Two groups for tests and activities. Test 4--high jump Introduced modified hurdling, low barriers to determine lead leg. Primarily exposure to the activity. Groups switched. Test 4--30-yard dash.	Completed Test 4 on the high jump and 30-yard dash. Test 4--333-yard run (2 groups) Last session for mental practice. Kick ball.
Wednesday	**Thursday**
No meeting.	Completed any tests remaining. Subject interviews about mental practice. Kick ball

APPENDIX B

DIRECTIONS FOR MENTAL PRACTICE

30-yard dash: Close your eyes and keep them closed until we finish. Try to imagine yourself running the 30-yard dash, starting from the blocks. You will be running with an opponent just like when you are being timed. You should be able to beat your opponent. Raise your hand when you have finished the race. When I give the signal;

"Take your marks."
"Get set."
"Go!" (watch started, to time practice)

(Five repetitions)

High jump: Close your eyes. You should be looking at the cross-bar from the side you approach it. You should be able to clear the bar every time. Let me know you have finished the jump by raising your hand. Go when I give the signal.

"Ready."
"Go!" (watch started, it was stopped when the last person raised his hand)

(Five repetitions)

333-yard run: Close your eyes. You will be racing with other people. The starting line is the same place as it is when we are timing your run. At the signal, begin running. Raise your hand when you finish the race.

"Take your marks."
"Get set."
"Go!" (watch started)

333-yard run: The following verbal signals were also given:

"You're rounding the first turn."
(at 15 seconds)
"Now you're half-way around."
(at 30 seconds)
"You've just passed another runner."
(at 40 seconds)

(Three repetitions)

(The range of elapsed time was recorded)

APPENDIX C

QUESTIONS ABOUT MENTAL PRACTICE

What did you see and feel while you were imagining the _____?

30-yard dash

1. Were you running or watching someone else run while imagining the race?

2. Could you feel yourself in the blocks before the race?

3. Did the signals, "Take your marks, get set, go," help you start the race in your imagined practice?

4. Did you feel yourself running?

5. Were you able to beat the person you were running against?

6. Did you feel like you were running faster during the imaginary race than you did when you were really running?

High jump

1. Were you jumping, or were you watching someone else jump?

2. When your eyes were closed, could you see the high jump area, the bar, etc.?

3. Did you know how high the bar was? Was it as high as you have jumped before?

4. Did the bar look high to you as you ran toward it during the mental practice?

5. Did you always jump over the bar, or did you ever miss it while taking the imaginary jumps?

6. Did you jump higher during the imagined practice, than you actually did when jumping the bar? If so, can you tell me how high you went?

7. Do you think the mental practice helped you jump higher? If it did, how did it help?

333-yard run

1. Were you running or watching yourself (or someone else) run?

2. What did you see while you were running (imagining the race in your mind)?

3. Did you ever pass anyone while imagining this race? Can you name the person?

4. Did you ever feel tired when you were mentally practicing the long distance?

5. Did you run faster while you were "thinking" the race than when you actually ran for time?

6. Did the cues (You're starting around the curve, etc.) seem to help you while you were "thinking" the race? Did they ever mix you up (were you ahead of or behind the cues)?

7. When you were really running on the track for time, did you ever think about running as you did while imagining the race?

Final questions

1. Did you find it hard to concentrate when we were thinking about the events?

2. Did you get tired of sitting at any time while you were imagining either of the races or the high jump?

APPENDIX D-1

RAW SCORES FOR THE EXPERIMENTAL GROUP IN THE 333-YARD RUN

Subject	week 1	2	3	4
22	61[ab]	65	. .	. .
29	65	63	62	. .
13	66	67	. .	. .
30	67	64	68	65
10	69	78	. .	. .
27	72	74	. .	. .
18	73	65	76	66
24	73	80	66	64
17	74	69	73	71
12	83	81	89	89
20	95	77	77	79
7	105	96	. .	. .
4	210	120	98	. .

[a]Subject order determined by initial score in this event. Horizontal divisions indicate the three skill levels.

[b]Expressed in seconds.

APPENDIX D-2

RAW SCORES FOR THE CONTROL GROUP IN THE 333-YARD RUN

Subject	week 1	2	3	4
14	57[ab]	55	. .	. .
28	60	61	. .	. .
11	63	. .	68	. .
2	65	65	65	65
19	66	70	. .	. .
15	68	65	. .	. .
26	68	. .	85	69
23	73	73	83	. .
5	78	75	. .	. .
16	80	90	83	81
25	82	76	76	76
18	83	83	. .	. .
21	84	76	81	74
6	86	86	79	77
1	97	87	76	. .
3	105	. .	102	. .
9	110	90	. .	. .

