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A COMPARATIVE STUDY OF THREE METHODS
OF TEACHING TUMBLING

DISSERTATION

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

For the Degree of

DOCTOR OF EDUCATION

By

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This investigation compares the results of three different methods of teaching tumbling, the Trampoline Method, Mental Practice, and the Traditional Method.

The study also investigates whether sex and ability level significantly affect the results of the teaching methods.

The subjects were the ninety members of the junior-level gymnastics classes for physical education majors at New Mexico State University during the fall and spring semesters of the 1972-1973 school year. There were forty-five female and forty-five male subjects.

A stratified random sample was constructed to insure equality of the teaching-method groups. The motor educability scores of the Johnson-Metheny Test were used to develop high-, medium-, and low-ability groups. The subjects in the ability groups were randomly selected and assigned to one of the teaching methods.

The study was conducted for thirty minutes during thirty class periods of each semester. The instructor did all of the teaching but was assisted by cadet teachers and demonstrators. The Trampoline Group practiced on the trampoline and then on tumbling for fifteen minutes each. The Mental Practice Group went through the skills mentally for six minutes, had a three-minute rest, then six minutes of additional mental practice. They then practiced tumbling for fifteen minutes. The Traditional Group practiced on tumbling for thirty minutes.

The results of the study were determined by three judges using the fifteen-item elementary tumbling test developed for this study. The analysis of variance and Duncan's New Multiple Range Test were employed to determine the significant differences between the variables. The statistical design was a 3 X 3 X 2 factorial design. The .05 level of confidence was the point at which hypotheses were retained or rejected.

The analysis of variance showed significant differences among the teaching methods, ANOVA $P = 0.0004$. There were no significant interactions between the variables, ANOVA $P = 0.4725$. There were no significant differences attributable to sex, ANOVA $P = 0.2927$. There were significant differences attributable to ability groups, ANOVA $P = 0.0000$.

Duncan's test showed that the Trampoline Method was significantly better than the Mental Practice and Traditional Methods. The mean difference between the Trampoline and Mental Practice Methods was 7.78, and Duncan's critical value was 4.78 (the difference is significant if it is greater than Duncan's critical value). The mean difference between the Trampoline and Traditional Methods was 9.28, and the critical value was 5.025. There was no significant difference between the Mental Practice and Traditional Methods. The mean difference was 1.50, and the critical value was 4.78.

The high-ability group performed best in the Trampoline Method and worst in the Traditional Method. The means were 62.58 for the Trampoline Method, 52.98 for Mental Practice, and 49.74 for the Traditional Method.

The medium-ability group performed best in the Trampoline Method and worst in the Traditional Method. The means were 48.28 for the Trampoline Method, 46.13 for Mental Practice, and 35.64 for Traditional.

This study recommends that the Trampoline Method be used whenever possible, that classes in tumbling be coeducational, that studies similar to this one be conducted with secondary

school and elementary school subjects. Similar college-level studies should be undertaken using intermediate and advanced tumbling skills.

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CHAPTER I

INTRODUCTION

Gymnastics, tumbling, and trampoline activities contribute recreational as well as educational benefits if included in a physical education program. The individual typically derives many benefits from participation in these three types of activities. For example, it is possible to improve coordination, agility, flexibility, strength, and courage through involvement in gymnastics, tumbling, or trampolining.

During the years between 1920 and 1950 gymnastics was abandoned in most physical education programs. This era was the team sports and recreational activities period. Gymnastics equipment remained idle and gathered dust in some secluded corner.

After World War II a new interest in gymnastics, tumbling, and the recently discovered activity of trampolining was awakened. Barry Johnson (9, p. 1) made reference to the gymnastics situation when, in his book on beginning gymnastics, he wrote

A revival of interest in gymnastics programs is apparent in many schools and colleges throughout the United States. This is partially due to the recognition of the fact that the majority of our physical education activity programs have been devoted primarily to running games and other activities which do not contribute enough towards upper body development. This emphasis on games which require very little upper body strength has pointed out a definite need for such activities as gymnastics, weight training and isometric training. Proof of this need can be found in many recent studies which have been conducted concerning physical fitness (9, p. 1).

Otto Ryser (19, p. 5), the long-time coach of the University of Indiana gymnastics team and author of many text books and teacher's manuals for physical education, said

Proof that something has been lacking in our physical education programs in the last 20 years was found in the records of induction centers during the last war. A definite and pronounced weakness was noticed in the shoulder girdle, arms, chest and upper back of the majority of men inducted into the service. The games and sports type of programs have adequately taken care of the legs and "wind" of the participants but the upper body's development has been neglected to some extent (19, p. 5).

He went on to point out the values that can be derived through participation in tumbling and apparatus.

Participation in tumbling and apparatus work may benefit an individual in the following ways:

1. By promoting individual health and organic stimulation through vigorous exercise involving all parts of the body.

2. By increasing strength--especially in the arms, shoulder girdle, chest, and upper back.

3. By developing neuro-muscular coordination (time-rhythm) which enables one to work and play with greater conservation of energy. It also helps a person to better handle his body and to take care of himself in dangerous situations.

4. By increasing flexibility and litheness.

5. By developing precision and exactness of movement.

6. By developing a kinesthetic sense, a sense of relocation which helps in adjusting the body to being whirled about and to know in which direction one is moving despite the position of the body; a quality of utmost importance, especially to flyers.

7. By developing a better sense of balance which lessens the danger of falling on slippery surfaces.

8. By conditioning for other sports. Many divers, for example, "work out" considerably on the trampoline. The ability to handle the body well is a prime factor of success in any sport.

9. By encouraging quick and accurate decisions and actions.

10. By building a strong, good-looking body. The general body build of most gymnasts is well proportioned.

11. By serving as a recreational activity since it is enjoyable.

12. By making available all the acknowledged benefits of competition when engaged in as competitive sport.

13. By providing a competitive sport in which the smaller boys can excel. Most of the other varsity sports place a premium on size and weight.

14. By providing an activity in which handicapped individuals may participate. Gymnasts with only one leg or one arm often compete in gymnastics meets.

15. By providing an activity with carry-over value into family life. A father and son (or daughter) can do many of the partner balancing stunts right in the home, and mother can join the fun (19, p. 5).

James Sweeney (23, p. 1) points out some additional values of gymnastics.

In many respects gymnastics is quite unique in the field of sport. Practically no other athletic endeavor contains the dual requirements of raw athletic courage and artistic execution. It is the combination of these two elements that make gymnastics so appealing and challenging to increasingly more people, both spectators and performers (23, p. 1).

Musker, Casady, and Irwin (15, p. 78), in their discussion of tumbling, made this remark, "Many gymnastics authorities believe tumbling to be the foundation of the gymnastics program" (15, p. 78).

George Szypula (24, p. vii) in his book on tumbling and balancing, speaking from his background and accomplishments in tumbling and gymnastics, said "tumbling is the backbone of all gymnastics; most movements learned in tumbling, for example, can be incorporated into performance on the apparatus" (24, p. vii). In his discussion of tumbling he went on to say

Tumbling has numerous justifications for inclusion in a physical education program. Like any good sport, it provides healthful exercise and develops cooperation and good sportsmanship. Since many stunts are performed individually it also develops a student's self-reliance. By training the student to perform intricate body movements skillfully, tumbling develops the body control and coordination basic to many sports. As in other sports, the tumbler has the opportunity to perform in demonstrations and shows as an amateur, as a competitor on an intramural or on an extramural level (regardless of his size), or as a professional entertainer (24, p. vii).

In his book A Complete Book of Gymnastics (12, p. 5), Loken gave a definition of what tumbling is and some of the advantages of participation in tumbling activities. He said

Tumbling is a basic motor skill that covers extensively the mechanics of rolling, turning, springing and twisting. From watching children at play, one can see that it is a natural activity to include in a physical education program. Besides the fun aspects it serves as a fine background for apparatus work and also as a carry over activity for other sports. It is challenging and exciting to develop tumbling skills, whether they are elementary or advanced.

Tumbling is generally done on tumbling mats in a gymnasium, but there is no reason to avoid performing stunts outdoors on a suitable area of grass or beach (12, p. 5).

Since gymnastics and tumbling were overlooked during most of the first half of the twentieth century, research into methods of teaching these activities has not kept pace with the developments in other sports.

The paucity of opportunity for experiences in tumbling is partially caused by the small number of teachers with the proper methods of teaching tumbling. The traditional approach to teaching tumbling lacks imagination and creativity. There are other methods of teaching tumbling that may be more efficient, motivating, and interesting than the traditional method. This study is directed towards testing two methods of teaching tumbling that are different from the traditional method. The

three methods of teaching tumbling that were compared in this study were The Trampoline Method, The Mental Practice Method, and The Traditional Method.

The Trampoline Method of teaching tumbling was developed by a tumbler who learned to work on the trampoline. The trampoline is a relatively new addition to gymnastics activities. Jeff Hennessy, professor of physical education at the University of Southern Louisiana, director of the Third Annual World Trampoline Championship, and author of the book Trapolining (8, p. 2), when referring to the history of the trampoline in the United States, said

For years the trampoline was used by theatrical and circus people. These professionals contributed significantly to the sport by developing new skills, by perfecting techniques, and by popularizing the sport through their performances. One such performer was Joe E. Brown, who performed a triple back somersault with a full twist on a 4' X 7' trampoline with a canvas bed and elastic shock cords.

The trampoline came into its own with the outbreak of World War II when it was introduced into the recreational and physical education program of the armed forces. It proved to be an efficient means of instructing pilot trainees in many of the body positions and sensations associated with true flight. In addition, it helped in the development of muscular control and coordination, a sharp sense of timing and balance, relocation, and mental and physical confidence, all of which are absolutely essential to flying.

Many physical educators who witnessed the benefits and enjoyment of trapolining in the service

programs introduced the activity in schools throughout the United States upon returning home after the war. This, beginning as early as 1946, led to the development of trampolining as a competitive sport.

Trampolining is a sport on the move. Schools, colleges, universities and other organizations such as the AAU, YMCA, YWCA and Recreation Clubs, now include this activity in their programs. Probably the biggest drawback to success is the lack of knowledge of the sport and the assumption that it is dangerous. This attitude is a direct reflection of lack of knowledge (8, p. 2).

The first National Trampoline Championship was held in 1948. Before 1953 nearly all the coaches kept their tumblers off the trampoline in the mistaken belief that the trampoline would weaken the legs of their athletes and destroy their athletes' timing for tumbling. The first performer to win a major championship in both the trampoline and tumbling competition did so in 1953, when Robert M. Hazlett won both the NCAA Trampoline and the Big Ten Tumbling Championships. Since 1953, the best tumblers have performed and ranked high on the trampoline (16).

It was observed that the trampoline training seemed to enhance the tumbling performance. It was theorized that the trampoline should be used as an aid to teaching tumbling.

Between 1952 and 1955 The Trampoline Method of teaching tumbling (Appendix A) was developed. Although The Trampoline Method has been taught to many teachers and used by some since

1956, it has never been tested empirically to determine its effectiveness as compared with other methods. Three National Tumbling Champions were taught from the beginning by The Trampoline Method. These three champions may have become just as proficient if they had been taught by other methods of teaching tumbling.

The Mental Practice Method was included in this study. The method is a result of the work of a great number of researchers (1, 2, 5, 11, 18, 20, 25, and 26), the first being W. G. Anderson.

Anderson (2, p. 265) asked the question, "Could muscles be trained to execute movements by thought rather than by actual physical practice?" (2, p. 265). After several investigations he reported that gymnastics movements could be learned by training of the mind only rather than actually using the muscles. The Mental Practice Method (Appendix B) is a synthesis of the findings of the researchers into mental practice.

The Traditional Method (Appendix C) was included in the study. The Traditional Method is the method that has been used most by tumbling teachers. This method is constructed around an efficient learning progression. The skills are taught in the order of their difficulty and also according to how they fit into the scheme of a group of skills. A good example is

the progression used in teaching the backward roll group, which includes the backward roll, backward roll snap-up, backward roll piked, and backward roll handstand. Each skill leads naturally into the next skill level.

Statement of the Problem

The problem of this study was to determine the relative effectiveness of each of the three following methods of teaching tumbling: The Trampoline Method, The Mental Practice Method, and The Traditional Method.

Sub-problems of the study were to determine the effects of sex and motor educability on the results of the teaching methods. The subjects were divided into three groups according to their scores on the Johnson-Metheny Test; the groups were as follows: high ability--Group I, medium ability--Group II, and low ability--Group III.

Purposes of the Study

The following purposes have been formulated:

1. To ascertain the effect of the following three methods of teaching tumbling: The Trampoline Method, The Mental Practice Method, and The Traditional Method.
2. To demonstrate the relative effectiveness of each of the three methods, including the advantages and disadvantages of each method.

Concomitant purposes of this study were to ascertain whether the sex of the subjects in the study has a significant effect on the results of any one of the teaching methods. The effects of three different levels of motor ability were also studied.

Hypotheses

The tenability of the following hypotheses was examined:

I. There will be a significant difference among the three methods of teaching tumbling.

a. There will be a significantly better performance by the subjects using The Trampoline Method than the performance by the subjects using The Mental Practice Method.

b. There will be a significantly better performance by the subjects using The Mental Practice Method than by the subjects using The Traditional Method.

c. There will be a significantly better performance by the subjects using The Trampoline Method than by the subjects using The Traditional Method.

II. There will be no significant difference in the results of any one of the three methods attributable to sex.

III. There will be a significant difference in the results of the teaching methods attributable to motor ability level.

a. The results of the high motor ability group (Group I) will show that their best performance will be in The Trampoline Method. Their worst performance will be in The Traditional Method.

b. The results of the medium motor ability group (Group II) will show that their best performance will be in The Trampoline Method. Their worst performance will be in The Traditional Method.

c. The results of the low motor ability group (Group III) will show that their best performance will be in The Trampoline Method. Their worst performance will be in The Mental Practice Method.

Background and Significance of the Study

The Background and Significance has been divided into four areas. They are as follows: The teaching of tumbling, Mental practice, Factors influencing mental practice, and Mental practice instructions.

The Teaching of Tumbling

Studies have been conducted to ascertain the most efficient method of teaching tumbling, but they are not as numerous as they might be.

In a study to determine whether the whole method was more effective than the whole direct repetitive method in teaching basic gymnastics to male college students, Wickstrom (27, p. 118) concluded that learning according to the whole method, generally, required fewer trials. He also stated that "the modicum of experimentation in methods of teaching motor skills in physical education indicates that, in the long run, the whole method is superior to the part method" (27, p. 118).

Girdin and Hanson (7, p. 85) studied the relationship between ability to perform tumbling skills and ability to diagnose performance errors of execution in the performance of the skills. A knowledge test was administered to the subjects to determine their knowledge of the mechanics of execution for each skill. The subjects' performance of these skills were photographed and evaluated by expert judges. The subjects diagnosed errors in the execution of each of eleven skills from a cinematographic presentation of demonstrator performances. A significant correlation as expressed by an $\underline{r} = .49$ was found between performance ability and diagnostic ability with a significant correlation coefficient of $\underline{r} = .51$ between knowledge and diagnostic ability. However, no significant relationship was indicated between performance ability and knowledge.

Fath (6, p. 25), comparing the traditional approach of teaching tumbling to the traditional approach with the addition of an understanding of mechanical principles governing the stunt, found that both groups were equally as efficient in learning the stunts after three weeks of instruction.

Shaw (21, p. 112) compared the relative effectiveness of the stunt method and the phase method of teaching gymnastics. No significant difference was discovered between the two methods.

Mental Practice

Investigations into the process of mentally practicing a perceptual motor skill began about thirty years ago. However, there has been marked increase in the amount of interest in this area of research in the last ten years (18, p. 95). At least twenty-five studies have been explicitly concerned with the effectiveness of this procedure.

Though mental practice has been the term most frequently used, the same topic has been investigated under a variety of other names, such as symbol rehearsal, imaginary practice, implicit practice, mental rehearsal, conceptualizing practice, and conceptual practice.

In the physical practice group the intervening activity consists of physical practice of the skill to be acquired.

In the mental practice group the intervening time is occupied in sitting or standing and rehearsing the skill in imagination for periods ranging from one to thirty minutes.

The evidence from Verdelle's (26, p. 568) study of basketball throwing suggests that with each increase in task familiarity the advantage of physical practice tends to decline. Among the novices, physical practice is almost twice as effective as mental practice, but with the more experienced junior and senior varsity groups mental practice appears to be as valuable as physical practice.

Using a two-hand, three-ball juggling task, Trussel (25, p. 94) found that following the initial trial, a five-minute mental practice period on each of six days followed by fourteen days of physical practice resulted in the greatest improvement, with physical practice alone the next best.

The trend in many of the studies shows that an alternation of physical practice and mental practice tends to produce the greatest improvement in performance. However, it is known from other studies and investigations that alternating physical practice with periods of rest is, in general, superior to massed physical practice. Little can be concluded as to the

efficacy of mental practice until experiments include a rest condition in their design.

One study has been found in which the effect of mental practice on retention has been the focus of research. Sackett (20, p. 392) had three groups of subjects learn a finger maze to the criterion of two errorless repetitions. He then dismissed the physical practice group, having instructed them to draw the maze as often as possible from memory and in particular to draw five independent reproductions of the maze route each night before retiring. The difference between the two groups was not significant.

Many gymnasts, jumpers, and divers are known to employ a type of mental practice, and some attempts to study the effectiveness of this procedure have been reported from the U. S. S. R. In a study by Abelskaya and Surkov (1, p. 472), for example, it was found that when high jumpers were encouraged to imagine the detailed movement of their jump prior to take off, improvement was superior to that of jumpers who did not employ this procedure. It may be that mental practice procedures derive part of their value through establishing set to the task (18, p. 107).

The mental practicing of motor skills has been studied from various view points. Different types of motor skills and different mental practice methods have been studied. The evidence indicates that a combination of mental-physical practice with a rest factor would be the most efficient method.

Factors Influencing Mental Practice

Some of the individual factors that may facilitate or inhibit the amount of improvement gained from mental practice that have been studied are abstract reasoning, games ability, imagery, vividness both visual and kinesthetic, intelligence, mechanical reasoning, motor ability, selective attention, sex, and spatial relations.

Mental Practice Instructions

Start and Richardson (22, pp. 280-284) attempted to control the effects of differing mental practice instructions by using mental practice sheets (one for each student) in conjunction with verbal instruction from the experimenter. Each movement of the task (single leg upstart on the Olympic high bar) was "seen" and "felt" just after it was described by the experimenter and read by the subject on his sheet.

In a study by Leuba and Dunlap (11, pp. 352-355), it was shown that imagery can be conditioned. Start and Richardson

found that successful mental practice required the subject to have a vivid, controlled visual and kinesthetic image of himself throwing an object at a visually-imaged target. As he imagines himself through the sequence of the actions that constitute his throw, he will produce corresponding, though minute, innervations of the relevant muscles. The actual kinesthetic feed-back from the image that occurs is assumed to be capable of evoking the associated visual image (11, pp. 352-355). On the basis of feed-back information of this kind, which may well be utilized at a level below that of conscious awareness, appropriate correction can be made to the next imagined throw. As these imagined throws become more accurate, neuromuscular coordination should also be facilitated.

Egstrom (5, p. 481) sums things up by saying that the findings of his study appear to support the theory that conceptualizing mental practice is effective as a method of acquiring and improving motor skills.

Definition of Terms

For the purpose of this study the following definitions have been formulated:

Physical practice.--Actually going through the skill. Utilizing the muscles to perform the skill.

Mental practice.--Imagining, or seeing the self in the mind's eye, yourself doing a physical skill over and over. Seeing it in slow motion as well as normal speed.

Motor ability.--The immediate capacity of an individual to perform in many varied stunts or athletic events (13, p. 161).

Motor educability.--The ease with which a person learns new skills (13, p. 161). Tests of motor educability may be used as a method to place students in homogeneous groups for physical education classes. For the purposes of this study, the Johnson-Metheny Test is considered a motor educability test.

Limitations

The primary limitation of this study was that it was limited to an intact group, a physical education class in beginning gymnastics and tumbling for physical education majors. This will limit the generalizations that can be made. Generalizations can be made to similar groups.

Basic Assumptions

It is assumed that all the students cooperated fully and performed to the best of their ability.

Instruments

The Johnson-Metheny Test (Appendix E) was employed to separate the class into three groups according to high (Group I), medium (Group II), and low (Group III) ability (educability). Clarke (3, p. 85), Cratty (4, p. 6), Latchaw and Brown (10, p. 102), McCloy and Young (14, p. 98), Oxendine (17, p. 76), and Mathews (13, p. 161) agree that the Johnson-Metheny Test is a test of motor educability and that it correlates highly with tests of tumbling ability. Mathews (13, p. 161) stated, "Metheny, in a study of the Johnson Test found that tests 5, 7, 8, and 10 for boys correlated with the total Johnson scores ($\underline{r} = .977$). In addition, she found that these items correlated ($\underline{r} = .934$) against criterion of learning tumbling stunts. For girls the Metheny revision using tests 5, 7, 8, and 10 correlated ($\underline{r} = .868$) with the entire Johnson Test" (13, p. 161). The Johnson Test is a test of motor educability.

A post-test was administered to determine the effects of the teaching methods. The items on this test included only items taught to the class during the conduct of the experiment. The test was validated by a panel of experts (Appendix F). The Executive Director of the United States Gymnastics Federation, Frank Bare, recognized this group as the best possible panel

of experts (Appendix H). The post-test was judged by three judges of tumbling and gymnastics, all well-known in the southwest for their judging abilities. Bonnie Bennett, Jerry Allman, and John Pruit were the judges.

Procedures for Collection of Data

For the purpose of this study the subjects were the members of the P. E. 345 Gymnastics class at New Mexico State University. This class was made up of male and female junior-level physical education majors. Most of the subjects had had neither gymnastics nor tumbling training.

The class was divided into three groups. Each group was exposed to a different experimental variable; Group A was the Trampoline group (Appendix A), Group B was the Mental Practice group (Appendix B), and Group C was the Traditional group (Appendix C).

The class was divided into the three groups according to their scores on the Johnson-Metheny Test (Appendix E). A stratified random sample was taken so that each of the teaching method groups contained one-third high, one-third medium, and one-third low subjects according to their scores on the Johnson-Metheny Test and also according to sex. The female records were kept separate from the male records.

The class was one and one-half hours long and included work on the gymnastics activities. The subjects reported to the instructor (Robert M. Hazlett) for attendance check and the warm-up exercise routine. Immediately after the warm-up routine was completed, they were divided into their respective groups, Group A, Group B, and Group C. The experimental treatment was administered for one-half hour during twenty-five periods. The remainder of the class time was utilized in teaching the other gymnastics activities such as parallel bars and side horse. The class met two days a week for one semester.

For the first fifteen minutes of the experiment each day, the Trampoline group (Appendix A) practiced on the trampoline and the second fifteen minutes they practiced on the tumbling mats. The Mental Practice group (Appendix B and D) was involved in the Mental Practice for the first fifteen minutes and then went to tumbling physical practice for the second fifteen minutes. The Traditional Method group (Appendix C) remained on the tumbling mats for the full thirty minutes of physical practice.

General Outline of the Schedule

Day 1--Orientation and Johnson-Metheny Test.

Day 2--Continue orientation and testing.

Day 3--Begin instruction.

Days 4 through 28--The experiment.

Day 29--Tumbling post-test.

Day 30--Tumbling post-test and debriefing.

The same demonstrations and audio-visu-als were presented to all the groups.

This class was chosen because most of the extraneous variables could be controlled. All of the students were exposed to the same gymnastics training except for the experimental study. The students in the experiment were cautioned not to do any diving or trampoline work outside of class. They were cautioned not to mentally practice the activities outside of class. The instructor rotated from group to group. Each group had eight days with the instructor teaching their specialty for the entire thirty minutes.

Procedures for Analysis of Data

The data were collected, organized, and analyzed on a computer at the computer center of North Texas State University. The experimental design is a three by three by two factorial design (Figure 1).

The comparison of the three methods was accomplished through the use of the analysis of variance, to detect significant

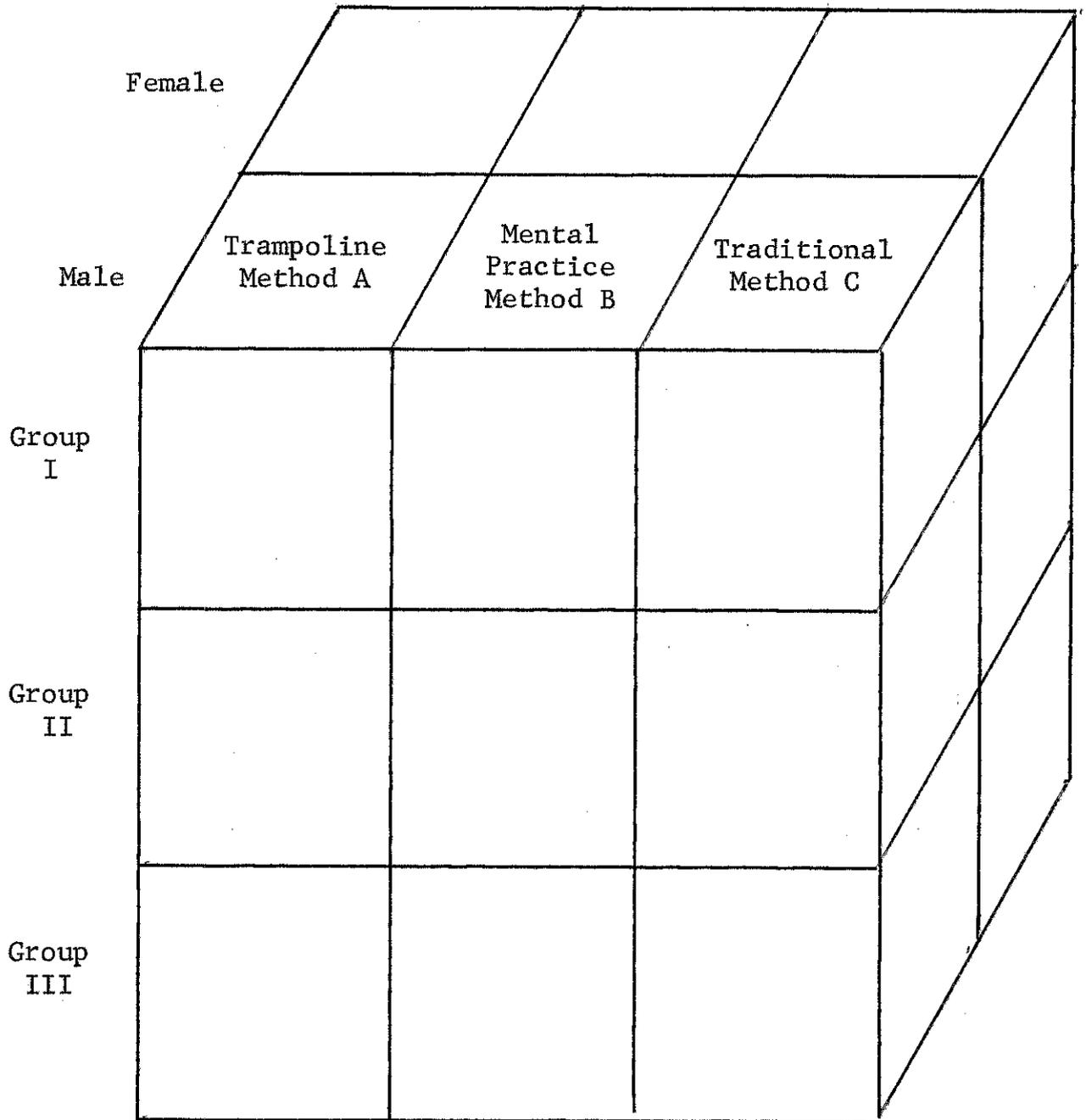


Fig. 1--3 X 3 X 2 factorial design

differences. Duncan's New Multiple Range Test (2, p. 93) was used to test the significance of the differences.

The main effects were the differences in the three methods, the differences attributable to sex, and the differences attributable to motor ability level.

The first-order interactions were all possible combinations of two variable means, such as Group I and Method A.

The second-order interactions were the combining of all three variables, i.e., sex, ability groups, and methods, or the concomitant effects of the combination.

Further Organization of the Study

A survey of related literature is presented in Chapter II. The literature was hypothetically divided into four categories. The categories were related to teaching (tumbling, gymnastics, and trampoline), prediction, mental practice, factors influencing mental practice, and mental practice instructions.

The methods and procedures related to the activity classes, collection of data, and treatment of data are presented in Chapter III.

The presentation of data and the analysis of data indicating the results of the study, as related to the hypotheses, are developed in Chapter IV.

A summary of the study indicating the findings and implications, as they are related to the hypotheses, is included in Chapter V.

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CHAPTER II

REVIEW OF RELATED LITERATURE

Gymnastics, tumbling, and trampoline activities have become popular in our schools and colleges in recent years. Most of the interest in these activities occurred after World War II. In the preface of his book published in 1961, Ryser made the statement

Recently, research has disclosed disturbing deficiencies in the physical fitness of American youth. As a direct result, physical education in general and gymnastics in particular has been brought to the fore in the minds of our political leaders and educators. Until the nation as a whole became cognizant of the relative weakness of our children and young people (especially in the upper body) the field of gymnastics was not regarded as being too important by many of the physical education leaders in the country. Now its value as an aid in developing total body fitness is generally recognized and there is an increased demand for the inclusion of gymnastics in the physical education programs throughout the nation (69, p. 3).

This same trend is continuing today and is contributing to the need for more and better teachers and better methods of teaching gymnastics, tumbling, and trampoline.

The teaching of tumbling is of primary importance to teachers of physical education, gymnastics coaches, boys' club sponsors, boy scout leaders, and YMCA leaders. People involved in directing recreation have found that they have a need to be able to teach tumbling effectively. It is obvious to these people that the most effective methods should be utilized.

To facilitate the review, it has been hypothetically divided into four categories. The categories are as follows: Teaching (which includes all items related to teaching and methods of teaching gymnastics, tumbling, and trampoline other than mental practice), Prediction, Mental Practice, and Mental Practice Instructions.

Teaching

Abernathy (2, p. 11), in an address to the 1961 meeting of the American Academy of Physical Education, states "As each of you know, change is an actuality--all around us is evidence of change." Referring to physical education, she stressed the re-examination and revision of methods including lectures, discussion, and independent study, utilizing such teaching aids as educational television and teaching machines.

Neimeyer (54, p. 124), in 1962, expressed the need in motor learning for experimentation in actual teaching situations to compliment the research which has been done under the closely controlled laboratory conditions.

In a study to determine whether the whole method or the whole-direct repetitive method was more effective in teaching basic gymnastics and tumbling to male college students, Wickstrom (99, p. 118) concluded that learning according to the whole method, generally, required fewer trials. He also states "The modicum of experimentation in methods of teaching motor skills in physical education indicates that in the long run, the whole method is superior to the part method" (99, p. 118).

Shay (76, pp. 62-67) found this true in teaching the up-start in the horizontal bar, as did Coombs (13, p. 95) in teaching track activities and Knapp and Dixon (41, pp. 331-336) in experimenting with learning to juggle.

Klucinski (43, pp. 18-26) investigated the comparative effectiveness of formal, informal, and combination methods of teaching freshman men's tumbling classes. The formal method involved activity conducted as a class unit on command or at the direction of the teacher. No individual help was given. The informal group went through the same activity but individual

help and suggestions were given. The combination group alternated between formal and informal instruction. The number of skills mastered was the criterion for determining the most effective teaching method. As a result of the findings, the investigator concluded that the methods ranked as follows: informal, combination, and formal.

In another type of study in which formal and informal types of methods were employed, Jennings (35, p. 97) found that the informal method is slightly more effective than the more formal type.

Girdin and Hanson (26, pp. 80-92) studied the relationship between ability to perform tumbling skills and ability to diagnose performance errors of execution in the performance of these same skills. A knowledge test was administered to the subjects to determine their knowledge of the mechanics of execution for each skill. The subjects' performance of these tumbling skills was photographed and evaluated by expert judges. Errors in execution of each of eleven skills were diagnosed by the subjects from a filmed presentation of the demonstrator's performance. A significant correlation as expressed by an $\underline{r} = .49$ was found between performance ability and diagnostic ability with a significant correlation coefficient of $\underline{r} = .51$ between

knowledge and diagnostic ability. However, no significant relationship was indicated between performance ability and knowledge.

An experiment in teaching tumbling with and without motion pictures was accomplished by Brown and Messersmith (8, pp. 304-307). A Battery of ten stunts was employed. They concluded that while the experimental group made a little more progress (not statistically significant), it is possible that the time devoted to filming of the class activities in this study could have been used to greater advantage in actual practice of the events included in the lesson. There was a tendency for students to be highly motivated when moving pictures are made of them in action and later screened for their viewing.

In another study using instant replay video-recorder in teaching trampoline, it appeared to Penman, Bartz, and Davis (58, pp. 10-60) that there is no benefit in using the instant replay video-recorder to teach beginning trampoline skills to Washington State University freshman students.

The value of gymnastics conditioning exercises to the speed of learning selected gymnastics skills was the problem that Ray (63, pp. 73-78) tackled. She discovered that the flank vault and handstand hold were learned significantly

faster (less than .05) by the gymnastics exercise group. When all tests were combined into one test battery, the same group showed significantly increased speed of learning.

Shaw (73, pp. 1-50) compared the relative effectiveness of the stunt method and the phase method of teaching gymnastics. No significant difference was discovered between the two methods.

Traditional

The traditional method of teaching tumbling has not been the subject of many research studies, but has been written about in books on tumbling and gymnastics by many authors.

One study by Fath (25, pp. 20-26) was discovered. A comparison was made between the traditional approach to tumbling and the traditional approach with the addition of an understanding of mechanical principles governing the stunts. Both approaches were equally effective in student learning after three weeks of instruction.

Distribution of Practice

Massed and distributed practice in beginning gymnastics for college women was investigated by Dixon (20, pp. 64-70). No significant difference was found between the massed and distributed practice methods.

Knapp, Dixon, and Lazier (42, pp. 32-36) compared the results of their study in 1957 with a previous one conducted by Knapp and Dixon (41, pp. 331-336). Both studies were concerned with the effects upon the learning of a juggling skill. The former investigation included two groups of high school boys, while the latter included two groups of college men. Both age groups utilized a five-minute daily practice session and a fifteen-minute practice session. The comparison disclosed that no significant difference existed between the high school and the college men. It was noted, however, that the five-minute daily practice sessions for both age groups produced more learning than did the fifteen-minute sessions.

Javelin throwing was used by Murphy (53, pp. 161-162) a year after Lashley (45, pp. 105-128) conducted his research of javelin throwing. Murphy found that ten subjects practicing the javelin throw three days a week attained the skill better than the same number of subjects practicing five days a week.

Young (103, pp. 231-243), in 1954, studied the rate of learning in college archery and badminton classes by comparing two types of distributive practice. She found that a two-day-per-week practice schedule was more effective in learning

badminton after twenty lessons, while a four-day-per-week practice schedule was better in acquiring archery skill after twenty lessons.

Rest Periods

In 1950, Knapp and Dixon (41, pp. 331-336) tested whether longer work periods should be followed by longer rest periods for efficient learning to occur. The motor skill of juggling three balls was selected for two groups of college male students to practice until each subject within a group had successfully made one hundred consecutive catches. In Group I, thirty-five subjects juggled three tennis balls five minutes each day, while thirty-one subjects in Group II practiced for fifteen minutes every second day. Knapp and Dixon concluded

The five-minute daily practice sessions facilitated more rapid learning than the fifteen-minute every second day sessions; and fewer practice periods were needed to learn a motor skill when longer work-rest distribution is used, as demonstrated by one minute of practice in Group I found to equal two minutes and twenty seconds of practice in Group II (41, p. 336).

Inhibition

In 1943, Hull (32, p. 85) presented his theoretical concepts of reactive inhibition and conditional inhibition. According to Hull, these two inhibitory processes occur when

a subject makes repeated responses of an act. He considered reactive inhibition as temporary by nature, while conditional inhibition is relatively permanent. Thus, Hull's theory attempts to account for the difference in performance levels under massed and distributed practice conditions. In massed practice, reactive inhibition presumably accrues and depresses the subjects performance as he responds. The temporary inhibition supposedly dissipates during rest, thus allowing the permanent inhibition to develop. Under distributed practice conditions, reactive inhibition will build up during practice but dissipates during each rest interval. It is claimed that Hull's theory is the most representative one of the work theories and has probably instigated most of the recent investigations in the area of massed and distributed practice (72, pp. 77-78).

Attitude

Juel (39, pp. 118-123) administered an attitude scale to students being taught by three different methods to ascertain the effects of these methods upon the attitudes toward physical education of the student. There was slight evidence that a more liberal method of teaching produces the best results in changing attitudes, followed by the control method, and then

the "middle-of-the-road" method. Landiss (44, p. 307) and Erickson (24, p. 68) noted similar findings.

Retention and Learning

Purdy and Lockhart (62, pp. 265-272) retested thirty-six college women on retention and relearning of five novel skills which they had practiced nine to fifteen months previously. The skills included a nickel toss, ball toss, volley, lacrosse, and a balancing board. The investigators concluded that gross motor skills may be retained to a high degree by all levels of skill ability after extended periods of no practice, and that relearning to previous levels of proficiency can occur rapidly. The retention of stabilometer performance, which was a novel gross motor task involving the use of major muscle groups, was high.

In an investigation by Swift (79, pp. 131-133), in 1906, ball juggling was practiced by two subjects to determine the amounts of learning and retention. The task involved the juggling of two balls with one hand. After the last period Swift waited almost two years before administering a retention test to each subject. The test disclosed that both subjects performed better than after the original practice.

The basis for investigation in motor learning is perhaps summed up best by Whitely.

In recent years the assumptions and generalizations upon which physical educators have based their teaching methodologies have increasingly been questioned. As a result more research has been directed toward methods of practice and the effects that different teaching methods and practice conditions have upon motor learning (98, p. 576).

Prediction

Prediction of Olympic balance beam performance from standardized and modified tests of balance by Sandborn and Wyrick (71, p. 174) was another attempt to study some phase of gymnastics.

Wettstone (96, pp. 101-115) developed tests for predicting potential ability in gymnastics and tumbling for men, but there have been none developed for women.

Tests of motor educability were studied in text books by Clarke (12, p. 85), Cratty (17, p. 63), Johnson (36, p. 149), Latchaw (46, p. 102), Mathews (50, p. 161) McCloy and Young (51, p. 98), and Oxendine (56, p. 76).

Mental Practice

Investigations into the process of mentally practicing a perceptual motor skill began about thirty years ago. However, there has been marked increase in the amount of interest in

this area of research in the last twenty years (65, p. 95). At least twenty-five studies have been explicitly concerned with the effectiveness of this procedure.

Though mental practice has been the term most frequently used, the same topic has been investigated under a variety of other names, such as symbol rehearsal (70, p. 376), imaginary practice (59, p. 2), implicit practice (52, p. 28), mental rehearsal (93, p. 561), conceptualizing practice (23, p. 472), and conceptual practice (48, p. 21).

In the physical practice group the intervening activity consists of physical practice of the skill to be acquired. In the mental practice group the intervening time is occupied in sitting or standing and rehearsing the skill in imagination for periods ranging from one minute (59, p. 70) to thirty minutes (92, p. 248).

Some evidence from Twining's (91, pp. 432-435) study suggests that a period of five minutes is probably the longest in which concentration can be maintained without a rest pause.

In a study conducted by Jones (38, p. 270), the gymnastics motor skill of a hock swing upstart was utilized with college men as subjects. Each subject was given a pass or fail rating on the skill. In order to receive a pass rating the subjects

were required to achieve a correct finishing position for the skill on two successive attempts. Two separate stages were utilized in conducting the study. In the first stage, six mental practice sessions were used and a mechanical analysis of the skill was read. The subjects were then divided into two mental practice groups, directed and non-directed. The directed practice was conducted by having the subjects and the experimenter read through the various phases of the hock swing upstart skill and then mentally practice the various phases of the skill. The non-directed group did not utilize any type of verbal or visual aid. Upon being tested following the first stage, the undirected group performed significantly ($p < .02$) better than the directed group. The second stage differed from the first in that the researcher recorded the number of test days each subject required to obtain a pass rating. Two test trials were allowed each day. Somewhat surprisingly, the undirected mental practice group once again performed significantly ($p < .01$) better. Jones concluded that male university students could learn a gymnastics gross motor skill by utilizing a learning procedure which involved familiarization with mechanical aspects of the skill and mental practice.

A gymnastics motor skill was also used by Start (81, pp. 316-320) in one of his studies involving mental practice. The skill was the single-leg upstart on the Olympic high bar. The subjects were college men who were unfamiliar with the motor skill. Each subject mentally practiced the single-leg upstart for five minutes on six consecutive days. A detailed written analysis was read by each subject prior to his mental practice. On the day after the final mental practice session, the subjects attempted to physically perform the motor skill and were rated by three judges. Start felt that mental practice did contribute to acquisition of the single-leg upstart.

Phipps and Morehouse (60, 373-378) utilized the hock swing to a horizontal bar, jump-foot, and soccer hitch kick as the motor skills in their study of mental practice. These three motor skills are considered to be different in their degree of difficulty. The hock swing is considered to be the least difficult, the jump-foot next most difficult, and the soccer hitch kick the most difficult of all. Eighty male volunteers were randomly assigned to either a control group or a mental practice group. Each subject was tested on the three skills prior to the start of practice sessions. The study consisted of three phases, each one week in duration. Different motor skills

were practiced during each phase although the practice procedures were similar. The mental practice group received demonstrations and printed copies of how the skill was to be performed. In addition, the investigator read the performance procedures to the mental practice group. Following testing, Phipps and Morehouse indicated that mental practice without prior physical practice did not appear to be effective in learning either the jump-foot or the soccer hitch kick, but it was effective in learning the hock swing. As indicated earlier, the hock swing is considered to be the least complicated of the three motor skills. They went on to suggest that perhaps the value of mental practice depends not only on the difficulty of the skill but is also specific to even the simpler skills.

An investigation to determine if mental practice would facilitate improved performance of the volleyball motor skills of volleying and serving was conducted by Schick (77, pp. 110-118). The subjects were college women. The investigation was carried out as three sub-studies. The first sub-study involved two groups, mental practice and no practice. The no practice group did not participate in mental or physical practice during the two-week experimental period. The mental practice group devoted three minutes of daily mental practice to each motor

skill, i.e., the volley and service. Following testing, it was found that there was no significant difference between the two groups on the volley skill. However, the mental practice group did perform significantly better ($p < .025$) on the service motor task. The second sub-study combined physical and mental practice and lasted for five weeks. Following testing over the two motor skills, the subjects were divided into high-, medium-, and low-skill categories and randomly assigned to one of two groups. Both groups physically practiced during regular class sessions, but one group mentally practiced each skill one minute each day while the second group mentally practiced each skill three minutes each day. After post-test analysis, it was found that there was no significant difference between the two groups on the volley motor skill. The three-minute mental practice group did perform significantly better ($p < .05$) than the one-minute mental practice group on the service motor skill. It was found that most of the improvement came in the low-skill group. The third sub-study combined physical and mental practice and was the same as the second sub-study, except for duration. This study was only three weeks long. Post-test analysis revealed no significant differences in the two groups at any of the three skill levels. Schick concluded that improved

performance in the volley motor skill is not facilitated by mental practice. No definite conclusions were reached concerning the value of mental practice in improving the service motor skill even though in two of the sub-studies results indicated significant improvement in performance. The conclusion that mental practice does not contribute significantly to improved performance was in agreement with Wills (101, p. 116) and Wilson (102, p. 97).

The evidence from Verdelle's (93, pp. 560-569) study of basketball throwing suggests that with each increase in task familiarity the advantage of physical practice tends to decline. Among the novices, physical practice is almost twice as effective as mental practice, but with the more experienced junior and senior varsity groups mental practice appears to be as valuable as physical practice.

Start (83, pp. 280-284) conducted a study using the basketball foul shot as the motor skill. The shot was attempted by the underarm method. He felt this was a motor skill which was new to his subjects. The subjects were twelve-year-old boys from mixed secondary modern school in Lancashire, England. The pre-test and post-test consisted of ten free throw attempts. The subjects were placed in five groups according to academic

achievement. Each group participated in nine daily sessions of five minutes of mental practice. Each practice consisted of either instructor-led or individual mental practice. At the end of the nine practice periods, thirty-five boys had perfect attendance and were post-tested. Start concluded that mental practice does contribute to improved performance. This was based on the fact that there was a significant ($p < .05$) gain in mean average scores from pre-test to post-test. He also concluded that there was no significant relationship between intelligence and improvement in performance under conditions of mental practice.

Verdelle (93, pp. 560-569) used the Pacific Coast one-hand foul shot. High school male subjects were grouped according to basketball experience as varsity, junior varsity, or novice players. Two methods were employed as practice procedures. One was physical practice, and the other was mental practice. All subjects were tested by shooting twenty-five warm-up shots and then twenty-five test shots. For the physical practice groups this procedure was utilized each practice period, except only five warm-up shots were attempted. The mental practice group mentally rehearsed five warm-up and twenty-five practice shots each day. Verdelle found that both physical and mental

groups improved significantly ($p < .01$) in performance. It was concluded that mental and physical practice did not differ significantly for the varsity and junior varsity subjects, and that mental practice was not effective for the novice subjects.

In still another study utilizing the basketball free throw, Hertz (30, pp. 1-85) divided the subjects into three practice groups to study the effects of mental practice. The first group practiced overtly. The second group was an overt-implicit learning group, which was intended to represent mental and visual aspects of learning, as well as physical learning. The third group utilized a kinesiological method in attempting to improve in free throw shooting. The subjects were pre-tested and post-tested by attempting fifty free throws. A successful try constituted the subject making the foul shot without hitting the rim of the basket. Following the investigation, Hertz concluded that the overt-implicit and kinesiological groups were as effective as the overt practice group.

In another early experimental study, Vandell, Davis, and Clugston (92, pp. 243-250) used thirty-six male subjects. Twelve were in junior high school, twelve were in senior high school, and twelve were college freshmen. The junior high school subjects and the college freshmen used the motor skill

of dart throwing. The high school subjects practiced the basketball foul shot. Each of these groups was then divided into three groups for method of practice. One group did not practice, one group practiced daily, and the third group engaged in mental practice. The two groups involved in dart throwing used identical practice methods except the college freshmen were allowed only fifteen minutes practice each day as opposed to thirty minutes for the junior high school subjects. The subjects were tested on the first and last day of the study. Eighteen days of practice were allotted. The following findings were apparent in the experiment involving dart throwing: (a) the junior high school control group showed a 2 per cent improvement, while the college freshmen control group showed no improvement; (b) the junior high school physical practice group showed a 7 per cent improvement, while the college freshmen physical practice group improved by 23 per cent; and (c) the junior high school mental practice group improved by 4 per cent, while the college freshmen improved 22 per cent.

The twelve senior high school boys involved in shooting the basketball foul shot procuded the following findings: (a) the no practice group improved by 2 per cent, (b) the

physical practice group improved 41 per cent, and (c) the mental practice group improved 43 per cent.

Vandell and others (92, p. 249) concluded that under the conditions of the experiment, a lack of mental or physical practice of a motor skill results in no improvement in that skill. The authors further concluded that mental practice appeared to be very close to physical practice in effectiveness as a method of learning the motor skills.

Halverson (28, pp. 90-105) also found that groups using physical practice with a basket, and physical practice without a basket, along with mental practice, significantly improved after practice in shooting the basketball. It should be pointed out, however, that the least amount of improvement was in the mental practice group.

In another study using more than one motor skill, Oxendine (57, pp. 755-763) conducted three simultaneous studies involving the pursuit rotor, a soccer kick for accuracy, and a modified basketball jump shot. The subjects were seventh-grade boys. In each experimental study there were four groups and each group practiced for eight successive days. The four groups for each experiment consisted of the following practice procedures: (a) eight overt practice days with no mental practice, (b) six overt practice days and two days of mental practice, (c)

four overt practice days and four mental practice days, and (d) two overt practice days and six days of mental practice.

The sequence of practice was as follows: (a) eight overt; (b) one mental, three overt, one mental, three overt; (c) alternating mental and overt; and (d) three mental, one overt, three mental, one overt.

The findings of Oxendine lend support to the theory that mental practice is beneficial in motor learning. Included in his conclusions were the following:

First, given a specific amount of time, or practice trials, a schedule combining both physical and mental practice can be as beneficial as practicing physically only.

Second, up to 50 per cent of practice time or trials can be devoted to mental practice and is as effective as 100 per cent physical practice, provided the motor task is within the motor capacity of the learner.

Third, the nature of the task might serve as a guideline as to how much practice should be mental and how much should be physical.

Oxendine also found that the subjects were receptive to the idea of mental practice with the exception of the groups which primarily utilized the mental practice method. Most of

the subjects felt that physical practice was less complicated after mental practice.

Buck (9, pp. 84-95), in ascertaining the effects of mental practice upon improved performance in swimming, utilized three groups. One group did land practice. Another group practiced different activities than the selected strokes, and the third group practiced mentally. Although all groups improved significantly on the selected swimming strokes, it was concluded that mental practice or land practice did not facilitate improved performance any more than additional time in the water participating in different activities.

Conceptual practice of a motor skill is apparently of value in learning the skill and also in improving performance. Evidently, the degree of success with which conceptual practice may be used depends upon the difficulty of the skill, familiarity, amount of time for conceptual practice, and quite possibly is unique to various skills.

DeWall (19, pp. 97-108) used ninth-grade girls in her study of the effects of mental practice upon target archery shooting. The subjects had no experience with archery shooting prior to the study. A shooting test followed one week of instruction concerning the motor skill. The subjects were involved in one of three methods of practice. These methods were (a) physical

practice, fifteen minutes daily; (b) mental practice, seven and one-half minutes, followed by physical practice, seven and one-half minutes; and (c) mental practice, fifteen minutes each session. Following ten days of practice, a post-test was administered. DeWall found no significant changes in performance for any of the groups.

Many gymnasts, jumpers, and divers are known to employ a type of mental practice and some attempts to study the effectiveness of this procedure have been reported from the U. S. S. R. In a study by Abelskaya and Surkov (1, p. 472), for example, it was found that when high jumpers were encouraged to imagine the detailed movement of their jump prior to the take off, improvement was superior to that of jumpers who did not employ this procedure. It may be that mental practice procedures derive their value through establishing an appropriate set to the task (65, p. 106).

Studies Utilizing Novel Skills

Smith and Harrison (78, pp. 299-307), in their study involving mental practice, utilized a one-minute speed test-retest on a three-hole stylus punch-board as the motor task. They employed six groups which used different practice methods. The six groups were control, visual, reversed visual, mental, motor,

and guided practice. Following retest, they concluded that visual practice and mental practice improved accuracy on the motor task, while motor and guided practice did not. Another interesting factor in the study was the finding that the control, motor, and reversed visual practice groups significantly improved performance in terms of correct hits and the total number of trials; however, the errors were not reduced. The visual and mental groups did reduce their total number of errors while significantly increasing their improvement in performance.

An early study by Perry (59, pp. 70-76) utilized five motor tasks. The tasks were three-hole tapping test, card sorting test, peg board test, symbol digit substitution, and mirror tracing test. Following pre-test and post-test, Perry concluded that five imaginary practices were equivalent to two actual practices for card sorting, three actual practices for three-hole tapping, and five actual practices for the peg board task. He went on to say that the relative efficiency of actual and imaginary practice methods varied with the motor task; on all tasks utilized, except peg board, actual practice was best.

Richardson (65, pp. 95-107), in his review of mental practice research, pointed out a study by Gilmore and Stolurow which also found mental practice to be ineffective. In their

study, the subjects utilized a Munn type of ball-and-socket task. Following post-test, it was found that the mental practice group actually declined in performance. The experiment was independently repeated and the same results were obtained.