[a]Subject order determined by initial score in this event. Horizontal divisions indicate the three skill levels.

[b]Expressed in seconds.

APPENDIX D-3

RAW SCORES FOR THE EXPERIMENTAL GROUP FOR THE 30-YARD DASH

Subject	week 1	2	3	4
29	5.0[ab]	5.2	5.0	. .
22	5.0	5.2	. .	. .
17	5.1	5.1	5.3	5.1
13	5.1	5.6	. .	. .
10	5.3	5.3	. .	. .
24	5.4	5.6	5.3	5.5
18	5.4	5.8	5.7	5.7
27	5.5	5.3	. .	. .
30	5.6	4.8	5.3	5.2
20	5.6	6.2	5.9	5.7
4	5.9	6.5	6.2	. .
12	6.0	5.6	5.4	5.3
7	6.5	6.5	. .	. .

[a]Subject order determined by initial score in this event. Horizontal divisions indicate the three skill levels.

[b]Expressed in seconds.

APPENDIX D-4

RAW SCORES FOR THE CONTROL GROUP FOR THE 30-YARD DASH

Subject	week 1	2	3	4
28	4.8[ab]	4.9	. .	. .
14	4.9	5.0	. .	. .
19	5.0	5.2	. .	. .
25	5.1	5.4	5.9	5.5
15	5.2	4.9	. .	. .
5	5.2	6.0	. .	. .
2	5.3	5.3	5.5	5.3
11	5.3	5.4	5.4	. .
23	5.3	6.4	5.6	. .
26	5.4	. .	5.1	5.2
8	5.4	5.4	. .	. .
1	5.5	5.6	5.5	. .
16	6.1	5.9	5.7	5.5
21	6.2	6.2	6.2	6.1
3	6.4	. .	5.6	. .
6	6.5	5.6	6.1	5.6
9	6.5	6.0	. .	. .

[a]Subject order determined by initial score in this event. Horizontal divisions indicate the three skill levels.

[b]Expressed in seconds.

APPENDIX D-5

RAW SCORES FOR THE EXPERIMENTAL GROUP FOR THE HIGH JUMP

Subject	week 1	2	3	4
29	42[ab]	42	42	. .
22	42	42	. .	. .
30	41	39	40	40
10	37	36	. .	. .
13	36	36	. .	. .
24	35	35	34	35
4	33	32	36	. .
17	33	37	34	35
27	33	34	. .	. .
12	30	36	36	36
20	28	33	35	35
18	18	32	38	38
7	18	28	. .	. .

[a]Subject order determined by initial score in this event. Horizontal divisions indicate the three skill levels.

[b]Expressed in inches.

APPENDIX D-6

RAW SCORES FOR THE CONTROL GROUP FOR THE HIGH JUMP

Subject	week 1	2	3	4
14	42[ab]	42	. .	. .
28	42	40	. .	. .
25	40	38	38	38
15	37	35	. .	. .
19	36	32	. .	. .
11	36	. .	35	. .
8	34	35	. .	. .
1	34	32	38	. .
26	33	. .	37	37
3	33	. .	34	. .
2	32	32	35	37
6	30	33	35	35
23	30	30	32	. .
5	30	30	. .	. .
9	30	28	. .	. .
16	28	28	30	32
21	26	30	32	32

[a]Subject order determined by initial score in this event. Horizontal divisions indicate the three skill levels.

[b]Expressed in inches.

APPENDIX E

Cochran-Cox t-test

$$t = \frac{\bar{D}_2 - \bar{D}_1 - (\bar{\Delta}_2 - \bar{\Delta}_1)}{\sqrt{\frac{s^2_{D_1}}{n_1} + \frac{s^2_{D_2}}{n_2}}}$$

$$\text{with df} = \frac{\left[\frac{s^2_{D_1}}{n_1} + \frac{s^2_{D_2}}{n_2}\right]^2}{\left[\frac{s^2_{D_1}}{n_1}\right]^2 \frac{1}{n_1+1} + \left[\frac{s^2_{D_2}}{n_2}\right]^2 \frac{1}{n_2+1}} - 2$$

$\bar{D}_1$ = mean difference score for the experimental group.

$\bar{D}_2$ = mean difference score for the control group.

n_1 = sample size for the experimental group (n = 8).

n_2 = sample size for the control group (n = 10).

$s^2_{D_1}$ = variance of the difference scores for the experimental group.

$s^2_{D_2}$ = variance of the difference scores for the control group.

$(\bar{\Delta}_2 - \bar{\Delta}_1)$ = the difference between the mean difference scores as stated in the null hypotheses, i.e. 0.