A novel motor skill was also used by Egstrom (23, pp. 472-481) in his study involving conceptualizing practice techniques. The subjects used a wooden paddle held in the nonpreferred hand and attempted to strike a small rubber ball and direct it toward a large target twenty feet away. The subjects were pre-tested and post-tested on the motor skill. Six groups were employed during the study. They were manual practice only; first half manual, second half conceptual; first conceptual, second half manual; alternating conceptual and manual practice; conceptual practice only; and no practice. Testing and manual practice consisted of striking twenty-five balls at the target. Conceptualizing practice consisted of a five-minute rehearsal session of the skill. A written description of the mechanics involved in the skill was read prior to each conceptual practice session. Egstrom felt that his findings supported the theory that conceptualizing practice is effective as a means of acquiring gross motor skills. He did feel, however, that manual was

better than conceptual practice, and alternating conceptual and manual practice has merit.

Twining (91, pp. 432-435) utilized a ring toss to see if mental practice would facilitate improved performance. His subjects were college men. Three groups were formed to employ the procedures of no practice, physical practice only, and mental practice only. The control group was tested on the first and twenty-second days of the study. The physical practice group tossed seventy rings each practice day in addition to testing and retesting. The mental practice group was tested and then spent fifteen minutes each practice day rehearsing the ring toss before being retested. There was improvement in mean scores in both the mental practice and physical practice groups. However, the physical practice group improved by 137 per cent and the mental practice group improved by 36 per cent.

Tossing a handball at a compartmentalized target was the motor skill used in a study by Stebbins (85, pp. 90-97). The target compartments were different colors and each color had a different value. His subjects were male college students. Individuals of the mental practice group observed individuals of the physical practice group as they practiced. This was intended to provide the mental practice subjects a more vivid

picture of the movements involved in the motor skill. An initial test and a final test were given to the subjects in order to determine practice results. He concluded that the greatest amount of improvement in performing the motor skill was accomplished by practice methods involving combinations of mental and physical practice techniques. One of these combinations was a group which practiced nine times mentally and then nine times physically; the other combination group reversed the order of practice. He further concluded that, under the conditions of his study, the mental practice only method did not facilitate improved performance.

Beattie (6, pp. 107-128) followed the study of Vandell, Davis, and Clugston (92, pp. 243-250) with another investigation involving dart throwing. His primary purpose was to confirm the findings of Vandell and others, but to do so utilizing larger groups. The experiment did yield results which added support to the findings of the earlier study. Morrisett (52, p. 28) and Arnold (4, p. 118) also used the motor skill of dart throwing, but found that physical practice was significantly better than mental practice.

Studies Utilizing Juggling

With college women as subjects and juggling tennis balls as the motor skill, Trussell (90, pp. 90-118) studied the effects of mental practice, utilizing five groups. These groups were (a) control; (b) physical practice, twenty daily sessions; (c) mental practice, six days, followed by fourteen days of physical practice; (d) mental practice, fourteen days, followed by six days of physical practice; and (e) twenty days of mental practice only. The findings showed that the group which utilized six days of mental practice and fourteen days of physical practice learned the task best. Physical practice only was the next best group. The mental practice only group and the control group failed to gain significantly in performance.

Corbin (15, pp. 52-75) conducted an experiment in which he studied the effects of mental practice on the development of the unique skill of wand juggling. One hundred twenty subjects were assigned to high-, medium-, and low-skill groups following a practice juggling test. Following this, the subjects within each skill level were randomly assigned to one of four practice groups. These groups and their practice methods were as follows:

The control group was subjected to no practice of any kind for twenty-one days of experimental periods.

The mental practice group practiced the criterion task mentally thirty times each day for twenty-one days. The subjects performed as prescribed by a direction sheet which was read every day of the practice. The task was demonstrated on the first day of the experiment only.

The mental-physical practice group practiced the criterion task in action fifteen times each day and fifteen times each day mentally as prescribed by a practice sheet; they also practiced for twenty-one consecutive days.

The physical practice group practiced the criterion task in action thirty times each day for twenty-one consecutive days.

Following the experimental practice period, all the subjects were again tested on the criterion task. The results indicated that mental practice was not effective in facilitating improved performance of the motor skill under the conditions of the study. Corbin felt that his study supported the premise of other experiments that mental practice is most effective in combination with physical practice (15, pp. 52-75).

In still another study by Corbin (16, pp. 534-538), the effects of mental practice were again observed. High school

boys served as subjects, and wand juggling was the motor task. Three groups had controlled physical practice for five days. For the thirteen days following the controlled practice, one group did not practice, the second group mentally practiced, and the third group continued physical practice. It was found that the physical practice group was superior in performance. However, it was felt that mental practice did seem to facilitate actual skill performance after controlled practice, and mental practice appeared to be better utilized when based on experience and when actual practice preceded performance of the skill. Corbin also found that the subjects did have some degree of confidence in the worth of mental practice. This is basically the same finding of Johnson (37, p. 83), who indicated that actual physical practice was the most effective method of improving performance of a gross motor skill. Johnson did suggest, however, that it appeared that experience and skill in the use of conceptualizing techniques logically should make additional contributions to human learning and performance of gross motor activities (37, p. 83).

Studies Involving Retention

Only two studies were found in which the effect of mental practice on retention was the focus of research. Sackett

(70, pp. 390-395) had three groups of subjects learn a finger maze to the criterion of two errorless repetitions. He then dismissed the physical practice group, having instructed them to draw the maze as often as possible from memory and in particular to draw five independent reproductions of the maze route each night before retiring. The difference between the two groups was not significant.

Rubin and Rabson (67, pp. 33-40) found that five physical trials on the piano followed by a four-minute mental practice period followed by physical practice trials to the criterion of one errorless repetition led to significantly better retention one week later. They studied three groups of skilled piano players. One of these other groups had physical practice to the criterion followed by a period of four minutes of mental practice. The other had physical practice followed by more mental practice.

A Study Involving Bowling

Waterland (94, pp. 107-109) compared a physical practice and a mental practice group in a ten-pin bowling skill. Mental practice under these conditions was found to produce a smoother action, greater speed of delivery, and higher scoring than when bowling was carried out under the standard physical practice conditions.

Studies Involving Strength

In another study which suggests that physical practice should be used when possible, Kelsey (40, pp. 47-54) studied the effects of mental practice upon muscular endurance. His subjects were college men and the motor task was sit-ups. He had three groups which participated in the experiment. One group served as the control group and were pre-tested and post-tested only. A second group served as the physical practice group, and the third group was the mental practice group. The pre-test, practice procedure, and post-test all involved five minutes daily for the mental practice and physical practice groups. Kelsey concluded that both mental and physical practice, under the conditions of the experiment, were effective in increasing muscular endurance. He went on to say, however, that mental practice should not be used exclusively where physical practice is possible. Similar findings were reported by Russell and Fisher (68, p. 330) and Williams (100, p. 41).

Razor (64, pp. 118-140) also completed an investigation of the effects of mental practice upon increasing strength. The subjects were ninety-one male college students. Five groups were utilized during the study. They were no practice, physical practice, mental practice, physical and mental practice, and

mental and physical practice. Hand grip strength was the criterion measure for both the preferred and non-preferred hand. Razor concluded that the physical practice procedure was the most effective method for increasing hand grip strength. Cronk (18, p. 94) reported similar findings with female subjects.

Factors Influencing Mental Practice

Abstract Reasoning.--In abstract reasoning, Wilson (102, p. 15) obtained an insignificant correlation between amount gained from mental practice on the tennis forehand and backhand drives and scores on the test of abstract reasoning from the Differential Aptitude Test (D.A.T.) battery.

Imagery.--Several investigations have mentioned the possible importance of imagery in achieving any benefit from mental practice procedures. They include the studies of Verdelle (93, p. 560), Vandell and others (92, p. 243), and Trussell (90, p. 90). Whitely (97, p. 12), who made the first attempt to measure an imagery variable, used a simple test of position memory.

Vividness.--Start and Richardson (82, p. 644) investigated the relation between combined vividness and control of imagery

and per cent gain from mental practice on a simple gymnastics skill. The Sutcliffe (88, pp. 72-95) revision of the Betts (7, pp. 304-307) test was used to measure vividness of visual and kinesthetic imagery, while control was measured on a modified version of the Gordon (27, p. 156) test. It was predicted (82, p. 649) that those with vivid controlled imagery would perform best, and in descending order of performance scores, those with weak controlled imagery, those with weak uncontrolled imagery, and those with vivid uncontrolled imagery. A significant difference was found between the terminal group.

Intelligence.--This variable has been investigated by Perry (59, pp. 74-76), Start (81, p. 320), Verdelle (93, pp. 568-569), and Whitely (97, p. 12). Only Perry, using the Kuhlman-Anderson group test, obtained positive results on one of his tasks. Those subjects with high IQ's (above the median IQ 124) performed better on the mirror-drawing task after mental practice than those with low IQ (below the median).

Mechanical Reasoning.--Wilson (102, p. 15) obtained an insignificant correlation (ρ 0.067) between improvement associated with mental practice and test of mechanical reasoning from the D.A.T. battery.

Motor Ability.--This variable was studied by Whitely (97, p. 12) and a significant positive correlation of 0.48 was obtained between per cent gain scores on his ball-throwing task and motor ability as measured by the Iowa-Brace test.

Spatial Relations.--In the light of the earlier discussions on imagery, it might have been expected that a measure of spatial relations would correlate significantly with per cent gain scores from mental practice. Wilson (102, p. 15) obtained an insignificant correlation between improvement in the tennis forehand and backhand drive and the space relations test from the D.A.T. battery. As no other investigators have been found that have studied the relationship between gain from physical practice and individual difference variables, it is of interest that Wilson obtained significant correlation (ρ 0.461) between gain from physical practice and the spatial relations measure.

Mental Practice Instructions

The effect of mental practice instructions was included in a study by Start and Richardson (82, p. 648). They attempted to control this rate of practice variable by using mental practice sheets (one for each student) in conjunction with verbal instruction from the experimenter. Each movement of the task

(single-leg upstart on the Olympic high bar) was "seen" and "felt" just after it was described by the experimenter and read by the subject on his sheet.

In a study by Leuba and Dunlap (47, p. 354), it was shown that imagery can be conditioned. Start and Richardson found that successful mental practice required the subject to have a vivid, controlled visual and kinesthetic image of himself throwing an object at a visually-imaged target. As he imagines himself through the sequence of actions that constitute his throw, he will produce corresponding, though minute, innervations of the relevant muscles. See Jacobson and Shaw (75, p. 48). The actual kinesthetic feedback that occurs is assumed to be capable of evoking its associated visual image. On the basis of feedback information of this kind, which may well be utilized at a level below that of conscious awareness, appropriate correction can be made to the next imagined throw. As these imagined throws become more accurate, neuromuscular coordination should also be facilitated.

The trend in many of the studies shows that an alternation of physical practice and mental practice tends to produce the greatest improvement in performance. However, as it is known from other investigations, Buxton (11, p. 196), Knapp and Dixon (41, p. 336), and Start and Riley (66, p. 16) alternating

physical practice periods with periods of rest is, in general, superior to massed physical practice. Little can be concluded as to the efficacy of mental practice until experiments include a rest condition in their design.

Egstrom (23, p. 481) sums things up by saying that the findings of his study appear to support the theory that conceptualizing mental practice is effective as a method of acquiring and improving motor skills. Other investigators (3, 10, 29, 34, 59, 66, 68, 74, 75, 81, 84, 91, 93, and 95) have reported similar evidence.

Despite a variety of methodological inadequacies, the trend of most studies indicates that mental practice procedures are associated with improved performance on the task. Statistically significant positive findings were obtained in ten studies. They were studied by Eggleston (22, p. 73), Perry (59, p. 76), Rubin and Rabson (67, p. 40), Beattie (6, p. 128), Waterland (94, p. 109), Verdelle (93, p. 569), Smith and Harrison (78, p. 307), Whitely (97, p. 12) Egstrom (23, p. 481), and Steel (86, p. 108).

Five further studies which show a positive trend were by Sackett (70, p. 394), Twining (91, p. 435), Harby (29, p. 248), Steel (86, p. 108), and Abelskaya and Surkov (1, p. 472).

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CHAPTER III

PROCEDURES OF THE STUDY

The study was conducted at New Mexico State University during the school year 1972-1973. It was necessary to use both the fall and the spring semesters to provide the ninety students needed for the study. Since the same procedures, gymnasium, general instructions, specific instructions, instruction sheets, preliminary tests, and final tests were used during both the fall and spring semesters, the procedures will be described only one time but they will apply to both semesters.

Description of the Subjects

The subjects for the study were members of the fall and spring class of the course P. E. 345 Gymnastics for Physical Education Majors. P. E. 345 is a junior-level coed course. The fall class contained twenty-two female and twenty-three male students. The spring class was made up of twenty-three female and twenty-two male students. Most of the students enrolled in P. E. 345 had never had any gymnastics, trampoline, or tumbling instruction.

Because of the physical layout and isolation of the gymnastics area used for this class, the environmental variables were held constant for both semesters.

Preliminary Testing of the Subjects

The study involved three methods of teaching tumbling and intact groups; therefore, a stratified random sample was constructed. Each teaching method had fifteen female and fifteen male students. They were divided into three groups which were high (Group I), medium (Group II), and low (Group III) ability. Each ability group, within each teaching method, had five female subjects and five male subjects.

The Johnson-Metheny Test (4, 6, 13, 15, 16, and 18) (Appendix E), a motor educability test, was administered to the students prior to the beginning of instruction. The test was performed within the area of an outline painted on the red mat with white paint. The test consisted of four tumbling items which included the forward roll, backward roll, jump one-half turn, and jump full turn. Forty points was the maximum score possible on the test.

Equating of the Method Groups

The subjects were divided into three groups according to their scores on the Johnson-Metheny Test. The high group (Group I) consisted of subjects with scores from twenty-eight through forty. The medium group (Group II) consisted of subjects with scores from twenty-three through twenty-seven. The low group (Group III) consisted of subjects with scores from fourteen through twenty-two. The female scores were kept separate from the male scores. At the completion of the division of the ability groups, each group contained thirty subjects, fifteen female subjects and fifteen male subjects.

A random sample of each ability group was taken so that each of the three teaching methods had one-third high-, one-third medium-, and one-third low-ability subjects. The stratified random sample was constructed in the following manner:

1. All of the scores of Group I were placed in a hat, all of the females first, then the males. The subjects' names were on the score tickets.
2. The scores were drawn out of the hat, one at a time by a randomly selected student.
3. The first score drawn was placed in the Method A Group; the second score drawn was placed in Method B Group; the third score drawn was placed in Method C Group; the fourth score

drawn was placed in Method A Group. This procedure was continued until all the scores were removed from the hat and each method group contained ten subjects, five female and five male subjects.

4. The process was repeated on Groups II and III until all the scores were drawn and each method group contained fifteen female subjects and fifteen male subjects.

Tables I and II show the distribution of the scores. The scores for the Johnson-Metheny Test are listed in numerical order. Table I shows the distribution of the female subjects' scores. Table II shows the distribution of male subjects' scores.

Description of the Student Assistants

It was necessary for the instructor to rotate from method group to method group. One class he would be with the group in Method A, the next class with Method B, the next class with Method C, and then the following class be back with Method A. This procedure was adhered to throughout the study.

Student assistants were enlisted to monitor or proctor the groups when the instructor was not teaching their group. There were three different assistants each semester. There were one female and two male assistants during the first semester. There were two females and one male assistant during the second

TABLE I
 SCORES ON THE JOHNSON-METHENY TEST FOR FEMALE SUBJECTS

Ability Groups	Teaching Method A	Teaching Method B	Teaching Method C
I	1.	36	40
	2.	32	36
	3.	32	34
	4.	30	30
	5.	28	29
II	1.	27	26
	2.	26	25
	3.	25	25
	4.	23	23
	5.	23	23
III	1.	22	22
	2.	21	20
	3.	20	19
	4.	20	18
	5.	16	16

semester. The student assistants were volunteers from Mr. Hazlett's P. E. 372 Methods and Directed Teaching class. The student assistants from P. E. 372 were called cadet teachers. The cadet teachers did not do any teaching during the study.

TABLE II
 SCORES ON THE JOHNSON-METHENY TEST FOR MALE SUBJECTS

Ability Groups	Teaching Method A	Teaching Method B	Teaching Method C
I	1.	36	34
	2.	34	32
	3.	34	31
	4.	28	30
	5.	28	28
II	1.	27	27
	2.	26	26
	3.	25	26
	4.	24	23
	5.	23	23
III	1.	22	22
	2.	22	21
	3.	17	20
	4.	14	20
	5.	10	15

They operated as proctors to see that the subjects were in attendance, practicing the prescribed skills, and generally following instructions. They also acted as time keepers to make certain that each practice session was precisely the proper length.

Three orientation sessions were held for the cadet teachers before each semester. They were taught how to proctor the teaching method they had selected to be responsible for. All six cadet teachers did an excellent job as proctors. The cadet teachers for the fall semester were Patricia Weaver, Terry Anderson, and Stephen Carr. The cadet teachers for the spring semester were Nancy Dessauer, Stacy Isler, and Charles Romig.

Description of the Three Teaching Methods

The Trampoline Method

The Trampoline Method of teaching tumbling (Appendix A) was developed between 1952 and 1961. The basic idea of the Trampoline Method is that tumbling is learned more rapidly and with better technique and form when the trampoline is employed as a preconditioner to the tumbling. The trampoline and tumbling skills are so similar that there is a direct transfer from the trampoline to the tumbling mat. In the Trampoline Method the tumbling skills are attempted and practiced first on the trampoline and later on the tumbling mat. The length of time devoted to practice on the trampoline before going to the tumbling mat may vary with the class organization or the skill being learned. The half-hour of the study was divided

into fifteen-minute sessions. The subjects in Method A practiced on the trampoline for the first fifteen minutes and then went to the tumbling mats for the second fifteen minutes of the study. This method could be called the trampoline and tumbling method of teaching tumbling. Instruction sheets were given to all the students in the study (Appendix G). The sheets included complete descriptions of the skills and sequence drawings.

The Mental Practice Method

The Mental Practice Method of teaching tumbling (Appendix B and D) involves the student in visualizing, in his "mind's eye," himself actually performing tumbling skills. Most of the authors (3, 9, 12, and 20) writing about the subject of mental practice recommend a combination of mental and physical practice and also a rest period in between bouts of mental practice. The Mental Practice Method constructed for this study incorporated both mental and physical practice and a rest factor. The half-hour of each class period devoted to the study was divided into a fifteen-minute mental practice session and a fifteen-minute physical practice session. The mental practice session was divided into a six-minute mental practice session, then a three-minute rest period, followed by another six minutes of mental practice. The mental practice sessions were held in

a room that is adjacent to the gymnastics area. The room was clean, well lighted, air conditioned, and quiet. The chairs in the room were very comfortable.

During the rest break, of three minutes, the students were permitted to go to the rest rooms, the water fountain, or just walk around in the room, but they were not allowed to go into the gym where the other method groups were practicing. They could talk during the rest period but not during the mental practice sessions. Subjects in the Mental Practice Method were given the same instruction sheets as the Trampoline Method and the Traditional Method groups (Appendix G). In addition, the Mental Practice Method group got attached instruction sheets which contained specific instructions on how to mentally practice the skills (Appendix D). During the mental practice sessions (two six-minute sessions in each class) the subjects studied the instruction sheets, both the general and specific mental practice sheets. After the sheets were studied, the subjects attempted to follow the instructions and to actually "see" themselves executing the skills in their minds. Some visualized better with their eyes closed, while others preferred to keep their eyes open.

The Traditional Method

The Traditional Method of teaching tumbling (Appendix C) is the method that has been used for a long time. It involves the subjects in physically practicing the skills on the tumbling mat, without the addition of trampoline or mental practice. Most teachers and coaches have used this method. Overhead safety belts and hand spotting belts were used in all three methods. Audio-visual aids, such as motion pictures, were presented to all three method groups. Anything that was not unique to one of the methods was introduced to all three methods.

Class Procedures

Procedures for each day of the study were standardized and made uniform. Each day, after the instruction phase of the study began, the same routine was followed. The total class time was one hour and thirty minutes, but the study lasted only thirty minutes. The general outline of the schedule was as follows:

Day 1--Orientation and the Johnson-Metheny Test.

Day 2--The testing was continued.

Day 3--The instruction began.

Days 4 through 28--The instruction classes.

Day 29--The tumbling test.

Day 30--Tumbling test and debriefing.

The first day of class was primarily orientation, but the pre-testing with the Johnson-Metheny Test was begun. The orientation was an explanation of what the study was all about. The instructor explained that the study was to be the collection of data for his doctoral dissertation at North Texas State University. The class was told that the instructor had received written permission from the administration of New Mexico State University to carry on the study.

The students were asked to sign a form which stated that they were volunteering to be subjects for the study. It was made clear that no pressure was being applied to force them to be subjects. They were assured that no animosity would be created with the instructor if they declined to volunteer. Their grade was not affected in any way by the study. All of the students volunteered for the study and their attendance was excellent. None of the students dropped the course nor dropped out of the study.

During the first day, the daily routine was explained and the warm-up exercises were introduced. After the warm-up

exercises were completed, the Johnson-Metheny Test was administered.

During the second day, the Johnson-Metheny Test was completed and the three method groups were formed, in accordance with ability groups and sex, as described earlier. The cadet teachers were present both days. They helped to keep order while the instructor administered the Johnson-Metheny Test.

The subjects were requested to please cooperate and not to do any diving, tumbling, or trampoline work outside of class. They were cautioned not to do any mental practicing outside of class. They were asked not to talk to anyone about the study, except to those subjects in their own group and in class only. The subjects cooperated very well in controlling outside variables.

The third day was the first day of instruction. Before the instruction began, the cadet teachers were introduced to their teaching method groups. The instructor explained to each separate group the specifics of the particular teaching method to be used.

The next twenty-five days were conducted the same way each day. A typical day is described as follows: The subjects reported to the instructor in the gymnastics area for attendance

check. The warm-up exercise routine followed attendance check. The skill that was to be learned or practiced on that day was explained and demonstrated by the instructor or the cadet teachers. The spotting and general safety techniques were explained and demonstrated to the entire class. The instruction sheets (Appendix D and G) were distributed to the subjects by the cadet teachers. The sheets were returned to the cadet teachers after the study each day. The half-hour of the study began immediately following the explanation and demonstration. During the first fifteen minutes of the study, the three method groups went to their area to practice their specialties.

The Traditional group and their cadet teacher stayed on the tumbling mats, where the demonstration had been presented.

The Trampoline Method group and their cadet teacher went to the three trampolines. There were five subjects assigned to each trampoline. The subjects had time to rest between practices while they were spotting. They would take their turn on the trampoline and then stand at the end or side in order to safe-guard the performer. The subjects were instructed to read the skill sheets (Appendix G) first and then attempt to perform the skill on the trampoline as it was explained, demonstrated, and written on the skill sheets.

The general instruction sheets were given to all the subjects in the study. The fifteen sheets are found in Appendix G.

The Mental Practice group went to the mental practice room, accompanied by their cadet teacher. They were instructed to read the general instruction sheet (Appendix G) first and then read the specific mental practice sheet (Appendix D). After reading the sheets, they were to try to visualize for six minutes and then have a three-minute rest. Six more minutes of mental practice followed the rest period.

Members of the Mental Practice Method group were the only subjects to receive the mental practice sheets. The fifteen sheets are found in Appendix D.

The instructor taught the Trampoline Method group on the first day of instruction to insure that the basic trampoline safety and jumping techniques were understood. The instructor rotated to a different group each day. The same rotation routine (A to B to C to A to B to C) was followed throughout the entire study. The rotation insured that each group had the same number of classes with the instructor teaching their specialty.

At the completion of the first fifteen minutes of the study, all three groups reported to the tumbling mats for physical practice on the tumbling phase of the study. The final fifteen minutes were consumed in the tumbling practice. The method groups were kept separated from each other during the tumbling practice.

The Teaching Progression

The skills in the tumbling test (Appendix F) are arranged in an efficient learning progression. The skills were taught to the subjects in the same order of progression. Some complimentary balancing skills were taught along with the tumbling skills. When a balancing skill was employed in conjunction with a tumbling skill, it was taught to all three methods groups. Some of the more advanced skills were allotted two days in the schedule. The schedule of the presentation of the skills follows:

Day 3--Jump full twist

Day 4--Forward roll

Day 5--Backward roll

Day 6--Handstand forward roll

Day 7--Backward roll snap-up

- Day 8--Backward roll snap-up (review and practice)
- Day 9--Backward roll piked
- Day 10--Backward roll piked (review and practice)
- Day 11--Cartwheel
- Day 12--Cartwheel (review and practice)
- Day 13--Roundoff
- Day 14--Roundoff (review and practice)
- Day 15--Kip-up
- Day 16--Kip-up (review and practice)
- Day 17--Headspring (arched)
- Day 18--Headspring (arched) (review and practice)
- Day 19--Tinsica
- Day 20--Tinsica (review and practice)
- Day 21--Front handspring (arched)
- Day 22--Front handspring (review and practice)
- Day 23--Flip flap
- Day 24--Flip flap (review and practice)
- Day 25--Running forward somersault
- Day 26--Running forward somersault (review and practice)
- Day 27--Standing backward somersault
- Day 28--Standing backward somersault (review and practice)

Each day, at the completion of the half-hour of the study, the class was taught the other skills and apparatus that are a part of the P. E. 345 gymnastics course. The activities were carefully selected so that they would not have an influence upon the tumbling study. Horizontal bar, parallel bars, side horse, rings, balance beam, and uneven parallel bars were the activities participated in for the remaining hour of each period.

There were two weeks of classes remaining at the completion of the study. The Mental Practice group and the Traditional group received their trampoline instruction and practice during the last two weeks of the semester.

Final Testing Procedures

On the twenty-ninth day of the study the tumbling testing was begun. The test used (Appendix F) was devised for this study and is described in the section on instruments which follows. During the first day of testing, skills numbered one through eight were tested. During the second day of testing, skills numbered nine through fifteen were tested. The judges did not know which groups the subjects represented. The subjects were listed alphabetically, with no identifying marks. The subjects were tested in alphabetical order for the

first eight skills only and then in reverse alphabetical order for the last seven skills so that the first person would not always be the same. The judges sat in comfortable chairs that were placed five feet apart. They could not see what score the other judge gave the subjects. If something unusual did happen, they were allowed to have a conference and discuss it and then go back to their chairs and score the skill independently.

Before the testing each day, the class went through the warm-up exercises together. Next, they lined up in alphabetical order. During the testing, each subject had a tag with a number on it pinned to their uniform on the left side, waist high. The number corresponded to their name and line on the test sheets. Each subject was instructed to step to the middle of the mat and stand erect, so that all three of the judges could see the number. On the signal of "go" from the middle judge, the subject would execute the skill. Immediately upon the completion of the skill, the judges would mark their scores in the appropriate box on the test sheets. This procedure continued until all fifteen skills were judged for all forty-five subjects. Exactly the same procedures were followed, with

the same judges, at the end of the spring semester. Figure 2 is a sample of the judge's sheet for the tumbling test.

Each judge was given an instruction booklet with all the general skill sheets (Appendix G) included. On the back of each skill sheet was typed the specific judging instructions for each skill (Appendix I), to help facilitate uniformity of judging. Three orientation periods were held with the judges before the two days of testing. These sessions were in the form of discussions. All questions were answered by the instructor and possible problems were discussed. The three judges for the fifteen skills were Bonnie Bennett, Jerry Allman, and John Pruitt.

Bonnie Bennett was a member of the gymnastics team at the University of New Mexico. She was the state champion in the floor exercise and balance beam in New Mexico. She was the assistant gymnastics coach of the women's team at the University of New Mexico. She has been an instructor of physical education and gymnastics coach at Colorado State University at Greeley, Colorado. She is the head coach of the women's gymnastics team and assistant professor of physical education at New Mexico State University, Las Cruces, New Mexico.

TUMBLING TEST	NAME						
1. Jump Full-Twist							
2. Forward Roll							
3. Backward Roll							
4. Handstand Forward Roll							
5. Backward Roll							
5. Snap-Up							
6. Backward Roll Piked							
7. Cartwheel							
8. Roundoff							
9. Kip-Up							
10. Headspring							
11. Tinsica							
12. Front Handspring							
13. Flip Flap							
14. Running Forward Somersault							
15. Standing Back Somersault							
TOTAL							

- 1 = Complete failure
- 2 = Very poor
- 3 = Poor
- 4 = Fair
- 5 = Good
- 6 = Very good
- 7 = Excellent

Fig. 2--Judge's sheet for the Tumbling Test

Her specialty is tumbling and she is considered by the coaches of the area as one of the best tumbling and gymnastics judges in the southwest. She completed her doctor's degree at Colorado State University at Greeley in June, 1973.

Jerry Allman was a high school gymnast and tumbler at Lovington High School in Lovington, New Mexico. His high school team was the state champion in gymnastics all four years in which he competed. Allman worked the all-around and tumbling. He was a member of the New Mexico State University gymnastics team for four years and was captain of the team in his senior year. He was the assistant gymnastics coach at New Mexico State University in 1970. Now he is the head gymnastics coach at Raton High School in Raton, New Mexico. The New Mexico Gymnastics Association voted him one of the outstanding gymnastics, tumbling, and trampoline judges in the southwest.

John Fruit is a first-class gymnast, tumbler, and trampolinist. He is also acknowledged by the coaches in New Mexico and Texas as one of the best judges of tumbling, trampoline, and gymnastics in the southwest area of the United States. He was coached by three of the best coaches in the United States. His high school coach was Ross Black at Lovington High School. He attended college at Eastern New Mexico State University where his coach was former Olympian Garland O'Quinn. He

transferred to New Mexico State University to work under the direction of Robert M. Hazlett. While in high school, he won every state title that is contested in gymnastics. He was state champion in tumbling, trampoline, side horse, parallel bars, horizontal bar, rings, long horse, floor exercise, and all-around. He was head gymnastics coach at New Mexico State University and is now head gymnastics coach at New Mexico Junior College in Hobbs, New Mexico. His Junior College team is ranked second in the United States.

Instruments

The Tumbling Test (Appendix F) used to assess the results of the teaching methods in this study was constructed especially for this study after a review of the literature (1, 2, 5, 8, 10, 11, 14, 17, 19, 21, 22, and 23). A jury of ten tumbling experts were consulted to establish the validity of the test to determine elementary tumbling ability. All of the judges agreed that the test is a good test to determine elementary tumbling ability. Frank Bare, the executive director of the United States Gymnastics Federation, (Appendix H) wrote, "The most knowledgeable and experienced tumbling experts in the United States were represented on this validation jury."

The members of the jury were George Bauer, William Cornelius, Harold Frey, Joseph Gialombardo, Richard Holzaepfel, Newton Loken, Bill Meade, Charles Pond, Hartley Price, and George Szypula.

George Bauer is an associate professor of physical education at the University of Wisconsin in Madison, Wisconsin. Bauer has had extensive experience in coaching tumbling, trampoline, and gymnastics. In his competitive days he was the captain of the gymnastics team. He performed, with his sons, all over the world in a professional acrobatic act. They have performed with the Globe Trotters basketball team. He also developed a set of rules for the judging of gymnastics on a division of labor set-up. His rules were tested in the Big Ten Championship Gymnastics Meet.

William Cornelius is an instructor of physical education and head gymnastics coach at North Texas State University. Although he is the youngest member of the jury, he is one of the most knowledgeable. During his undergraduate days, he was the captain of the Arizona State University Gymnastics team and was voted its most valuable gymnast. He was the state all-around champion and trampoline champion in Arizona. He placed high in the National Championships. He has done an

excellent job of coaching at North Texas State University. He was the founder and first president of the Texas Gymnastics Association.

Harold Frey is the head gymnastics coach and professor of physical education at the University of California, Berkeley, California. Frey was the national tumbling champion while at Penn State University. He won the national all-around title twice. During his coaching career he has coached many individual tumbling, trampoline, and gymnastics champions. His University of California team has won the NCAA Gymnastics Championships.

Joseph Gialombardo is probably the best tumbling and trampoline judge in the world. He is recognized by the profession as the outstanding gymnastics judge in the United States. He has been the head judge for the Big Ten and NCAA Championships for many years. As an undergraduate at the University of Illinois, he was recognized by the coaches as the greatest gymnast in the history of the university. He won the national all-around title three times. He also won the Big Ten all-around title three times. He was the national tumbling champion five times. He is the director of athletics and head gymnastics coach at New Trier High School in Wilmette, Illinois.

Richard Holzaepfel is an associate professor and head gymnastics coach at the State University of Iowa. He has had the national champion gymnastics team at Iowa, but his greatest accomplishments seem to be in producing expert tumblers and trampoline performers. He has produced the second most trampoline champions, being surpassed by the University of Michigan. He has produced the second most tumbling champions; only the University of Illinois has produced more. He has coached many championship all-around men and is considered to be the number-one side horse coach in the United States. The State University of Iowa is located at Iowa City, Iowa.

Newton Loken is the number-one coach of trampoline performers. His trampolinists have won more titles for the University of Michigan than have the trampolinists from any other university. Loken was the national all-around champion when he was a gymnast at the University of Minnesota. He was a fine tumbler, as well as an all-around champion. His teams have won several national titles and have won the Big Ten Championship many times. He is a prolific author of gymnastics, trampoline, and tumbling books and articles, among which is

his Complete Book of Gymnastics (14). He is a professor of physical education and the head gymnastics coach at the University of Michigan, Ann Arbor, Michigan.

Bill Meade was employed by Southern Illinois University at Carbondale, Illinois, when it had no gymnastics program. Within a span of only five years he built up the most powerful gymnastics team in the country. His team dominated the NCAA gymnastics competition for eight or ten years before some other universities caught up. He has produced many NCAA individual champions and his teams have won the national title at least five times. Two of his gymnasts were the stars of our Olympic gymnastics teams. Meade is the head gymnastics coach at Southern Illinois University and is a teacher of physical education. During his undergraduate days at Penn State, he was the national tumbling champion. Bill Meade is one of the most influential personalities on the international gymnastics scene.

Charles Pond's University of Illinois gymnastics team has won more Big Ten Championships than has any other coach's teams. He has produced more national tumbling champions than has any other tumbling coach. His gymnastics team has also won many NCAA gymnastics championships. He is considered the "Dean" of tumbling coaches by the profession. He is one of

the most knowledgeable persons on the subject of tumbling in the United States. He is a professor of physical education and head gymnastics coach at the University of Illinois, Champaign, Illinois. He originated the famous Palaestra gymnastics school in Champaign and the summer camp in Michigan. He wrote an excellent book titled Tumbling for Total Gymnastics (19).

Hartely Price, Professor Emeritus and Gymnastics Coach Emeritus at Florida State University, is the chairman of the National Gymnastics Research Committee. He preceded Coach Pond at the University of Illinois and built a gymnastics empire that completely dominated the sport of gymnastics in the United States during the two decades of the 1930's and 1940's. He went to Florida State in 1946 and again built an outstanding gymnastics program. His teams have won more United States gymnastics titles than any other coach. His teams are especially good in the national AAU gymnastics championships, winning most of the team titles. Many of his gymnasts have become outstanding Olympic performers. He originated the outstanding children's tumbling group called the "Tallahassie Tumbling Tots." He was the "master mind" behind the famous Florida State "Gymkana," an exceptionally good gymnastics show.

George Szypula is the author of one of the best books on tumbling, Tumbling and Balancing for All (23). He was the NCAA tumbling champion in 1943 and the national AAU tumbling champion in 1940, 1941, 1942, and 1943. He is an assistant professor of physical education and head gymnastics coach at Michigan State University, East Lansing, Michigan. His teams have won the Big Ten and NCAA national championships many times.

Some of the accomplishments of the members of the validation jury have been mentioned, but it would take volumes to list all of their amazing records.

Reliability Test

The reliability of the Tumbling Test was investigated with the test-retest method. The subjects were the members of Allman's P. E. 125 Beginning Gymnastics class. The first four weeks of the class were devoted to the learning of tumbling skills. The tests were administered at the end of the tumbling unit. The tests were given one week apart. Test one (X) was administered on Friday, October 6, 1973, to the thirty subjects. Test two (Y) was completed on October 13.

The judges for the Reliability Tests were three members of Hazlett's P. E. 372 Methods and Directed Teaching class. The cadet teacher judges had completed the P. E. 345 Gymnastics

for Physical Education Majors course. Each of the judges earned an "A" grade and they were good judges of elementary tumbling ability. The same three judges were used on both of the tumbling tests.

Analysis of the results of the two tests was accomplished through the use of the Pearson Product Moment Correlation computational formula (23) as follows:

$$r = \frac{\frac{\sum XY}{N} - \bar{X}\bar{Y}}{\tilde{\sigma}_X \tilde{\sigma}_Y}$$

A high positive relationship was found ($\underline{r} = .908$) between the two tests. The test is a reliable instrument when administered by the same judge on more than one occasion. The raw data and computation of the correlation are in Appendix J.

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CHAPTER IV

PRESENTATION AND ANALYSIS OF DATA

The subjects of the study were divided according to sex and into three ability groups by their scores on the Johnson-Metheny Test (Appendix E) discussed in Chapter III. They were then placed at random into one of three teaching method groups. There was a total of ninety subjects, forty-five male and forty-five female. Each of the teaching methods contained thirty subjects. The subjects were taught using the three methods.

At the conclusion of the experimental period of twenty-four classes, the subjects were tested to find out which of the three teaching methods was the most efficient. The subjects were tested using the Tumbling Test designed for this study (Appendix F), as discussed in Chapter III.

The data were collected and entered on the specially prepared tumbling sheets (Figure 2). The men's and women's scores were kept separate.

The statistical treatments used were the analysis of variance and Duncan's New Multiple Range Test. The data were

analyzed on a computer at the Computer Center of North Texas State University.

The analysis of variance, (three-way design) from the Statistical Library ST012, North Texas State University, was employed to determine significant differences among the resulting means of scores for the three teaching methods.

The purposes formulated for this study were to ascertain the effects of the three methods of teaching tumbling, to ascertain whether the sex of the subjects had a significant effect on the results of the teaching methods, and to ascertain the effects of the three different levels of motor ability.

Hypotheses were stated on each of the variables involved in the study. The .05 level of confidence was selected as the point for retaining or rejecting the hypotheses. The analysis of the data includes significant differences that existed as they were related to the hypotheses of the study.

Presentation of the Data

The test items were jump full twist, forward roll, backward roll, handstand forward roll, backward roll snap-up, backward roll piked, cartwheel, roundoff, kip-up, headspring, tinsica, front handspring, flip flap, running forward somersault, and standing backward somersault. The final mean scores

of the subjects are presented in Tables III and IV. The raw data are found in Appendix K.

Analysis of Data

Directional hypotheses were used in this study.

Hypothesis I

It was hypothesized that there would be significant differences among the three methods of teaching tumbling. This hypothesis was retained. The analysis of variance showed significant differences did exist among the three methods. Table V is a presentation of the data of the analysis of variance.

The ANOVA F value for the methods was 8.70928. The Probability was $P = 0.0004$ (see Table V).

Duncan's New Multiple Range Test was used to indicate the direction of the significant differences between the variables. The formula for Duncan's New Multiple Range Test (2, p. 93) is

$$W_r = q_{rx} : r, v \sqrt{\frac{\text{M.S. Error}}{n}}$$

where the value of $q_{rx} : r, v$ is found in Table D-8 of Kirk (2, p. 533), M.S. Error = the mean square within of the analysis of variance data, and n = the number of subjects involved in the calculation.

TABLE III
TUMBLING TEST SCORES FOR FEMALES

Ability Groups	Teaching Method A	Teaching Method B	Teaching Method C	
I	1.	73.30	68.66	62.00
	2.	70.66	58.66	53.66
	3.	66.0	44.66	46.00
	4.	56.66	38.66	40.00
	5.	54.66	32.33	35.00
II	1.	61.33	49.66	57.00
	2.	57.66	47.66	48.66
	3.	50.00	47.00	32.66
	4.	42.66	42.33	32.66
	5.	41.66	33.33	29.00
III	1.	53.66	38.33	43.00
	2.	50.00	34.00	37.00
	3.	45.00	33.66	37.00
	4.	37.66	33.33	36.00
	5.	37.00	32.33	33.66

Table VI is a presentation of all of the comparisons of the means of the study. The comparisons are made by the use of Duncan's New Multiple Range Test.

TABLE IV
TUMBLING TEST SCORES FOR MALES

Ability Groups	Teaching Method A	Teaching Method B	Teaching Method C	
I	1.	83.66	71.66	65.00
	2.	61.66	65.33	53.33
	3.	56.33	62.00	53.00
	4.	52.66	46.66	52.66
	5.	50.00	41.00	37.66
II	1.	59.66	59.00	54.00
	2.	48.66	53.33	50.33
	3.	44.33	52.00	48.33
	4.	43.00	41.00	46.33
	5.	33.66	36.00	40.33
III	1.	52.00	42.66	49.00
	2.	50.33	38.00	39.66
	3.	48.00	33.66	29.33
	4.	47.33	32.33	29.00
	5.	43.00	29.66	22.66

TABLE V
DATA OF THE ANALYSIS OF VARIANCE

Source	Sum of Squares	Df	Mean Square	F Value	Probability
Rows ^a	3947.29689	2.	1973.64844	23.07093	0.0000 Sig.
Cols ^b	1490.10556	2.	745.05278	8.70928	0.0004 Sig.
Blocks ^c	96.10000	1.	96.10000	1.12336	0.2927
Ro-Col	322.41244	4.	80.60311	0.94221	0.4447
Ro-Blk	37.65067	2.	18.82533	0.22006	0.8030
Co-Blk	158.66467	2.	79.33233	0.92735	0.4003
R-C-B	305.71867	4.	76.42967	0.89342	0.4725
Within	6159.38400	72.	85.54700		
Total	12517.33289				

^aRows = Ability Groups.

^bColumns = Teaching Methods.

^cBlocks = Sex.

The critical value for the comparison of means covering two ranges, such as A-B, is as follows:

$$2 \text{ ranges } W2 = 2.83 \sqrt{\frac{85.547}{10}} = 8.2772$$

TABLE VI

DUNCAN'S NEW MULTIPLE RANGE TEST COMPARISONS
(Numbers rounded to closest hundredth)

Groups*	Means	Mean Differences	Duncan's Critical Value	Significance**
A-C	52.42-43.14	9.28	4.025	Sig.
A-B	52.42-44.64	7.78	4.78	Sig.
B-C	44.64-43.14	1.50	4.78	Not Sig.
AI-BI	62.58-52.98	9.60	8.28	Sig.
AI-CI	62.58-49.74	12.74	8.72	Sig.
BI-CI	52.98-49.84	3.14	8.28	Not Sig.
AII-BII	48.28-46.13	2.15	8.28	Not Sig.
AII-CII	48.28-43.93	4.35	8.72	Not Sig.
BII-CII	46.13-43.93	2.20	8.28	Not Sig.
AIII-BIII	46.40-34.80	11.60	8.28	Sig.
AIII-CIII	46.40-35.64	10.76	8.72	Sig.
BIII-CIII	34.80-35.64	-.84	8.28	Not Sig.

*A = The Trampoline Method; B = The Mental Practice Method; C = The Traditional Method.

**Significant if mean difference is greater than critical value.

The critical value for the comparison of means covering three ranges, such as A-C, is computed as follows:

$$3 \text{ ranges } W_3 = 2.98 \sqrt{\frac{85.547}{10}} = 8.7159$$

Hypothesis Ia

It was hypothesized that there would be a significantly better performance by the subjects using the Trampoline Method than the performance by the subjects using the Mental Practice Method. This hypothesis was retained. Duncan's test showed that the Trampoline Method was significantly different from the Mental Practice Method. The mean difference was 7.78 and the critical value was 4.78. The Trampoline Method had the greater mean, indicating the better performance (see Table VI).

Hypothesis Ib

It was hypothesized that there would be a significantly better performance by the subjects using the Mental Practice Method than by the subjects using the Traditional Method. This hypothesis was rejected. There was no significant difference between the two methods. The three teaching methods are graphically compared in Figure 3. The mean difference was 1.50 and the critical value was 4.78. The mean difference was not greater than the critical value, indicating a non-significant difference (see Table VI and Figure 3).

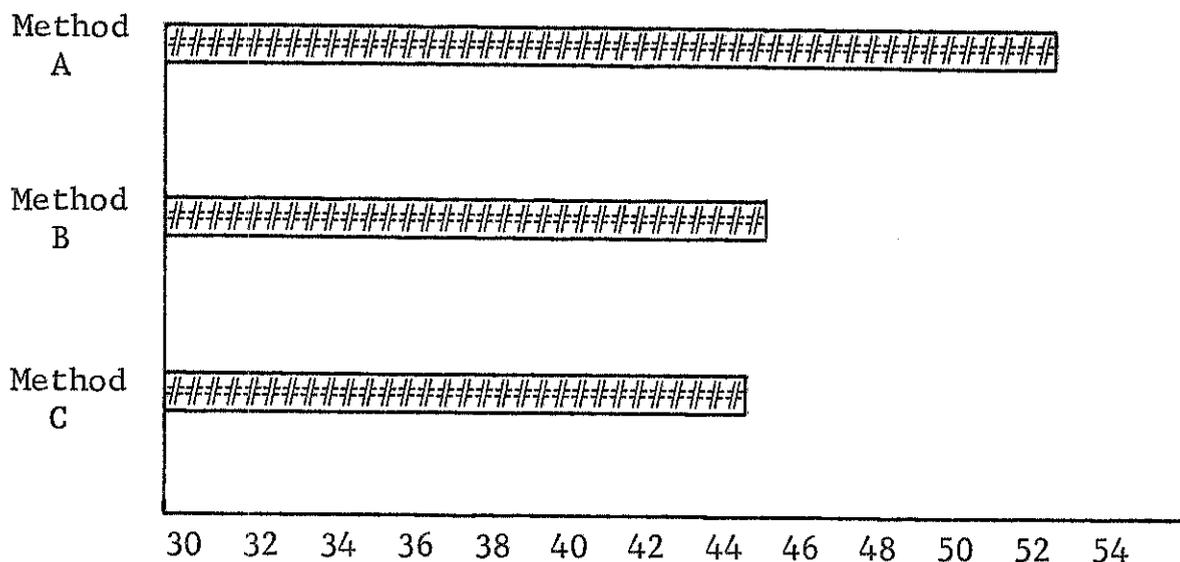


Fig. 3--A comparison of the total means of the three teaching methods.

Hypothesis Ic

It was hypothesized that there would be a significantly better performance by the subjects using the Trampoline Method than by the subjects using the Traditional Method. This hypothesis was retained. The mean difference was 9.28, and the critical value was 5.025. The Trampoline Method had the greater mean, indicating the better performance (see Table VI and Figure 3).

Hypothesis II

It was hypothesized that there would be no (null hypothesis) significant difference in the results of any of the three teaching methods attributable to sex. This hypothesis was

retained. The analysis of variance showed no significant difference attributable to sex. The ANOVA F value was 1.12336 and the probability was $P = 0.2927$. Duncan's New Multiple Range Test was not needed because of the nonsignificant findings in the ANOVA (see Table V).

Hypothesis III

It was hypothesized that there would be a significant difference in the results of the teaching methods attributable to ability level. This hypothesis was retained. The ANOVA F value was 23.07093 and the probability was $P = 0.0000$ (see Table V).

Hypothesis IIIa

It was hypothesized that the results of the high-ability group (Group I) would show that their best performance would be with the Trampoline Method. Their worst performance would be in the Traditional Method. This hypothesis was retained. The Trampoline Method group had a mean of 62.58; the Mental Practice Method group had a mean of 52.98; the Traditional Method group had a mean of 49.74 (see Table VI).

Hypothesis IIIb

It was hypothesized that the results of the medium-ability group (Group II) would show that their best performance would be in the Trampoline Method. Their worst performance would be in the Traditional Method. This hypothesis was retained. The Trampoline Method group had a mean of 48.28; the Mental Practice Method group had a mean of 46.13; and the Traditional Method group had a mean of 43.93 (see Table VI).

Hypothesis IIIc

It was hypothesized that the results of the low-ability group (Group III) would show that their best performance would be in the Trampoline Method. Their worst performance would be in the Mental Practice Method. This hypothesis was retained. The Trampoline Method group had a mean of 46.40; the Mental Practice group had a mean of 34.80; and the Traditional Method group had a mean of 35.64 (see Table VI).

Summary

In summary, significant differences were found among the three teaching method groups and the ability groups, Trampoline Method being significantly better than the Mental Practice Method and the Traditional Method. The ANOVA probability was

$P = 0.0004$. There was no significant difference between the Mental Practice Method and the Traditional Method, although the Mental Practice Method did have a slightly higher mean by 1.50 points.

In all three of the ability groups the best overall teaching method was the Trampoline Method. The high-ability group (Group I) and the medium-ability group (Group II) had their worst performances using the Traditional Method. The low-ability group (Group III) had their worst performance using the Mental Practice Method (see Table VI).

There were no significant differences attributable to the sex of the subjects. Further discussion of the results of the comparison of the three teaching methods will be presented in Chapter V.

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CHAPTER V

SUMMARY, CONCLUSIONS, IMPLICATIONS, AND RECOMMENDATIONS

Summary

The problem of this study was to determine the results of the comparison of three different methods of teaching tumbling. The three methods were the Trampoline Method, the Mental Practice Method, and the Traditional Method. The relative effectiveness of the three methods was determined.

Sub-problems of the study were to determine whether the sex of the subjects had a significant effect on the results of the teaching methods and whether the motor ability level had a significant effect on the results of the teaching methods.

A review of the related literature was accomplished and pertinent items were noted. Items vital to the success of the study were included in the design of the experiment. Items taken from the review and included in the study were primarily related to the Mental Practice Method.

The study was conducted at New Mexico State University during the fall and spring semesters of the 1972-1973 school year. The subjects for the study were members of the class

in gymnastics for physical education majors, P. E. 345. P. E. 345 is a junior-level coed course. There was a total of ninety subjects, forty-five female and forty-five male. Most of the subjects had had neither gymnastics nor tumbling instruction before enrolling in P. E. 345.

The study involved three methods of teaching tumbling and intact groups; therefore, a stratified random sample was constructed. Each teaching method had fifteen female and fifteen male subjects. They were divided into three ability groups by their scores on the Johnson-Metheny Test. The high-ability group was Group I. The medium-ability group was Group II. The low-ability group was Group III. The ability groups were then randomly selected and assigned to one of the three teaching methods. The Johnson-Metheny Test was administered before the instructional phase of the study began.

The first day of the study was orientation. The second and third days were devoted to the Johnson-Metheny Test. The fourth through the twenty-eighth days were the instructional days. The groups were divided on the second and third days and the instruction started on the fourth day. The twenty-ninth and thirtieth days were the tumbling test days. A fifteen-item tumbling test was the instrument used to collect the data to be analyzed.

During the instructional phase of the study the three teaching methods were kept separate. The Trampoline Method group practiced for fifteen minutes on the trampolines each day and then went to the tumbling mats for fifteen minutes of tumbling practice. The Mental Practice Method group went to the mental practice room for the first fifteen minutes and then went to the tumbling mats for fifteen minutes of physical practice. The Traditional Method group stayed on the tumbling mats for thirty minutes of physical practice.

The instructor taught all three of the methods with the assistance of three cadet teachers. A regular rotation was adhered to so that each group received eight thirty-minute class periods with the instructor. Each group had the instructor teach their specialty on every third class day after the instructional phase began.

The Trampoline Method skills were taught and practiced on the trampoline before they were ever attempted on the tumbling mats. The subjects in the Mental Practice group attempted to mentally practice the skills for two six-minute sessions with a three-minute rest break in between. The Traditional Method group physically practiced the skills for

thirty minutes. The subjects of the Traditional Method worked in pairs and while one practiced the other rested.

The statistical procedures used to analyze the data were the analysis of variance and Duncan's New Multiple Range Test. The results of the three teaching methods were analyzed using the analysis of variance. Significant differences noted in the analysis of variance were tested using Duncan's New Multiple Range Test. The .05 level of confidence was selected as the point at which the hypothesis was retained or rejected.

Summary of Findings

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

I. It was hypothesized that there would be significant differences among the three methods of teaching tumbling. This hypothesis was retained. There were significant differences noted among the three teaching methods. The ANOVA probability was $P = 0.0004$.

Ia. It was hypothesized that there would be a significantly better performance by the group using the Trampoline Method than by the group using the Mental Practice Method. This hypothesis was retained. Duncan's test showed that the Trampoline Method was significantly better than the Mental

Practice Method. The mean difference was 7.78 and Duncan's critical value was 4.78. The mean difference was greater than the critical value; therefore, it was significant.

Ib. It was hypothesized that there would be a significantly better performance by the group using the Mental Practice Method than by the group using the Traditional Method. This hypothesis was rejected. The Mental Practice Method was not significantly better than the Traditional Method. The mean difference was 1.50, and the critical value was 4.78.

Ic. It was hypothesized that there would be a significantly better performance by the group using the Trampoline Method than by the group using the Traditional Method. This hypothesis was retained. The Trampoline Method was significantly better than the Traditional Method. The mean difference was 9.28, and the critical value was 5.025.

II. It was hypothesized that there would be no significant difference in the results of any of the three teaching methods attributable to sex. This hypothesis was retained. There were no significant differences attributable to sex. The probability was $P = 0.2927$. Duncan's New Multiple Range Test was not needed because of the nonsignificant findings in the ANOVA.

III. It was hypothesized that there would be a significant difference in the results of the teaching methods attributable to motor ability level. This hypothesis was retained. There were significant differences noted. The ANOVA probability was $P = 0.0000$.

IIIa. It was hypothesized that the results of the high-ability group (Group I) would show that their best performance would be in the Trampoline Method. Their worst performance would be in the Traditional Method. This hypothesis was retained. The Trampoline Method had a mean of 62.58; the Mental Practice Method had a mean of 52.98; and the Traditional Method had a mean of 49.74.

IIIb. It was hypothesized that the results of the medium-ability group (Group II) would show that their best performance would be in the Trampoline Method. Their worst performance would be in the Traditional Method. This hypothesis was retained. The Trampoline Method had a mean of 48.28; the Mental Practice Method had a mean of 46.13; and the Traditional Method had a mean of 43.93.

IIIc. It was hypothesized that the results of the low-ability group (Group III) would show that their best performance would be in the Trampoline Method. Their worst performance would be in the Mental Practice Method. This hypothesis

was retained. The Trampoline Method had a mean of 46.40; the Mental Practice Method had a mean of 34.80; and the Traditional Method had a mean of 35.64.

Conclusions

As a result of the findings, the following conclusions were deemed appropriate within the limitations of the study:

1. The Trampoline Method is a more efficient method of teaching tumbling than the Mental Practice Method and the Traditional Method.

2. There is very little difference between the results obtained when using the Mental Practice Method or when using the Traditional Method.

3. Sex has very little effect in the learning of beginning tumbling skills. The female subjects did almost as well in the study as did the male subjects. The mean for the female subjects was 45.68, and the mean for the male subjects was 47.76, a nonsignificant difference.

4. The low-ability group had its worst performance when using the Mental Practice Method, while both the high- and medium-ability groups had their worst performance when using the Traditional Method. This may indicate that there is a

relationship between low motor ability and the lack of ability to mentally practice (conceptualize) a motor skill.

Implications

The following implications were developed during this study as a result of conclusions, observations, review of literature, and the analysis of data.

1. The findings indicate that the Trampoline Method of teaching tumbling should be used whenever possible.
2. In light of the findings that the sex of the subjects does not have an effect on the learning of beginning tumbling skills, beginning tumbling classes should be coeducational whenever possible.
3. Since there is very little difference in the results of the Mental Practice Method and the Traditional Method of teaching tumbling, either method may be employed when trampolines are not available.
4. When there is a situation where there is a large class, no trampolines, and a shortage of tumbling mats, it calls for a combination of the Mental Practice Method and the Traditional Method of teaching tumbling. Half of the class could be doing mental practice while the other half is doing physical practice. Time could be divided evenly so that half way through the class

period the two groups would trade activities. This would make one group do their physical practice before their mental practice, but this could be partially compensated for by alternating the groups each day of the tumbling unit.

5. The findings of this study could cause teachers of tumbling to look to the trampoline for help in teaching their students. This would result in an increase in the number of trampolines found in schools, colleges, universities, and similar organizations.

6. The findings of this study may make the sport of trampolining more safe. When teachers of tumbling use the Trampoline Method of teaching tumbling, they will be following a safe progression on the trampoline and more time will be spent on the basic movements. The main danger of the trampoline lies in the fact that it is easy to get high up into the air and most students want to advance too quickly, skipping over essential progression steps.

7. The findings indicate that for low-ability groups it would be better to use the Traditional Method of teaching tumbling rather than the Mental Practice Method, when there are no trampolines available.

8. The findings of the study could act as a source of stimulation for the development of other teaching methods using the trampoline.

9. Interest in using the trampoline for other purposes may be stimulated by the findings of this study.

Recommendations

The findings of this study suggest the following recommendations to consider in further research into the methods of teaching tumbling:

1. Further investigations similar to this study should be conducted, comparing the same three teaching methods. A study using only female subjects and one using only male subjects would shed more light upon the teaching methods. Even though there were no significant interactions of variables or differences attributable to sex, it would be helpful to have confirmation of the findings.

2. Similar studies should be conducted at the high school, junior high school, and elementary school levels to find if age and maturity have an effect on the results of the teaching methods.

3. A study similar to this one should be conducted, keeping all the same variables except for the use of intermediate-level skills.

4. A study similar to this study should be conducted, keeping all the same variables except for the use of advanced tumbling skills.

5. More studies using the Mental Practice Method of learning motor skills need to be conducted.

6. In the studies using the Mental Practice Method, all subjects should be provided an opportunity to practice the mental practice technique prior to the experimental periods.

7. An attempt should be made to determine if a subject is able to do the mental practice techniques (conceptualize the selected motor skills). A knowledge of this may be valuable in reducing limitations of subsequent studies.

8. A trampoline method of teaching skills for the horizontal bar, parallel bars, rings, long horse, uneven parallel bars, and balance beam should be tested.

9. Dismounts for all gymnastics should be practiced on the trampoline because of their close relationship to trampoline, tumbling, and diving skills.

APPENDIX A

(Group A)

THE TRAMPOLINE METHOD OF TEACHING TUMBLING (developed between 1952 and 1961)

The basic tenet of the method is that a skill can be practiced more times on the trampoline than on the tumbling mat and more efficient progression can be used.

Tumbling skills taught on the Trampoline:

- | | |
|----------------------------------|-------------------------------------|
| * 1. Forward roll | *20. Back somersault |
| 2. Forward roll walk out | 21. Back somersault (piked) |
| * 3. Handstand forward roll | 22. Back somersault (laid out) |
| 4. Dive roll | 23. Back S.S. w/ full twist |
| * 5. Backward roll | 24. Barani (for. S.S. 1/2 tw) |
| * 6. Backward roll snap-up | 25. Rudolph (for. S.S. i 1/2 twist) |
| * 7. Jump-full twist | 26. Back S.S. w/ 1 1/2 twist |
| * 8. Kip-up | 27. Double back S.S. |
| * 9. Backward roll (piked) | 28. Back S.S. w/ double twist |
| *10. Headspring | 29. Back S.S. w/ 2 1/2 twist |
| *11. Handspring | 30. Side S.S. |
| *12. Cartwheel | 31. Double side S.S. |
| *13. Roundoff | 32. Barani out fliffus |
| *14. Tinsica | 33. 1/2 in 1/2 out fliffus |
| 15. Handspring walk out | 34. Full in fliffus |
| *16. Flip Flap | |
| *17. Forward somersault (tucked) | |
| 18. Forward somersault walk out | |
| 19. Forward somersault (piked) | |

*= Items included in the experiment and the post-test.

Included in this teaching method is the use of over-head spotting (safety) belts, audio-visual aids, and demonstrations by the instructor and assistants. Teaching of the spotting techniques are also included. One of the main advantages of this method is that many more progressions (intermediate steps) can be employed on the trampoline than on the tumbling mat.

Definition of Terms

Body Positions:

Tuck = Upper body curled forward, legs bent, knees close to the chest, hands grasp the front of the lower leg immediately above the ankles.

Pike = Body bent forward at the hips to a 90 degree angle or less, legs straight.

Lay-out = laid-out = Body is held straight from head to heels or there is a slight arch in the back (there can be no piking action) legs must be straight.

Tumbling Skills:

Forward roll = Forward 360 degree turn of the body around its horizontal (transverse) axis, the performer's back makes contact with the mat.

Twist = A turning action around the vertical axis of the body, can be a one-half, full, one and one-half double or more.

Headspring = Forward 360 degree turn of the body around the horizontal (transverse) axis, in which the hands contact the mat and the arms bend and the body remains laid-out.

Handspring = Forward 360 degree turn of the body around the horizontal axis, in which the hands contact the mat and the arms remain straight and the body remains laid out.

Cartwheel = Sideward 360 degree turn of the body around the antero-posterior axis, both hands contact the mat, the body is in the laid-out position.

Backward roll = Backward 360 degree turn of the body around the horizontal (transverse) axis, the performer's back makes contact with the mat.

Tinsica = A forward handspring with an alternating hand take off and a walk out landing.

Flip flap = (backward handspring) A backward 360 degree turn of the body around the horizontal (transverse) axis, in which the hands contact the mat, the arms remain straight and the body bends backward.

Forward somersault = A forward 360 degree turn of the body around the horizontal (transverse) axis, in which nothing but the feet contact the mat.

Backward somersault = A backward 360 degree turn of the body around the horizontal (transverse) axis, in which nothing but the feet contact the mat.

Barani = Forward somersault with one-half twist (watching the mat through-out).

Sideward somersault = A sideward 360 degree turn of the body around the antero-posterior axis, in which nothing but the feet contact the mat.

Fliffus = Any double somersault with a twist ($1/2$, 1, $1\ 1/2$, 2 and etc.).

Spotting = Helping the performer through a skill or protecting them from a fall.

Walk-out landing = Feet separate in a walking fashion on landing, one foot preceding the other as opposed to the parallel simultaneous landing. Unless stated other-wise all landings will be the two foot simultaneous landing.

The spotting techniques are more efficient and easier to employ on the trampoline than on the tumbling mat.

Instruction sheets were given to each of the subjects.

The sheets had complete descriptions of the skills (Appendix G).

The instructor was with this group one-third of the time.

APPENDIX B
(Group B)

MENTAL PRACTICE METHOD

This Method is called the Mental Practice Method, but it may be, more accurately, named the Mental-Physical Practice Method. The first fifteen minutes of the study were devoted to mental practice (conceptualization) and the second fifteen minutes were devoted to actual physical practice (PP).

For the first fifteen minutes of the study, the subjects of this method went to a mental practice room where they did the mental practicing (visualization, imagery, conceptualization, symbol practice, Imaginary practice or implicit practice) for a six minute bout; then a rest period of three minutes; then another bout of six minutes of mental practice.

For the second fifteen minutes of the study they went to the tumbling mats for physical practice (PP).

Instruction skill sheets were given to each of the subjects. The sheets had complete descriptions of the skills, (Appendix G).

A description of how to accomplish mental practice was also included, (Appendix D).

The instructor was with this group one-third of the time.

APPENDIX C
(Group C)

This method is the one that has been employed to teach for many years. The approach utilizes the physical practice method (PP). The instructor, or an assistant demonstrated, the skill to be learned and then the subjects attempt to do it.

The method is constructed around an efficient learning progression. The skills are taught in the order of their difficulty and also according to how they fit into the scheme of a group of skills. A good example is the progression used in teaching the backward roll group: 1. Backward roll, 2. Backward roll snap-up, 3. Backward roll piked and 4. Backward roll handstand. Each of the skills leads naturally into the next skill higher.

The coach and pupil method was used in this method. The subjects worked in pairs. One subject performs the skill; while the other watches and makes corrections or spots the performer. The partners switch places after a certain number of attempts.

Instruction sheets were given to each of the subjects. The sheets had complete descriptions of the skills (Appendix G).

The instructor was with this group one-third of the time.

APPENDIX D

SPECIAL INSTRUCTIONS TO GROUP B

There was a special set of sheets of specific instructions for group B. The sheets contained hints and suggestions as to the best way to obtain the maximum from the mental practice sessions- Based on previous research by experimentors in the area of mental practice.

The first sheet was a general description of what mental is and how to do it. The remainder of the sheets were the individual skill sheets. The first sheet read as follows:

Mental practice means to think through the skill. You should attempt to see (image) yourself, in your mind's eye, actually performing the skill. You should see it in slow motion and at normal speed.

The room will be quiet and free from distractions. You will mentally practice the assigned skill for six minutes, and then rest for three minutes (think about something else or let your mind go blank). Another period of mental practice for six minutes will follow the rest period.

Some people create better imagery if they sit back and close their eyes. Some do better if they keep their eyes open and view the instruction sheet while they are mentally practicing. Try both methods, then use the most efficient one for you. If you prefer another method, talk it over with the instructor. Remember: Keep trying to see yourself performing the skills!

The fifteen sheets are on the following pages D-1 through D-15.

MENTAL PRACTICE

Jump Full Twist

1. Think of how the complete full twist looks. See Yourself doing the full twist.

2. In slow motion think of the vital points to emphasize when doing the full twist.
 - A. Jump straight up and stretch the body.
 - B. Push with the feet to start the twist action.
 - C. Throw the arm across the body in the direction of the twist.
 - D. Pull the left arm back into the left shoulder. if the twist is to the left (reverse if to the right).
 - E. Turn the head vigorously in the direction of the twist.
 - F. Keep the legs together while in the air.
 - G. Take off and land with the legs apart.

3. Continue to go over the complete full twist in your mind, at normal speed.

MENTAL PRACTICE

The Forward Roll

1. Think of the complete roll as it was demonstrated and is pictured in your instruction sheet. Be sure to see yourself doing the skill.

2. In slow motion think of the vital points to emphasize when doing the forward roll.

- A. Push with the legs to get the hips up over the head.
- B. Push with the arms to take the weight on the hands.
- C. Lower the body to the mat softly by bending the arms.
- D. Keep the body round (don't flatten your back).
- E. Grasp the legs and pull the feet under your body as you come to the squat position again.

3. Continue to go over the complete forward roll in your mind, at normal speed.

MENTAL PRACTICE

Backward Roll

1. Think of the complete roll as it was demonstrated and is pictured in your instruction sheet. Be sure to see yourself doing the backward roll.

2. In slow motion think of the vital points to emphasize when doing the backward roll.

- A. Bring the hands up over the shoulders when doing the squat.
- B. Keep the back round.
- C. Tuck the chin on the chest.
- D. Push with the arms as soon as the hands contact the mat.
- E. Take the weight off the neck.

3. Continue to go over the complete backward roll in your mind, at normal speed.

MENTAL PRACTICE

Handstand Forward Roll

1. Think of the complete skill as it was demonstrated and is pictured in your instruction sheet. Be sure to see yourself doing the skill.

2. In slow motion think of the vital points to emphasize when doing the handstand forward roll.

- A. Keep the arms straight in the handstand.
- B. Over-balance before trying to lower the body.
- C. Use the arms to lower the body softly to the mat.
- D. Keep the head up, looking at the mat until just before the shoulders contact the mat.
- E. Make the back round when the body contacts the mat.
- F. Grasp the legs and pull the feet under the body.

3. Continue to go over the complete handstand forward roll in your mind, at normal speed.

MENTAL PRACTICE

Backward Roll Snap-up

1. Think of the complete skill as it was demonstrated and is pictured in your instruction sheet. Be sure to see yourself doing the skill.

2. In slow motion think of the vital points to emphasize when doing the backward roll snap-up.
 - A. Keep the chin down until the snap.
 - B. Keep the back round until the snap.
 - C. Shoot up toward the ceiling with vigor.
 - D. Snap the arms straight.
 - E. Keep the legs straight on the snap-down.
 - F. Drive with the shoulders (hard) on the snap-down.

3. Continue to go over the complete backward roll snap-up in your mind, at normal speed.

MENTAL PRACTICE

Backward Roll Piked

1. Think of the complete skill as it was demonstrated and is pictured in your instruction sheet. Be sure to see yourself doing the skill.

2. In slow motion think of the vital points to emphasize when doing the backward roll piked.

- A. Lean as far forward as possible.
- B. Keep the tight pike position until the hands contact the mat.
- C. Catch the weight on the hands.
- D. From the sitting position try to bring the ankles over your head without bending the knees.
- E. Shoot to the handstand vigorously.
- F. Keep the arms straight in the snap-down.

3. Continue to go over the complete backward roll piked in your mind, at normal speed.

MENTAL PRACTICE

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Cartwheel

1. Think of the complete cartwheel as it was demonstrated and is pictured in your instruction sheet. Be sure to see yourself doing the cartwheel.

2. In slow motion think of the vital points to emphasize when doing the cartwheel.
 - A. Think of the body as a wheel with the hub in the abdominal area and the arms and legs as the spokes.
 - B. Keep the arms straight.
 - C. Keep the hands and feet in a straight line as they are placed on the mat.
 - D. Kick hard with the first leg over.
 - E. Place the first foot over, close to the hand, on the mat (in line).

3. Continue to go over the complete cartwheel in your mind, at normal speed.

MENTAL PRACTICE

Roundoff

1. Think of the complete roundoff as it was demonstrated and is pictured in your instruction sheet. Be sure to see yourself doing the roundoff.

2. In slow motion think of the vital points to emphasize when doing the roundoff.

- A. Place the first hand down directly in front of the lead foot.
- B. Snap the quarter twist when the body reaches the inverted position, and bring the legs together.
- C. Snap-down hard.
- D. Drive with the shoulders in the snap-down.
- E. Keep the feet apart on landing.

3. Continue to go over the complete roundoff in your mind at normal speed.

MENTAL PRACTICE

Kip-up

1. Think of the complete kip-up as it was demonstrated and is pictured in your instruction sheet. Be sure to see yourself doing the kip-up.

2. In slow motion think of the vital points to emphasize when doing the kip-up.

- A. Keep the legs straight.
- B. Push with the arms.
- C. Arch the back.
- D. Keep the head back.

3. Continue to go over the complete kip-up in your mind, at normal speed.

MENTAL PRACTICE

Headspring

1. Think of the complete headspring as it was demonstrated and is pictured in your instruction sheet. Be sure to see yourself doing the headspring.

2. In slow motion think of the vital points to emphasize when doing the headspring.

- A. Touch the front part of the top of the head to the mat.
- B. Whip the legs up over the body hard.
- C. Shoot legs upward and outward at a forty-five degree angle.
- D. Push with the arms.
- E. Arch the back.
- F. Keep the head back.

3. Continue to go over the headspring in your mind, at normal speed.

MENTAL PRACTICE

Tinsica

1. Think of the complete tinsica as it was demonstrated and is pictured in your instruction sheet. Be sure to see yourself doing the Tinsica.

2. In slow motion think of the vital points to emphasize when doing the tinsica.

- A. Start like a cartwheel.
- B. Keep the body straight.
- C. Keep the head back.
- D. Drive with the shoulders.
- E. Step out facing forward.

3. Continue to go over the tinsica in your mind, at normal speed.

MENTAL PRACTICE

Front Handspring

1. Think of the complete front handspring as it was demonstrated and is pictured in your instruction sheet. Be sure to see yourself doing the handspring.

2. In slow motion think of the vital points to emphasize when doing the handspring.

- A. Place hands down softly.
- B. Kick the legs over hard.
- C. Drive with the shoulders (shoulder shrug).
- D. Keep the head back throughout.
- E. Keep the legs straight.
- F. Arch the back.

3. Continue to go over the handspring in your mind, at normal speed.

MENTAL PRACTICE

Flip Flap

1. Think of the complete flip flap as it was demonstrated and is pictured in your instruction sheet. Be sure to see yourself doing the flip flap.

2. In slow motion think of the vital points to emphasize when doing the flip flap.

- A. The sit is very important (just like sitting in a chair, except the arms swing behind you).
- B. Weight back on the heels.
- C. Swing the arms around in a circular action.
- D. The head goes back when the arms are by the ears.
- E. It is important to look for the mat directly behind you (do not turn the head to the right or left).
- F. Drive the hips up toward the ceiling.
- G. Keep the arms straight.

3. Continue to go over the flip flap in your mind, at normal speed.

MENTAL PRACTICE

Running Forward Somersault

1. Think of the complete somersault as it was demonstrated and is pictured in the instruction sheet, Be sure to see yourself doing the somersault..

2. In slow motion think of the vital points to emphasize when doing the running forward somersault.

A. Keep the head up and the chest high on the take-off, from the mat.

B. Try to drive the hips up over the head.

C. Put the head between the knees.

D. Look for something about shoulder high for the signal to open up.

E. Snap open for the landing.

F. Look forward on landing, don't look down at your feet.

3. Continue to go over the somersault in your mind, at normal speed.

MENTAL PRACTICE

Standing Backward Somersault

1. Think of the complete somersault as it was demonstrated and is pictured in your instruction sheet. Be sure to see yourself doing the standing backward somersault.

2. In slow motion think of the vital points to emphasize when doing the standing backward somersault.
 - A. Bend the legs and keep the back erect in the preparation for the jump.
 - B. Throw the arms up as high as you can on the jump.
 - C. Jump as high as you can.
 - D. Don't let the head go back until you reach the top of your jump.
 - E. Bring the knees in to the chest vigorously.
 - F. Look for the mat.

3. Continue to go over the somersault in your mind, at normal speed.

APPENDIX E

THE JOHNSON-METHENY TEST

A canvas fifteen feet long is marked with a lane 24 inches wide in the middle (it was painted on the mat for this study) it is divided into ten equal sections. Every other line is three inches wide; the narrow lines are three-quarters of an inch wide. The centers of the lines are eighteen inches apart. A three-quarter inch line is drawn down the center of the 24 inch lane, running the length of the outline. The canvas should be placed over a mat with the ends and sides tucked under so that the canvas is stretched taut. Of course, the lines could be painted directly on the mat.

Front-roll Test

The subject starts from a standing position at one end of the 24 inch lane. He performs one front roll within the limits of the first half of the lane; he then does another front roll within the limits of the second half of the lane. Each roll is worth 5 points. Points are deducted as follows: (a) for each roll two points are deducted if the subject strays beyond the left boundary and a similar penalty is imposed if he overreaches the right boundary. (b) One point is deducted for each roll if the subject does not complete the roll within the designated half of the lane. (c) Five points are deducted for failure to perform a true roll. If the subject fails on the first roll, he is allowed to try to do the second roll in the last half of the lane.

Back-Roll Test

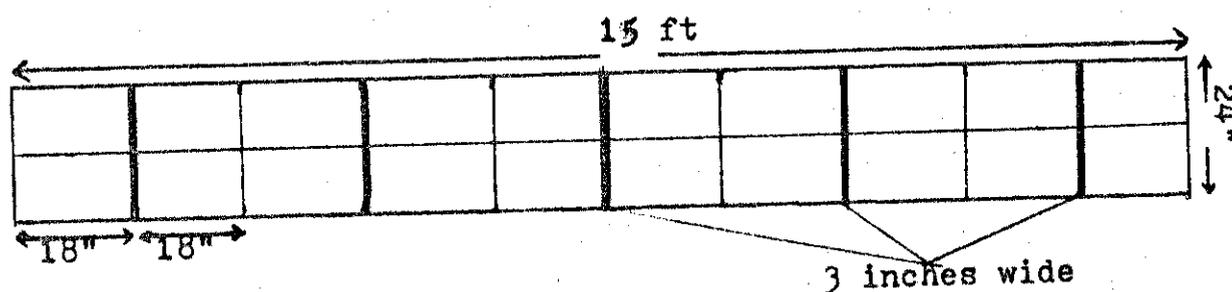
The subject starts from the end of the 24 inch lane and performs two back rolls. One roll is done within the first half of the lane; the other roll is performed within the second half of the lane. The scoring is the same as in the front-roll test

Jumping-Half-Turn Test

Standing on the first 3 inch line the subject jumps upward and executes a half turn in either direction, landing on the second 3 inch line. He is now facing the starting line. He then jumps upward making a half turn in the opposite direction from which the first jump was done. He proceeds in this manner alternating directions of the turns, until he completes four jumps. Perfect execution is worth ten points. Two points are deducted for each jump in which the subject does not land on the line with both feet, or if he should turn the wrong way (in the wrong direction), only two points.

Jumping-Full-Turn Test

The subject stands at the end of the lane, jumps upward with feet together, and executes a full turn in either direction while landing in the second section. He then jumps and makes another full turn in the same direction and lands in the fourth section. He continues the length of the mat in this manner. From a possible ten points, two points are deducted if the subject does not land on both feet, or if he fails to land in the designated section, or if he turns too far or not far enough, or if he moves his feet upon landing for balance.



JOHNSON-METHENY MAT

APPENDIX F

THE TUMBLING TEST

Three teachers of tumbling will judge the performance of the skills on the basis of a seven point scale:

1= Complete failure, 2= Very poor, 3= Poor, 4= Fair, 5= Good, 6= Very good and 7= Excellent.

(The validity of the test has been established by a panel of experts).

Skills included in the test:

1. Jump full twist
2. Forward roll
3. Backward roll
4. Handstand forward roll
5. Backward roll snap-up
6. Backward roll piked
7. Cartwheel
8. Roundoff
9. Kip-up
10. Headspring (arched)
11. Tinsica
12. Front handspring (arched)
13. Flip flap
14. Running forward somersault
15. Standing backward somersault

Validation of the Tumbling test was requested from ten experts in tumbling. All are accomplished performers, teachers, judges and researchers in tumbling. Seven members of the panel were National Tumbling Champions in the United States. The United States is the most knowledgeable country in the world in tumbling, therefore, it would seem that the ten best tumbling men in the United States would be among the best in the world.

Those selected for the panel of experts are:

Dr. George Baur, Associate Professor and Gymnastics Coach
University of Wisconsin, Madison, Wisconsin.

Bill Cornelius, Assistant Professor and Gymnastics Coach,
North Texas State University, Denton, Texas.

Dr. Harold Frey, Associate Professor and Gymnastics Coach,
University of California, Berkeley, California.

Joseph Gialombardo, National Gymnastics Judge and Coach,
Willmette, Illinois.

Richard Holzaepfel, Associate Professor and Gymnastics Coach,
State University of Iowa, Iowa City, Iowa.

Dr. Newton Loken, Professor and Gymnastics Coach, University
of Michigan, Ann Arbor, Michigan.

Bill Meade, Associate Professor and Gymnastics Coach,
Southern Illinois University, Carbondale, Illinois.

Charles Pond, Professor and Gymnastics Coach, University
of Illinois, Champaign, Illinois.

Dr. Hartley Price, Professor emeritus and Coach emeritus,
Florida State University, Tallahassee, Florida
(Chairman of the National Gymnastics Research Committee).

George Szypula, Associate Professor and Gymnastics Coach,
Michigan State University, East Lansing, Michigan.

All of the experts affirmed that the scores on this test are a good indication of Elementary Tumbling Ability!

Validation of a test to be utilized in the Doctoral
Dissertation of Robert M. Hazlett

(test validation by a panel of experts)

The test will be judged by three teachers of tumbling
(all former gymnastics and tumbling judges). All skills
included in the test will be taught in the tumbling class.

Performance on the test will be based on a seven-point
scale, as follows:

1= complete failure, 2=very poor, 3= poor, 4= fair,
5= good, 6= very good, 7 excellent.

Skills included in the test:

1. Jump full twist
2. Forward roll
3. Backward roll
4. Handstand forward roll
5. Backward roll snap-up
6. Backward roll piked
7. Cartwheel
8. Roundoff
9. Kip-up
10. Headspring (arched)
11. Tinsica
12. Front handspring (arched)
13. Flip flap
14. Running forward somersault
15. Standing backward somersault

Please draw a line through any of the skills you would
delete from this test?

Please list below (on the lines provided) all skills
you would add to this test of elementary tumbling ability?
(Since the skills are listed in a normal sequence for learning,
please list your inclusions between the proper skills already
listed). see example.

(example) "already listed"	"inclusion"	"already listed"
Jump full twist	Jump 1 and 1/2 twists	forward roll

The scores on this test are a good indication of
elementary tumbling ability Yes_____ No_____ (mark with X)

Name of Validator _____
 position _____
 school _____
 date _____

A Tabulation of the comments of the panel of experts.

Suggested Additions: (if there is a desire to increase the number of items in the test)

Baur= Ground kip, back roll to momentary handstand, cartwheel 1/2 turn and end like a handspring, one hand cartwheel, 1/2 turn dive roll, cradle.

Cornelius= Headstand, headstand forward roll, handstand snap-up

Frey= Handstand

Gialombardo= Back roll straddle, headspring arched, handspring arched.

Holzaepfel= "None"

Loken= Headspring off rolled mat, roundoff back handspring.

Meade= Headstand.

Pond= Arch stand (crab stand), knee elbow handstand, knee elbow headstand.

Price= Snap down, full turns (left and right), forward and backward straddle rolls, one arm cartwheels, headspring, kip-up.

Szypula= Headstand Bridge

Suggested Deletions: (if there is a desire to decrease the number of items in the test).

Baur= Running forward somersault, standing back somersault.

Cornelius= Tinsica, front handspring, flip flap, running forward somersault, standing back somersault.

Frey= "Make it just five items".

Gialombardo= Jump 1/2 turn.

Holzaepfel= "None"

Loken= "None"

Meade= Dive roll

Pond= "None"

(tabulation continued)

Price = Jump 1/2 turn, dive roll

Szypula = Tinsica, flip flap, running forward somersault,
standing back somersault

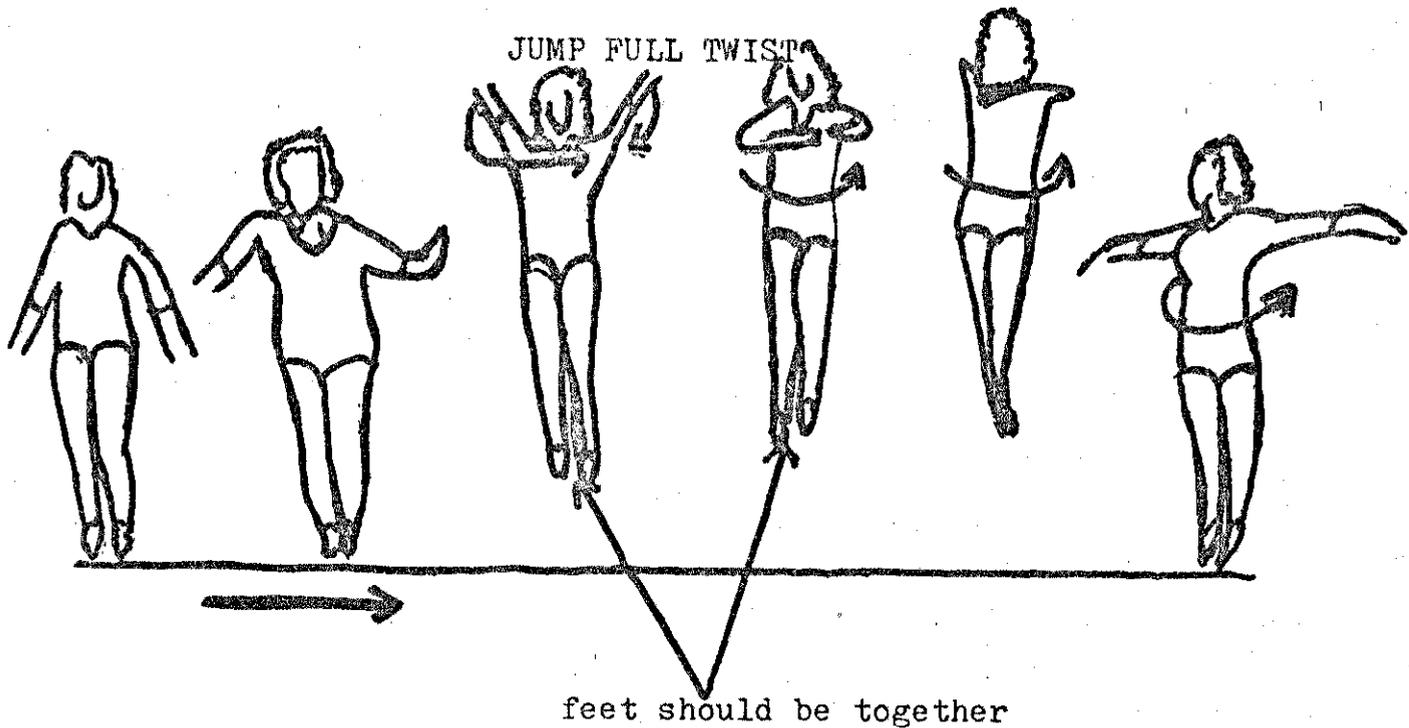
APPENDIX G

THE GENERAL SKILL SHEETS

The general skill sheets were given to all of the subjects in the study. Each sheet contains a detailed description of the skill. Also, included on each sheet is a sequence drawing of the skill. Each of the important progressions of the skill are included in the drawings. Learning hints are included in the drawings.

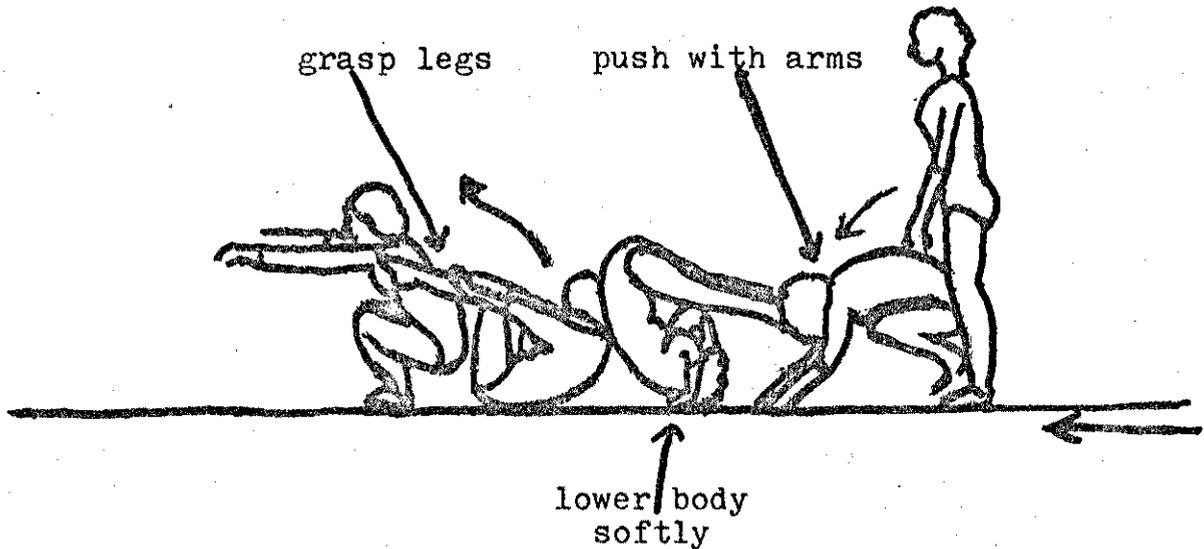
The subjects were instructed to read the instructions and to study them before they start to practice mentally or physically.

The fifteen sheets are on the following pages G-1 through G-15.



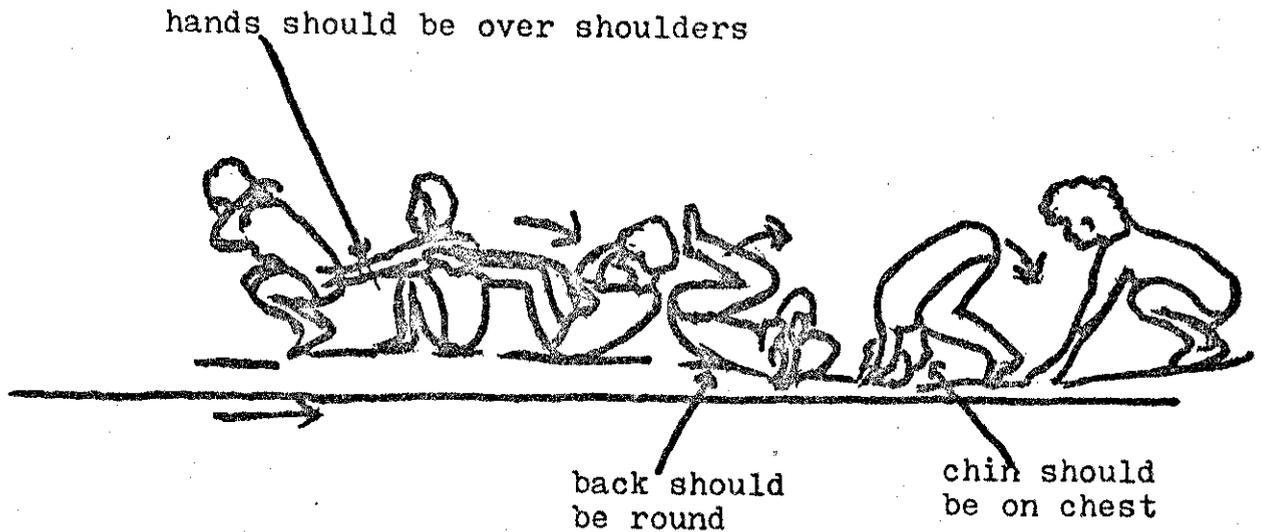
From the standing position facing forward, bend the knees and swing the arms back to begin the jumping action. Swing the arms up to shoulder height or a little higher, at the same time push with the legs, at the last moment before the feet leave the floor, push the mat to the right with the feet. When the body reaches its highest point throw the right hand directly at the left shoulder, at the same time throw the left hand at the left shoulder also, in addition, turn the head vigorously to the left. Keep both hands against the left shoulder until the full twist is completed. To stop the twist bring both hands out to the sides or down to the hips, face forward again. Legs should start about shoulder width apart be together in the air and be apart when the landing is made.

FORWARD ROLL



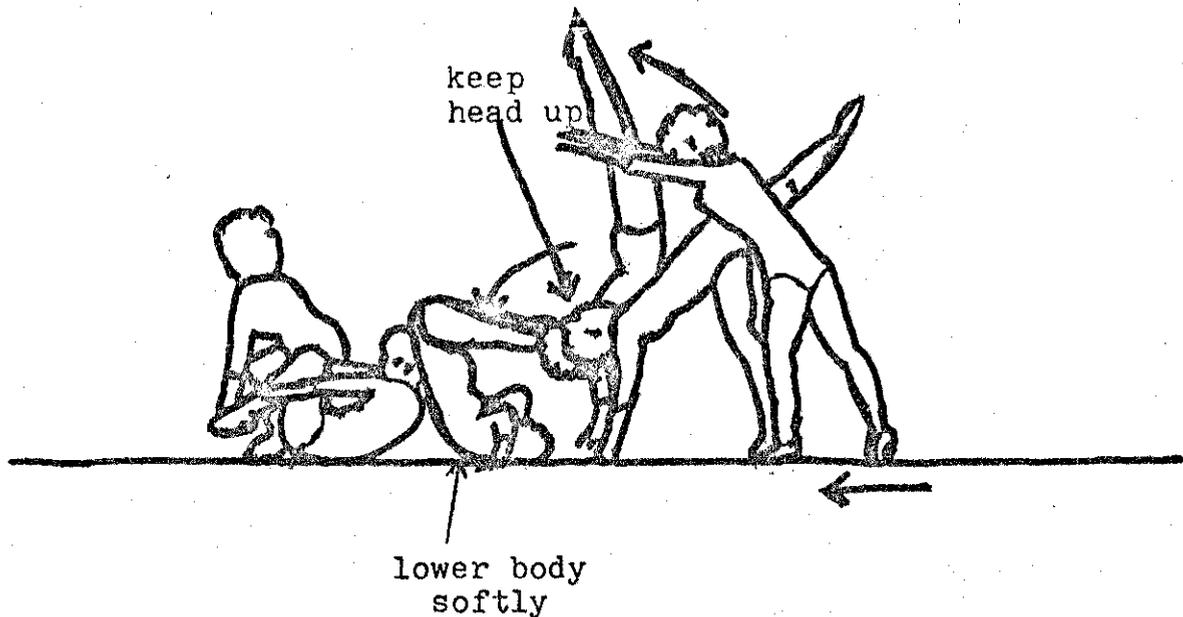
From the standing position, lower to a deep squat position with the knees together, place hands on the mat approximately eighteen inches in front of the toes, push down backward with the feet. Push with the arms to take the weight on the hands, bend the arms and lower the shoulders to mat, softly, (head tucks at the last possible second before shoulder contact). Keeping the legs extended, continue rolling, and as soon as the hips have contacted the mat, tuck the legs and come to a squat position grasping the legs immediately above the ankles. Eyes spot a stationary object to assist in maintaining balance while returning to the standing position. Should be continuous motion throughout.

BACKWARD ROLL



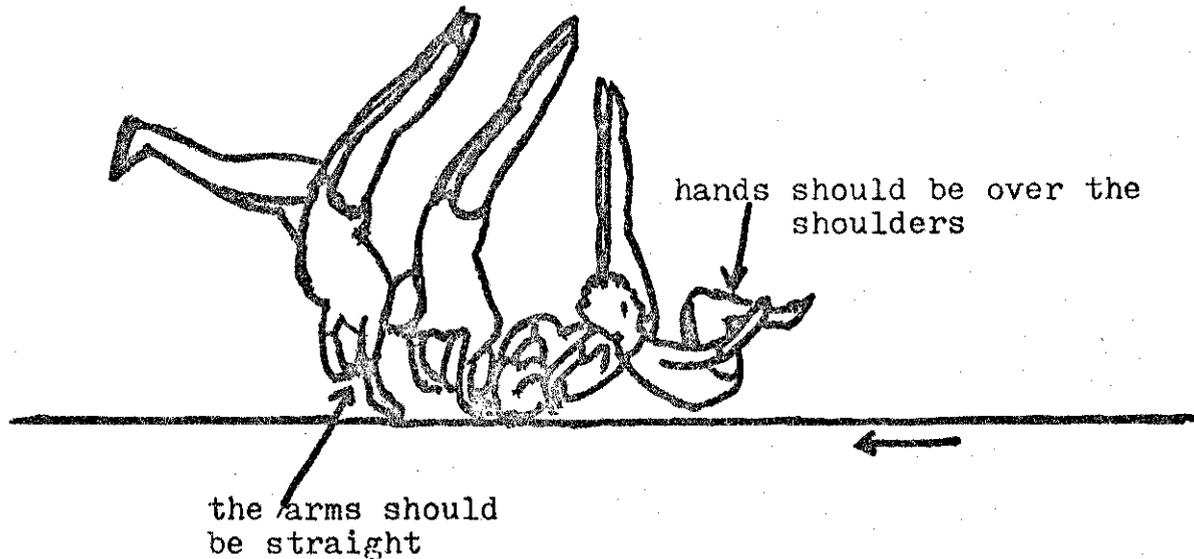
From the standing position, lower to a deep squat, at the same time bring the hands up over the shoulders with the palms facing upward and the fingers pointing back over the shoulders, thumbs near the ears. Tuck the chin on the chest and make the back round. Fall backward and place the hands on the mat as soon as possible, as soon as the hands touch the mat push with the arms and straighten them as quickly as possible. Continue the roll as the body is lifted from the mat by the arms, keep the chin down throughout the roll as the feet contact the mat, thrust with the hands and fingers to help the return to the standing position.

HANDSTAND FORWARD ROLL



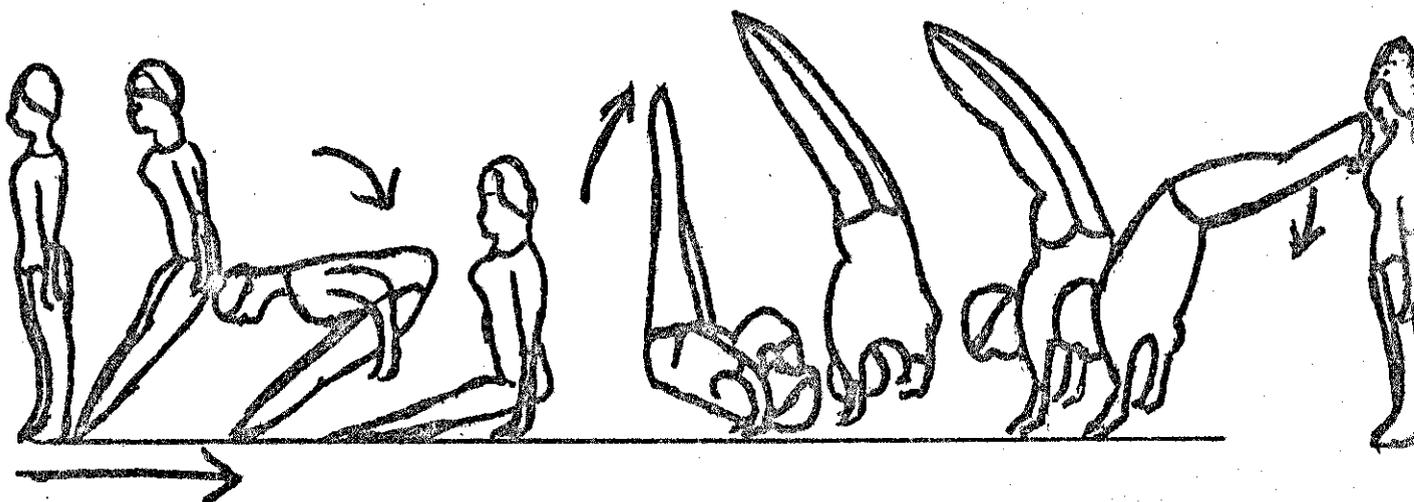
To kick to the handstand position, bend the left leg and place the hands on the mat shoulder width apart and about 12 to 18 inches in front of the left foot, fingers should be spread. Kick with the right leg keeping it straight. Push with the left leg and bring the legs together when the body is inverted. Keep looking at a spot about 18 inches in front of your hands. To complete the roll, lower the body with the arms, when the legs start to pull the body over toward the back. Continue bending the arms and place the shoulder area softly on the mat (duck the head at the last possible moment) tuck the knees in close to the chest and grasp the legs immediately above the ankles. Return to the standing position.

BACKWARD ROLL SNAP-UP



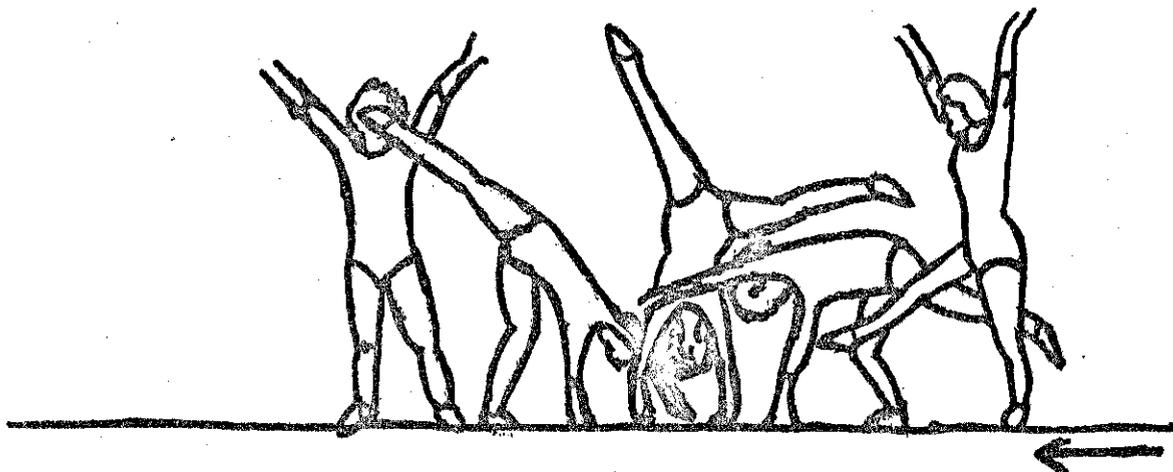
Begin the backward roll the same as in number 3. When the hands are on the mat, shoot the feet up toward the ceiling and extend the body, arch the back and look at the hands. Snap the arms straight. You should now be in a good handstand position. Snap down to the mat by simultaneously bending at the waist and driving hard with the shoulders. Raise your head and return to the standing position. Do not bend the legs in the snap-down.

BACKWARD ROLL PIKED



Begin by bending forward at the waist and keeping the hands by the hips, bend forward as far as possible with the upper body, tuck the chin on the chest. Fall backward as you continue to lean forward with the head and shoulders. Catch the weight on the hands. As soon as your bottom contacts the mat bring the hands up over the shoulders. As soon as the hands are on the mat shoot the feet toward the ceiling and arch the back, snap the arms straight. You should be in a handstand position. Snap-down by bending at the waist and driving with the shoulders. Return to the standing position. The legs should never bend during the execution of this skill, the legs should be held together.

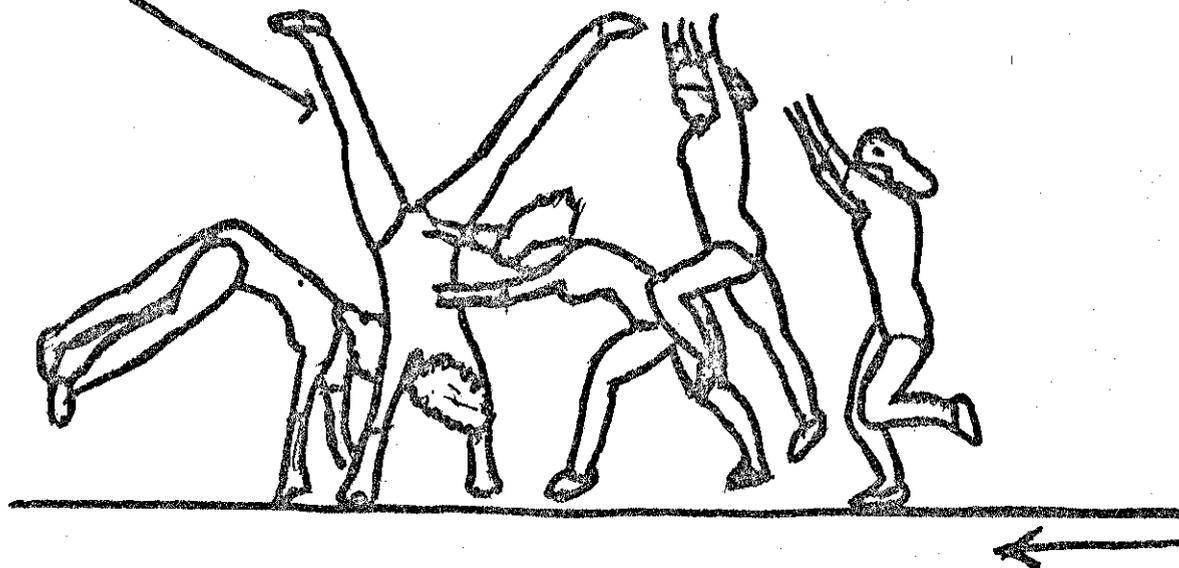
CARTWHEEL



From a tumbler's skip, right foot forward, bend the right leg and place the right hand directly in front of the right foot (about 18 inches away from the foot). Keeping it straight, kick the left leg up over the head. Place the left hand on the mat in line with the right foot and right hand, push with the right leg and straighten the leg. Continue the motion. Place the left foot in line with the right hand, right foot and left hand, continue the circular motion. Come to a straddle stand sideward. Think of the body as a wheel with the abdominal area as the hub and the arms and legs as the spokes.

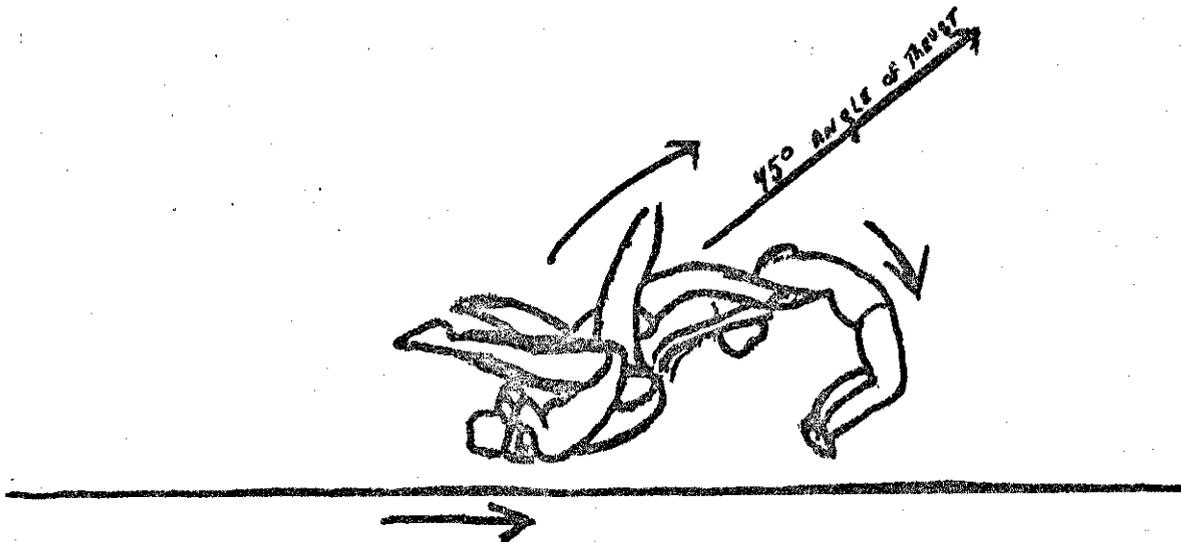
bring the legs together

ROUND OFF



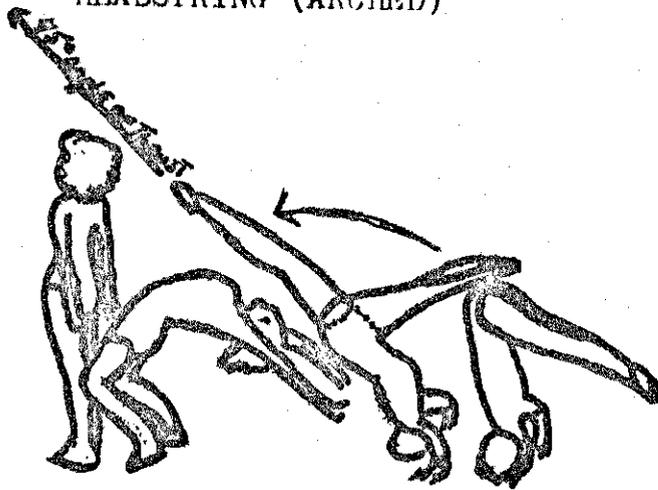
From the tumbler's skip with the left foot forward. Start the same as the cartwheel until both hands are on the mat. When the body is in the inverted position, the body makes a quarter turn so that the front of the body is facing back toward the starting position when it returns to the standing position. At the same time the twist is made bring the legs together and complete a snap-down action, by bending at the waist and driving with the shoulders. Land with the the feet about shoulder width apart.

KIP-UP



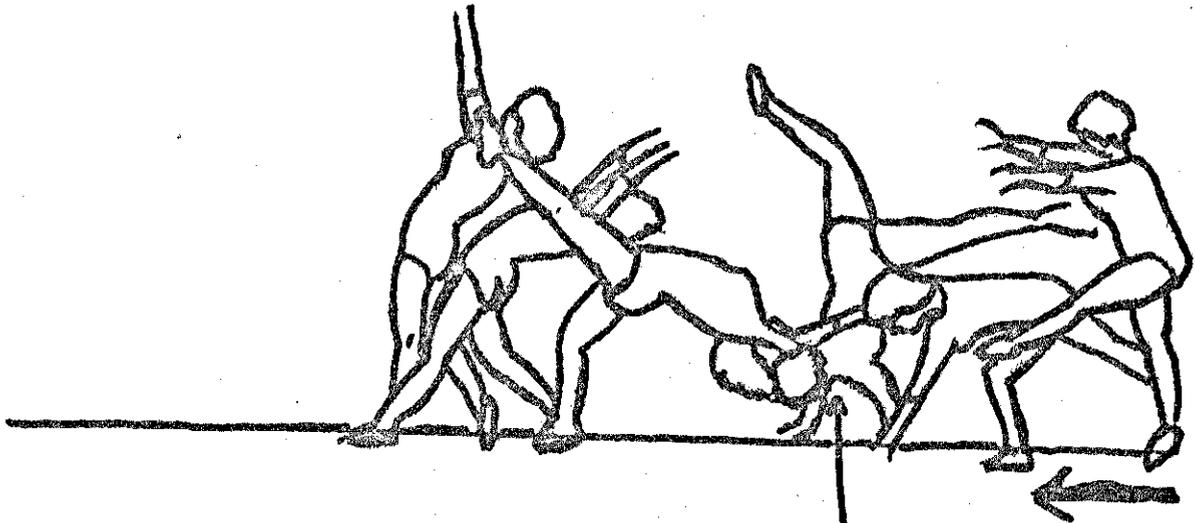
From a sitting position with legs straight. Rock back and place the hands on the mat over the shoulders (as in the backward roll) bring the legs back over the head so that the knees are right over the face. Kick upward and outward at a forty-five degree angle, at the same time push with the arms and arch the back. The snapping action will bring the body up off the mat. Keep the legs straight until the feet contact the mat. Keep the head back until the feet contact the mat. Return to the standing position.

HEADSPRING (ARCHED)



Start in a piked headstand, (hands shoulder width, weight on the front part of the top of the head, legs straight). Let the hips fall over toward the back. Keeping the legs straight whip them up over the body and shoot them up and out at a forty-five degree angle, push with the arms and straighten them. Arch the back and keep the legs straight until the feet contact the mat. Keep the head back throughout. Return to the standing position.

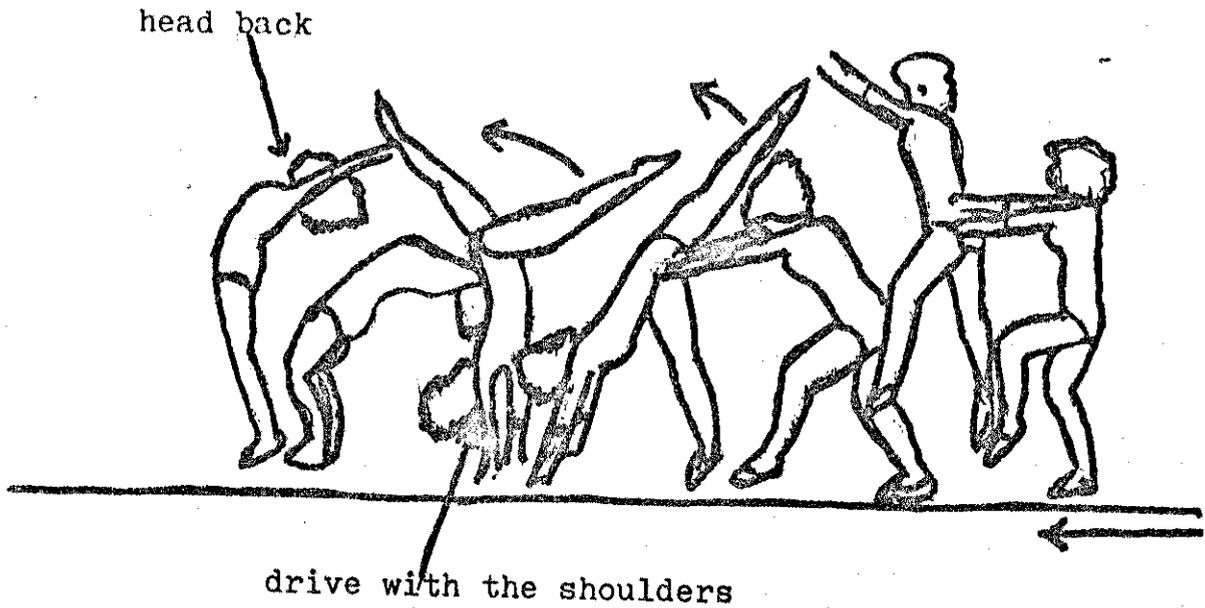
TINSICA



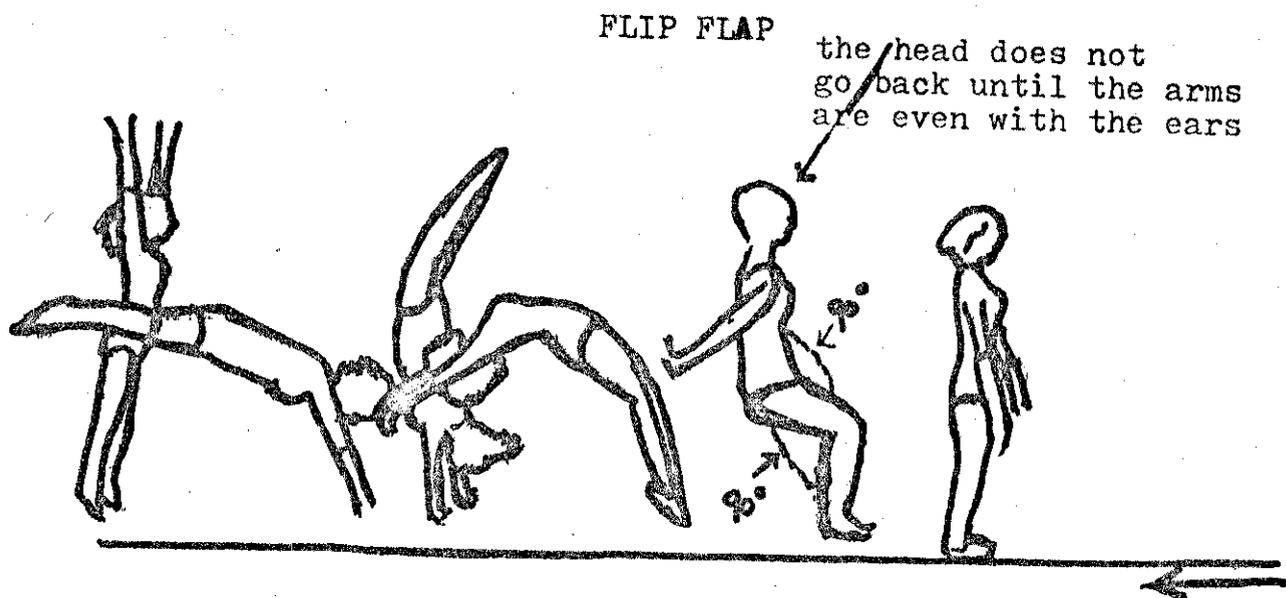
drive with the shoulders

Start like the cartwheel, but do not let the body twist (go straight over). Drive hard with the shoulders when the body is in the inverted position. Step out with the body facing forward. Keep the head back, as in the headspring.

FRONT HANDSPRING (ARCHED)

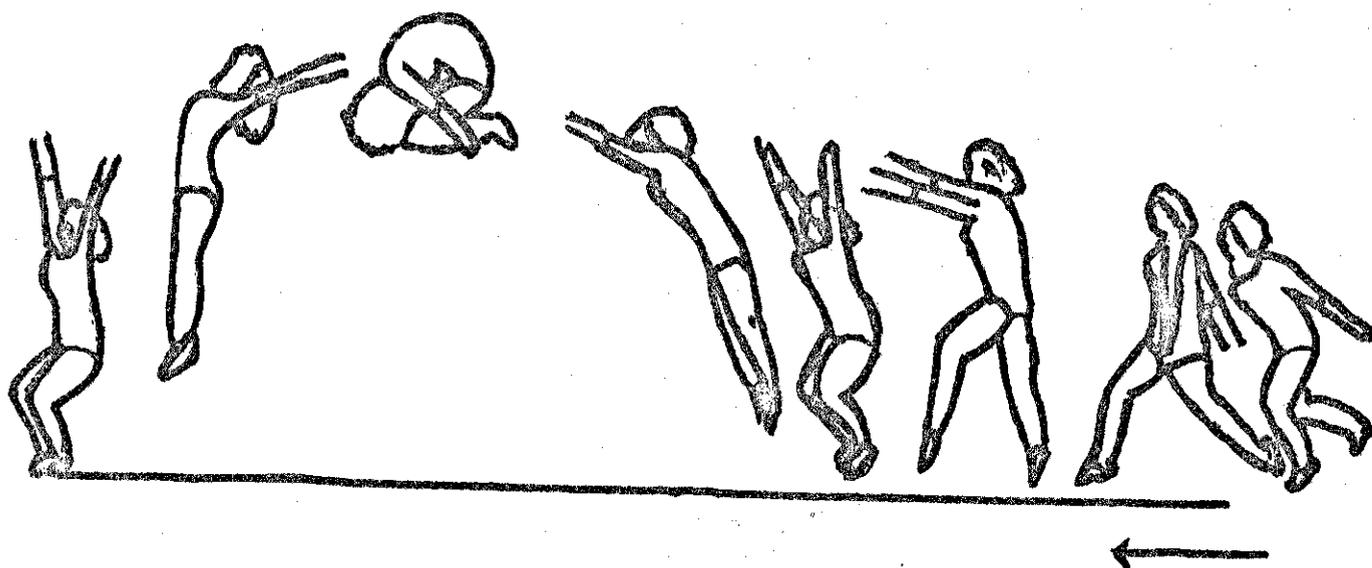


Start with the tumbler's skip, left foot forward. Place the hands down simultaneously, parallel about 18 inches in front of the left foot keeping the head back after the hands are on the mat. Keeping it straight, kick the right leg up over the head. Push with the left leg. Drive with the shoulders (keeping the arms straight) keep the legs straight and the back arched until the feet contact the mat. Keep the head back throughout, as in the headspring.



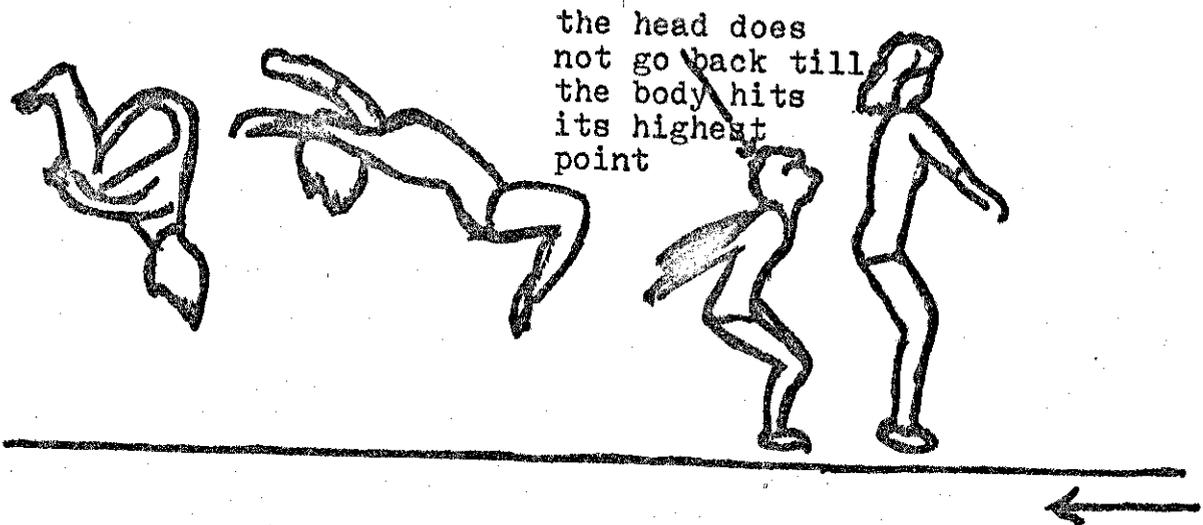
From the standing position bring the arms back and go into a sitting position, (off balance) with the upper body erect (just like sitting in a chair) with a 90 degree angle at the hip and knee joint. Swing the arms around in a circular action, over the head, (swing them from the shoulders, straight but not stiff) make them go as fast as possible. When the arms are even with the ears, the head is thrown back (look for the floor behind you) as the head goes back the hips are thrust vigorously upward and slightly forward, the legs are straightened as the body passes through the handstand position. Complete the snap-down by bending at the waist and driving with the shoulders. The arms should be kept straight throughout.

RUNNING FORWARD SOMERSAULT



Start with a run and a tumbler's skip bringing the feet together after the hop step (hurdle). With the arms up drive with the legs so that the body is thrust high up in the air. Before the feet leave the floor, keep the head up and the chest high, drive the hips up over the head with the leg drive. As the body reaches its highest point, snap the head between the knees and grasp the ankles, keep looking between your knees. When you see something about shoulder high in front of you, snap the body open into an arched position keep the body arched and the legs straight until the feet contact the mat.

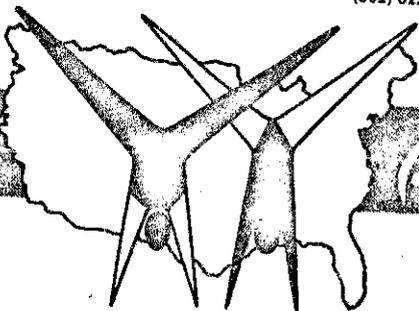
STANDING BACKWARD SOMERSAULT



From a standing position bring the arms back and bend the knees, as in the normal jumping action. Swing the arms up and drive with the legs so that the body is thrust high up in the air. When the body reaches its highest point, the head is snapped back, look for the floor behind you at the same time the knees are brought into the chest the front of the legs are grasped immediately above the ankles. When you see the mat judge your landing and open the body so that you return to the standing position.

United States Gymnastics Federation

Executive Offices: P. O. Box 4699, Tucson, Arizona 85717
(602) 622-3865 Cable Address "USGYM"



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American Sokol
Organization

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August 1, 1972

Mr. Robert M. Hazlett
Room 225, 200 D Avenue
The College Inn
Denton, Texas 76201

Dear Bob:

I have reviewed the panel you have created to evaluate the various phases of tumbling. I feel that you have selected the most knowledgeable and experienced tumbling experts in the United States. Mr. Pond, Mr. Meade and the others who make up your panel are unquestionably the finest tumbling coaches we have.

I wish you every success with your study and hope that if this office can be of assistance you will feel free to call upon us. Again, Bob, thanks for selecting a meaningful panel, comprised of real experts that will do justice to your study.

Sincerely,

Frank L. Bare
Executive Director

APPENDIX I

SPECIFIC JUDGING INSTRUCTIONS

The specific judging instructions were typed on the back of the general instruction sheets (Appendix G).

Each judge received an instruction booklet.

The cover page of the instruction booklet read as follows:

Tumbling Test

Instructions for rating the Tumbling Test, Three Judges.
On the following pages are the instructions that each subject studies. On the back of each of the sheets is the rating criteria (points to look for). Each skill is rated on a scale from 1 through 7.

1= Complete failure

2= Very poor

3= Poor

4= Fair

5= Good

6= Very good

7= Excellent

On the following pages the rating criteria are listed for skills 1 through 15.

Jump Full Twist

- 7= Perfect execution, arms at least shoulder high, both hands against the shoulder, controlled take-off and landing
- 6= Same as 7 except hands not against shoulders
- 5= Same as 6 except uncontrolled landing
- 4= Same as 5 except arms not shoulder high
- 3= Same as 4 except body bent in the air
- 2= Twist complete but uncontrolled
- 1= Twist not complete

I-2

Forward Roll

- 7= Perfect execution, weight on arms, shoulders lowered to the mat softly, ankles grasped, return to a straight standing position
- 6= Same as 7 except head ducked too early
- 5= Same as 6 except weight not taken on arms
- 4= Same as 5 except tuck not tight enough
- 3= Same as 4 except ankles not grasped
- 2= Same as 3 except form poor
- 1= Same as 3 except roll not completed

I-3

Back Roll

- 7= Perfect execution, hands up on the squat, chin down, back round, good push with the arms, return to the standing position
- 6= Same as 7 except hands not up on the squat
- 5= same as 6 except weak arm push
- 4= Same as 5 except back not round
- 3= Same as 4 except chin not down
- 2= same as 3 except hands not placed properly on the mat
- 1= Roll not completed

I-4

Handstand Forward Roll

- 7= Perfect execution, hands shoulder width apart, arms straight on the handstand, head up, body lowered with the arms, back round, grasp legs on recovery
- 6= Same as 7 except body not straight on the handstand
- 5= Same as 6 except head ducked too early
- 4= Same as 5 except body not lowered softly with the arms
- 3= Same as 4 except back not round
- 2= Same as 3 except ankles not grasped
- 1= Roll not completed

I-5

Backward Roll Snap-up

- 7= Perfect execution, hands up on squat, early snap, good handstand, good snap-down
- 6= Same as 7 except hands not up on the squat
- 5= Same as 6 except arms not straight on the handstand
- 4= Same as 5 except snap-up too late or weak shoulder drive on the snap-down
- 3= Same as 4 except legs bent in handstand
- 2= Same as 3 except legs bent on the snap down
- 1= No snap-down

I-6

Backward Roll Piked

- 7= Perfect execution, good forward bend of upper body, hands down on the mat by the hips, good snap-up to handstand, good snap-down, legs straight throughout
- 6= Same as 7 except not enough forward bend
- 5= Same as 6 except hands not down close enough to the hips
- 4= Same as 5 except weak snap-up to the handstand
- 3= Same as 4 except weak snap-down from the handstand
- 2= Same as 3 except legs very slightly bent
- 1= Legs bent on the roll

I-7

Cartwheel

- 7= Perfect execution, hands and feet in straight line, body straight, legs straight, controlled landing
- 6= Same as 7 except wobbly on landing
- 5= Same as 6 except legs bent slightly
- 4= Same as 5 except body slightly bent
- 3= Same as 4 except arms bent
- 2= Same as 3 except legs go around instead of up and over
- 1= Same as 2 except cartwheel not completed

I-8

Roundoff

- 7= Perfect execution, arms straight, legs straight, good shoulder drive on the snap-down, body straight on landing
- 6= Same as 7 except arms bent
- 5= Same as 6 except the legs bent
- 4= Same as 5 except a weak shoulder drive on the snap-down
- 3= Same as 4 except foot crossed over on the tumbler's skip
- 2= Same as 3 except the legs go around instead of over the top
- 1= Roundoff not completed

I-9

Kip-Up

- 7= Perfect execution, kick up and out with legs straight, good arm push, back arched, head back, legs straight until feet contact the mat
- 6= Same as 7 except legs slightly bent before landing
- 5= Same as 6 except legs slightly bent at the beginning
- 4= Same as 5 except head forward
- 3= Same as 4 except hips flexed
- 2= Landing in squat position
- 1= Kip-up not completed

I-10

Headspring (Arched)

- 7= Perfect execution, legs straight, head back, body arched, legs straight until feet contact the mat
- 6= Same as 7 except legs slightly bent before landing
- 5= Same as 6 except legs slightly bent at the beginning
- 4= Same as 5 except head forward
- 3= Same as 4 except hips flexed
- 2= Same as 3 except squatting on landing
- 1= Headspring not completed

I-11

Tinsica

- 7= Perfect execution, arms straight, good shoulder drive, body goes straight over, head back, controlled landing
- 6= Same as 7 except weak shoulder drive
- 5= Same as 6 except head forward
- 4= Same as 5 except legs bent before landing
- 3= Same as 4 except arms bent
- 2= Same as 3 except too much weight on the back foot
- 1= Tinsica not completed

I-12

Front Handspring (Arched)

- 7= Perfect execution, arms straight, legs kick forcefully, legs straight, head back, back arched
- 6= Same as 7 except legs slightly bent before landing
- 5= Same as 6 except legs slightly bent at the beginning
- 4= Same as 5 except head forward
- 3= Same as 4 except arms bent
- 2= Same as 3 except body flexed
- 1= Handspring not completed

I-13

Flip Flap

- 7= Perfect execution, good sit, good arm swing, head back with arms, good hip drive, legs straight after sit, good snap-down
- 6= Same as 7 except head back a little too soon
- 5= Same as 6 except legs bent slightly before landing
- 4= Same as 5 except not sitting enough
- 3= Same as 4 except hips thrown too soon
- 2= Same as 3 except hips not thrown hard enough
- 1= Flip flap not completed

I-14

Running Forward Somersault

- 7= Perfect execution, good leg drive, chest high, good tuck, fast spin, open early, straight body landing
- 6= Same as 7 except slightly forward lean on take-off
- 5= Same as 6 except slightly weak on the leg drive
- 4= Same as 5 except tuck not tight enough
- 3= Same as 4 except ankles not grasped
- 2= Same as 3 except body opens too soon
- 1= Forward somersault not completed

Standing Backward Somersault

- 7= Perfect execution, good arm throw and reach, good leg drive, good tight tuck, Straight body landing (good height)
- 6= Same as 7 except slight backward lean
- 5= Same as 6 except head goes back a little too soon
- 4= Same as 5 except arms not thrown high enough
- 3= Same as 4 except tuck not tight enough
- 2= Same as 3 except opening too soon
- 1= Back somersault not completed

APPENDIX J

Test-retest Reliability

Raw Data and Computations of the Pearson Product Moment Coefficient of Correlation

Reliability Test I Mean scores for Three judges	TOTAL															
	1. Jump Full-twist	2. Forward Roll	3. Backward Roll	4. Handstand Forward Roll	5. Backward Roll Snap-up	6. Backward Roll Pike	7. Cartwheel	8. Roundoff	9. Kip-up	10. Headspring	11. Tinsie	12. Front Handspring	13. Flip Flap	14. Running Forward Somersault	15. Standing Back Somersault	
1. Adams	5.3	4.7	4.0	4.0	4.0	5.3	4.3	2.0	3.0	3.3	1.0	2.3	2.3	5.7	4.0	53.9
2. Allen	6.0	5.0	5.3	2.3	5.7	6.0	6.0	6.3	4.3	3.3	4.0	6.7	2.7	1.3	5.7	70.6
3. Bruce	4.7	4.3	5.3	1.0	3.0	3.7	3.7	1.0	1.0	2.0	1.0	3.3	1.0	1.0	1.0	36.0
4. Burke	5.3	5.7	4.3	5.7	5.0	4.7	5.3	5.0	2.7	2.7	5.0	4.7	3.7	1.0	1.0	61.8
5. Campbell	3.3	4.7	4.7	5.3	4.7	4.0	6.3	5.0	2.3	3.0	1.3	3.3	3.3	1.0	2.0	53.9
6. Curry	6.0	5.0	4.7	4.7	5.0	3.7	4.3	3.0	4.0	3.7	3.3	4.0	4.3	3.3	3.0	62.0
7. Ellison	4.7	5.3	4.0	5.0	3.0	3.0	4.7	4.3	1.3	1.0	1.0	2.0	1.0	1.0	1.0	42.3
8. Eggert	5.0	4.3	3.7	3.3	3.0	3.3	4.0	1.3	1.0	1.0	1.0	1.0	1.0	1.0	1.0	34.9

(Continued)

APPENDIX J, Test I (Continued)

TOTAL

	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.	
9. Espinosa	5.3	4.3	4.7	4.0	5.3	3.3	5.0	3.7	1.0	1.3	4.0	4.0	3.0	6.3	3.7	58.9
10. Estancia	4.0	3.7	5.3	2.7	4.3	4.3	3.0	3.0	3.0	2.0	2.0	2.8	1.0	1.0	1.0	43.1
11. Frantz	5.0	5.0	4.0	5.7	6.3	4.3	5.7	6.7	6.7	3.0	6.0	6.0	6.0	7.0	7.0	83.7
12. Espinola	5.3	4.7	5.0	4.0	5.3	4.7	4.0	2.7	4.0	1.0	1.0	4.3	1.0	1.3	1.7	50.0
13. French	3.7	5.0	5.0	5.7	6.0	4.0	7.0	6.7	1.0	3.0	7.0	7.0	5.7	1.0	1.0	68.8
14. George	4.0	4.3	3.7	3.3	3.0	3.3	4.0	1.3	1.0	1.0	1.0	1.0	1.0	1.0	1.0	33.9
15. Harrel	6.0	5.0	5.0	3.0	5.0	5.7	4.3	4.3	3.0	3.0	4.0	2.0	5.3	5.3	5.0	65.9
16. Harrington	5.3	5.0	5.0	4.3	4.3	3.3	5.7	3.7	1.0	3.3	1.0	2.7	1.0	1.3	1.0	47.9
17. Harris	3.7	4.0	5.0	4.7	5.0	5.3	4.0	4.0	4.0	3.3	4.0	4.7	4.3	1.0	2.7	59.7
18. Issing	3.7	4.0	5.0	4.7	5.0	5.3	4.0	4.0	3.3	4.0	4.3	4.7	4.0	1.0	2.7	59.7
19. Jackson	6.0	6.0	6.0	4.7	4.0	4.7	5.0	4.7	2.0	2.0	3.3	3.3	3.0	1.0	1.0	56.7
20. Lewis	6.3	3.7	5.0	1.7	1.0	2.7	4.7	6.3	5.3	1.0	1.0	1.0	3.0	1.0	1.0	44.7
21. Morgan	5.7	6.3	3.7	3.7	4.3	5.0	5.3	1.7	1.0	2.7	1.0	1.0	1.0	3.7	1.0	47.7
22. Morrison	5.7	5.7	5.3	6.0	7.0	6.0	5.3	4.0	1.0	1.0	1.0	2.7	3.0	1.0	2.0	56.7
23. Moss	6.3	6.7	6.7	4.3	5.7	5.7	5.7	6.7	2.3	5.3	5.3	4.0	3.7	3.0	1.3	72.7

(Continued)

APPENDIX J, Test I (Continued)

TOTAL

	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.	
24. Stanley	3.7	5.0	6.3	6.0	4.3	4.7	5.7	4.3	2.0	1.0	1.0	2.0	1.0	1.0	1.0	49.0
25. Stevenson	3.0	7.0	5.0	3.3	6.0	5.3	3.7	3.3	2.3	2.0	1.0	1.0	1.3	2.0	2.3	48.5
26. Smirk	6.0	6.3	5.0	5.3	6.3	5.0	5.3	5.0	1.0	1.0	2.0	2.7	2.3	3.0	2.0	56.2
27. Vance	6.0	5.7	6.0	3.7	2.0	4.0	4.0	4.0	4.0	2.0	2.7	1.0	1.0	1.0	2.0	45.1
28. Willison	3.3	7.0	4.7	6.0	6.0	4.7	3.0	2.3	2.7	2.0	3.0	1.0	1.0	2.0	2.0	50.7
29. Wygant	4.3	5.7	5.7	4.0	1.0	1.0	4.2	4.7	1.0	1.0	1.0	1.0	1.0	1.0	1.0	37.6
30. Yanek	5.7	4.7	4.3	3.0	4.7	3.7	2.7	3.3	2.0	2.7	1.0	1.0	1.0	1.0	1.0	41.8

APPENDIX J

Test II

Test II	Subject's Numbers	1. Jump Full-twist	2. Forward Roll	3. Backward Roll	4. Handstand Forward Roll	5. Backward Roll Snap-up	6. Backward Roll Pike	7. Cartwheel	8. Roundoff	9. Kip-up	10. Headspring	11. Tinsica	12. Front Handspring	13. Flip Flip	14. Running Forward Somersault	15. Standing Back Somersault	TOTAL
	1.	5.7	4.7	4.0	5.0	5.0	4.0	2.3	3.0	3.7	1.3	2.3	5.0	4.0	1.0	1.0	56.0
	2.	7.0	5.0	5.3	2.3	5.7	6.0	5.0	6.3	4.7	3.3	5.0	7.0	3.3	2.0	5.7	73.6
	3.	4.7	4.3	5.0	1.7	2.0	3.7	4.0	4.0	4.0	1.0	1.0	3.3	1.0	1.0	1.0	40.7
	4.	6.0	5.7	4.3	5.7	5.0	4.7	5.3	4.0	3.0	4.6	5.0	5.0	3.3	2.0	2.0	65.6
	5.	4.0	4.3	4.3	5.7	4.3	4.0	6.3	6.0	2.3	3.0	3.3	3.3	3.3	2.0	2.0	58.1
	6.	6.0	5.0	4.7	5.7	5.0	3.7	4.3	4.0	5.7	3.7	3.3	4.3	4.0	3.3	3.0	65.7
	7.	4.7	5.3	4.0	5.0	3.0	4.7	5.3	2.3	1.0	1.0	1.0	2.0	1.0	1.0	1.0	44.3
	8.	6.0	4.3	3.7	3.3	3.0	3.0	1.3	2.0	2.0	1.0	1.0	1.0	1.0	1.0	1.0	36.9

(Continued)

APPENDIX J, Test II (Continued)

TOTAL

1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.	
5.3	4.3	4.7	4.0	5.3	3.3	5.0	3.7	2.0	2.3	4.0	4.0	3.0	6.3	3.6	60.8
4.0	3.7	4.3	2.7	3.3	3.3	3.0	3.0	3.0	2.0	2.0	2.7	1.0	1.0	1.0	40.0
4.7	5.3	4.0	5.0	5.3	4.7	4.0	2.7	4.0	2.0	2.0	4.3	2.0	2.3	1.7	54.0
5.0	6.0	3.0	5.7	6.3	4.3	5.7	6.7	3.0	6.0	5.0	5.0	6.0	6.0	7.0	80.7
4.7	5.0	5.0	5.7	6.0	4.0	7.0	6.7	2.0	4.0	7.0	7.0	5.7	3.0	2.0	73.8
4.0	4.3	3.7	3.3	3.0	3.0	2.3	2.0	2.0	2.0	2.0	2.0	1.0	1.0	1.0	36.6
5.0	5.0	5.0	3.0	4.0	5.7	4.3	4.3	3.0	3.0	2.0	4.0	5.3	5.0	5.3	63.9
5.3	5.0	5.0	4.3	4.3	3.3	5.7	3.7	1.0	3.3	2.0	2.7	2.0	1.3	1.0	49.6
3.7	4.0	5.0	4.7	4.0	5.3	4.0	2.0	2.3	4.0	4.3	4.7	4.0	1.0	2.7	57.7
3.7	4.0	4.0	4.7	6.0	5.3	4.0	4.0	4.3	4.0	4.3	4.7	4.0	2.0	3.3	62.3
6.0	6.0	6.4	4.7	4.0	5.7	5.0	4.7	2.0	2.0	3.3	2.3	4.0	2.0	2.0	59.7
6.3	3.7	5.0	1.7	2.7	5.0	6.0	5.3	2.0	2.0	3.0	2.0	2.0	1.0	1.0	48.7
5.0	7.0	3.7	3.7	4.3	4.3	5.0	5.3	1.7	1.0	2.7	2.0	1.0	2.0	2.0	49.1
6.0	6.0	5.7	6.0	7.0	6.0	5.3	4.0	1.0	1.0	2.0	2.7	3.0	2.0	2.0	59.7
6.3	6.3	7.0	4.3	5.7	5.7	5.7	6.7	2.3	5.3	5.3	4.0	3.7	4.0	1.3	73.6

(Continued)

APPENDIX J

Computations of the Pearson Product
Moment Coefficient of Correlation

$$r = \frac{\frac{\sum XY}{N} - \bar{X} \bar{Y}}{\sigma_X \sigma_Y}$$

$$\bar{X} = \frac{\sum X}{N} = \frac{1594.8}{30} = 53.16 \quad \bar{X}^2 = 2825.99$$

$$\sigma_X = \sqrt{\frac{\sum X^2}{N} - \bar{X}^2} = \sqrt{\frac{88941.84}{30} - 2825.99} = 11.79$$

$$\bar{Y} = \frac{\sum Y}{N} = \frac{1654.7}{30} = 55.16 \quad \bar{Y}^2 = 3042.26$$

$$\sigma_Y = \sqrt{\frac{\sum Y^2}{N} - \bar{Y}^2} = \sqrt{\frac{95913.05}{30} - 3042.26} = 12.44$$

$$r = \frac{\frac{\sum XY}{N} - \bar{X} \bar{Y}}{\sigma_X \sigma_Y} = \frac{\frac{91966.02}{30} - 2932.31}{11.79 \cdot 12.44} = \frac{133.22}{146.67} = .908$$

$$r = .908$$

APPENDIX K

Tumbling Test Raw Data

METHOD	1. Jump Full-Twist	2. Forward Roll	3. Backward Roll	4. Handstand Forward Roll	5. Backward Roll Snap-Up	6. Backward Roll Piked	7. Cartwheel	8. Roundoff	9. Kip-Up	10. Headspring	11. Tinsica	12. Front Handspring	13. Flip Flap	14. Running Forward Somersault	15. Standing Back Somersault	TOTAL
Group I																
1. Winter	5.00	5.00	4.00	5.66	6.33	4.33	5.66	6.66	3.00	6.00	6.00	7.00	6.00	7.00	6.00	83.66
2. Taylor	3.66	5.00	5.66	4.66	5.66	3.33	3.66	4.33	1.33	3.00	4.00	3.33	2.33	6.00	5.66	61.66
3. Dibise	5.66	5.66	5.33	6.00	7.00	6.00	5.33	4.00	1.00	1.00	1.00	2.33	3.00	1.00	2.00	56.33
4. Padilla	3.33	7.00	4.66	6.00	6.00	6.00	4.33	3.00	2.33	1.00	2.00	3.00	1.00	1.00	2.00	52.66
5. Ware	5.66	5.66	7.00	5.00	1.66	4.66	5.33	3.00	3.00	1.00	1.00	4.00	1.00	1.00	1.00	50.00

(Continued)

APPENDIX K, Method A Male, Group II(Continued)

Group II	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.	
1. Baily	3.66	4.00	5.00	4.66	5.00	5.33	4.00	4.00	3.33	4.00	4.00	4.66	4.33	1.00	2.66	59.66
2. Journey	3.00	7.00	5.00	3.33	6.00	5.33	3.66	3.33	2.33	3.00	1.00	1.00	1.33	1.00	2.33	48.66
3. Felton	2.66	5.00	5.66	2.66	6.66	4.66	4.00	2.66	1.00	1.00	1.00	1.33	3.33	1.00	1.66	44.33
4. Draper	3.00	4.00	3.66	3.00	3.66	4.33	4.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	33.66
5. Paul	4.00	3.66	5.33	2.66	4.33	4.33	3.00	3.00	3.00	2.00	2.00	2.66	1.00	1.00	1.00	43.00
Group III																
1. Williamson	5.66	5.66	7.00	5.00	1.66	4.66	5.33	3.00	3.00	1.33	1.00	4.00	1.00	1.00	1.00	50.33
2. Bowers	4.33	5.66	5.00	3.33	5.33	4.66	2.00	3.33	3.66	3.00	5.00	1.00	1.00	1.00	1.00	52.00
3. Jones	5.33	5.00	5.00	4.33	4.33	3.33	5.66	3.66	1.00	3.33	1.00	2.66	1.00	1.33	1.00	48.00
4. Snow	4.33	5.66	6.00	4.66	4.66	4.66	4.00	2.66	1.00	1.66	1.33	2.00	1.00	1.00	2.66	47.33
5. Decker	5.33	6.00	6.00	1.00	3.33	3.00	5.00	5.00	1.33	1.33	1.33	1.33	1.00	1.00	1.00	43.00

APPENDIX K, Method A Female

Group I Skills	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.	
1. Warnke	5.66	7.00	7.00	6.00	6.66	6.00	7.00	6.00	2.00	5.00	5.00	6.00	2.00	1.00	1.00	73.33
2. Carbajal	6.00	5.00	5.33	2.33	5.66	6.00	6.00	6.33	4.33	3.33	4.00	6.66	2.66	1.33	5.66	70.66
3. Contreras	6.00	5.00	5.00	3.00	5.00	5.66	4.33	4.33	3.00	3.00	2.00	4.00	5.33	5.00	5.33	66.00
4. Clem	6.00	6.00	6.00	4.66	4.00	4.66	5.00	4.66	2.00	2.00	3.33	2.33	4.00	1.00	1.00	56.66
5. Torres	6.33	5.33	5.33	5.00	3.66	4.33	6.00	3.66	1.00	2.00	4.00	1.66	4.00	1.00	1.33	54.66
Group II																
1. Huband	5.33	5.66	4.33	5.66	5.00	4.66	5.00	5.00	2.66	2.66	5.00	4.66	3.66	1.00	1.00	61.33
2. Jordan	4.66	4.00	4.33	3.33	3.00	2.66	6.66	6.00	1.00	3.33	6.00	6.33	4.33	1.00	1.00	57.66
3. Allen	4.00	4.00	5.00	3.33	5.33	4.66	3.66	2.00	3.33	3.66	3.00	5.00	1.00	1.00	1.00	50.00
4. Cohorn	6.00	5.00	7.00	4.66	1.00	3.66	4.00	4.33	1.00	1.00	1.00	1.00	1.00	1.00	1.00	42.66
5. Cabot	2.00	6.66	7.00	4.00	3.00	2.66	5.00	3.33	1.00	1.00	1.00	2.00	1.00	1.00	1.00	41.66
Group III																
1. Jameson	3.33	4.66	4.66	5.33	4.00	4.00	6.33	5.00	2.33	3.00	1.33	3.33	3.33	1.00	2.00	53.66
2. Ellison	5.66	5.66	7.00	5.00	1.66	4.66	5.33	3.00	3.00	1.00	1.00	4.00	1.00	1.00	1.00	50.00
3. Gonzales	3.00	5.00	5.66	2.66	6.66	4.66	4.00	2.66	1.00	1.00	1.66	1.00	3.33	1.00	1.66	45.00
4. Tapley	4.33	5.66	5.66	4.00	1.00	1.00	4.33	4.66	1.00	1.00	1.00	1.00	1.00	1.00	1.00	37.66
5. Grover	2.66	5.66	4.33	4.00	2.33	1.66	5.00	1.33	1.00	1.00	1.00	1.00	1.00	4.00	1.00	37.00

APPENDIX K, Method B Male

Group I Skills	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.	
1. Geareau	6.33	6.66	6.66	4.33	5.66	6.66	2.33	5.33	5.33	4.00	3.66	3.00	1.33	4.66	5.66	71.66
2. Romig	6.33	5.33	6.00	3.66	5.66	6.33	5.33	5.00	2.00	2.33	4.66	5.00	5.66	1.00	1.00	65.33
3. Jiron	6.00	5.00	4.66	4.66	5.00	3.66	4.33	3.00	4.00	3.66	3.33	4.00	4.33	3.33	3.00	62.00
4. Gonzales, M.	4.00	4.66	4.66	3.66	3.33	3.66	5.00	3.00	3.66	5.00	1.00	2.00	1.00	1.00	1.00	46.66
5. Shopp	4.66	4.00	4.00	5.00	3.00	3.00	3.66	4.33	1.33	1.00	2.00	2.00	1.00	1.00	1.00	41.00
Group II																
1. Mackey	5.33	4.33	4.66	4.00	5.33	3.33	5.00	3.66	1.00	1.33	4.00	4.00	3.00	6.33	3.66	59.00
2. Martel	6.00	6.33	5.00	5.33	6.33	5.00	5.00	3.33	1.00	1.00	1.00	2.00	2.66	2.33	1.00	53.33
3. Gonzales, R.	5.66	6.66	5.66	3.66	5.00	5.00	4.66	5.33	2.00	1.00	1.00	3.33	1.00	1.00	1.00	52.00
4. Stephenson	6.00	4.66	4.66	4.00	3.00	4.00	4.00	3.66	1.00	1.00	1.00	1.00	1.00	1.00	1.00	41.00
5. Cooper	4.66	4.33	5.33	1.00	3.00	3.66	1.00	1.00	1.00	1.00	3.33	3.66	1.00	1.00	1.00	36.00
Group III																
1. Martin	5.00	5.33	3.66	3.33	4.00	2.66	4.33	1.33	1.00	1.00	2.33	3.33	1.33	1.00	3.00	42.66
2. Mills	4.66	5.66	4.00	5.00	4.66	3.66	2.00	1.00	1.00	1.33	1.00	1.00	1.00	1.00	1.00	38.00
3. Tillman	3.66	5.33	5.00	3.00	3.33	2.66	2.66	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	33.66
4. Scott	4.66	6.33	4.00	2.66	1.00	2.00	3.33	1.33	1.00	1.00	1.00	1.00	1.00	1.00	1.00	32.33
5. Hall	5.00	3.00	3.00	2.00	3.00	1.66	4.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	29.66

APPENDIX K. Method B Female

Group I Skills	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.	
1. Young	3.66	5.00	5.00	5.66	6.00	4.00	7.00	6.66	1.00	3.00	7.00	7.00	5.66	1.00	1.00	68.66
2. Kurth	4.33	6.33	6.66	6.66	2.66	2.00	5.00	5.00	3.66	1.33	6.33	3.33	3.33	1.00	1.00	58.66
3. Coats	6.33	3.66	5.00	1.66	2.66	4.66	6.33	5.33	1.00	1.00	1.00	3.00	1.00	1.00	1.00	38.66
4. Dixon	5.33	4.66	4.00	4.33	1.33	2.33	5.33	4.00	1.00	1.00	1.00	1.33	1.00	1.00	1.00	44.66
5. Weston	4.33	4.33	3.00	2.66	2.66	2.00	5.00	1.33	1.00	1.00	1.00	1.00	1.00	1.00	1.00	32.33
Group II																
1. Grau	3.66	5.00	6.33	6.00	4.33	4.66	5.66	4.33	2.66	1.00	1.00	2.00	1.00	1.00	1.00	49.66
2. Godfrey	5.00	5.00	5.00	4.33	4.33	3.33	5.66	3.66	1.00	3.33	1.00	2.66	1.00	1.33	1.00	47.66
3. Corn	5.66	6.33	3.66	3.66	3.66	4.33	5.00	5.33	1.66	1.00	2.66	1.00	1.00	1.00	1.00	47.00
4. Llewelyn	4.33	5.33	4.00	5.00	3.00	3.00	4.66	4.33	1.33	1.33	1.00	2.00	1.00	1.00	1.00	42.33
5. Mirabal	4.33	5.66	4.00	2.00	3.00	2.33	3.66	1.33	1.00	1.00	1.00	1.00	1.00	1.00	1.00	33.33
Group III																
1. Gonzales, J.	5.33	4.66	4.00	4.33	1.33	2.33	5.33	4.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	38.33
2. Frizzell	4.00	4.33	3.66	3.33	3.00	3.33	4.00	1.33	1.00	1.00	1.00	1.00	1.00	1.00	1.00	34.00
3. Singleton	3.66	5.33	5.00	3.00	2.33	2.66	2.66	2.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	33.66
4. Bowlin	3.33	4.66	3.33	2.00	1.00	2.66	4.00	2.00	1.00	1.00	2.00	3.33	1.00	1.00	1.00	33.33
5. Stout	4.66	6.33	4.00	2.66	1.00	2.00	3.33	1.33	1.00	1.00	1.00	1.00	1.00	1.00	1.00	32.33

APPENDIX K, Method C Male

Group I Skills	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.	
1. Moralez	6.00	4.00	5.00	3.00	5.00	5.66	4.33	4.33	3.00	3.00	2.00	4.00	5.33	5.00	5.33	65.00
2. Spradling	4.66	6.00	5.00	5.00	4.00	6.33	5.00	3.00	2.00	2.00	1.00	2.00	2.00	2.66	2.66	53.33
3. Pratt	5.66	5.66	5.33	2.00	6.00	3.66	4.33	2.00	3.00	2.00	3.00	2.66	2.33	4.33	1.00	53.00
4. Gaume	4.00	3.66	4.66	3.33	5.66	4.66	4.00	2.66	3.00	3.00	4.00	4.00	1.00	4.00	1.00	52.66
5. Culbertson	5.66	3.66	4.33	3.00	4.00	2.66	2.66	2.00	2.00	2.66	1.00	1.00	1.00	1.00	1.00	37.66
Group II																
1. Baldonado	5.33	4.66	4.00	4.00	4.00	5.33	4.33	2.00	3.00	3.33	1.00	2.33	5.66	4.00	1.00	54.00
2. Van Winkle	5.33	4.66	5.00	4.00	5.33	4.66	4.00	2.66	4.00	1.00	1.00	4.33	1.00	1.33	1.66	50.00
3. McCloud	5.33	5.00	5.66	4.33	5.33	3.00	5.33	5.00	1.00	1.00	1.00	3.33	1.00	1.00	1.00	48.33
4. McCarey	6.00	5.66	6.00	3.66	2.00	4.33	4.00	4.00	2.00	2.66	1.00	1.00	1.00	1.00	2.00	46.33
5. Sundt	3.00	6.00	4.66	4.66	4.00	5.66	2.00	2.33	1.00	1.00	1.00	2.00	1.00	1.00	1.00	40.33
Group III																
1. Lucero	3.66	5.33	4.33	5.33	7.00	5.00	4.33	4.66	1.00	1.00	1.00	1.00	1.00	3.33	1.00	49.00
2. Anderson	5.33	4.66	4.33	3.33	4.00	3.00	2.00	3.33	2.00	2.66	1.00	1.00	1.00	1.00	1.00	39.66
3. Gutierrez	5.33	3.00	2.66	2.33	3.00	2.00	3.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	29.33
4. Foster	4.33	3.66	3.33	2.33	2.00	2.00	3.00	1.00	1.00	1.00	1.33	1.00	1.00	1.00	1.00	29.00
5. Guess	3.00	2.66	1.66	2.33	2.00	1.33	1.66	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	22.66

APPENDIX K, Method C Female

Group I Skills	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.	
1. Kemble	4.33	4.66	6.33	4.66	6.66	5.00	6.00	6.66	3.00	1.33	2.00	4.33	3.00	3.00	1.00	62.00
2. Smyth	6.00	6.00	5.33	5.33	2.33	3.33	5.00	6.00	2.00	2.33	2.33	2.00	2.33	2.33	1.00	53.66
3. Horner	6.33	3.66	6.00	1.66	2.66	4.66	6.33	5.33	1.33	1.00	1.00	3.00	1.00	1.00	1.00	46.00
4. Bassett	4.66	4.33	3.66	5.00	3.00	3.00	3.66	4.33	1.33	1.00	1.00	2.00	1.00	1.00	1.00	40.00
5. Lopez	5.00	4.33	3.66	3.33	3.00	3.33	4.00	1.33	1.00	1.00	1.00	1.00	1.00	1.00	1.00	35.00
Group II																
1. Conner	4.66	5.66	5.00	5.33	5.33	6.00	6.33	1.00	1.00	4.66	3.66	1.00	5.33	1.00	1.00	57.00
2. Salvo	5.66	7.00	4.00	4.00	1.66	3.00	6.33	6.00	2.00	2.00	1.00	2.66	1.33	1.00	1.00	48.66
3. Tulley	4.66	6.66	2.33	1.00	1.00	2.00	2.33	2.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	29.00
4. Isler	4.00	6.33	6.00	1.00	1.33	2.66	3.33	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	32.66
5. Groce	3.66	5.00	2.66	3.33	2.33	1.00	5.00	2.66	1.00	1.00	1.00	1.00	1.00	1.00	1.00	32.66
Group III																
1. Christensen	5.33	6.00	6.00	1.66	3.33	5.00	5.00	1.33	1.33	1.00	1.00	1.00	1.00	1.00	1.00	43.00
2. Smith	2.66	5.66	4.33	4.00	2.33	1.66	5.00	1.33	1.00	1.00	1.00	1.00	4.00	1.00	1.00	37.00
3. Herman	4.33	5.66	5.66	4.00	1.00	1.00	4.33	4.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	37.00
4. Bohl	4.66	6.00	3.66	2.66	2.66	2.00	4.00	3.33	1.00	1.00	1.00	1.00	1.00	1.00	1.00	36.00
5. Kartchner	3.33	4.00	3.33	1.00	2.00	2.66	5.00	4.66	1.33	1.33	1.00	1.00	1.00	1.00	1.00	33.66

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