# THE EFFECTS OF COACHING TO IMPROVE SCORES ON VERBAL ANALOGY AND NUMBER SERIES TESTS

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ABSTRACT

THE EFFECTS OF COACHING TO IMPROVE SCORES
ON VERBAL ANALOGY AND NUMBER SERIES TESTS

By

John Henry Schweitzer

This study was conducted to systematically investigate the effects of coaching to improve scores on two item types commonly used in reasoning tests, namely, verbal analogies and number series. The coaching was evaluated with respect to its effect on number of items solved correctly, the speed of solution, the testee's attitude toward the items, his test-taking confidence, the accuracy of this confidence, and the testee's own subjective evaluation of the coaching. The effects of the coaching on items dissimilar to the coaching material and the effects of the coaching over time were investigated. Also examined were the influences of initial ability level and sex of the person being coached upon the effectiveness of the coaching. The influence of coaching on test validity was also investigated.

Eighty-eight college freshmen were randomly assigned to one of two treatment groups. One group received coaching in verbal analogy solution techniques; the other was coached in solving number series problems. There were actually two experiments with each group serving as the control group for the other. The design for each study included the factors of sex and ability level based on pretest scores. At the time of the pretest the subjects had already been randomly assigned to one of the two major groups. Assignment to high and low ability level

was based on the grand median of all subjects of both sexes in both groups with scores at the grand median equally split between the high and low ability level within each sex in each treatment group. The post hoc blocking procedure resulted in unequal cell sizes so subjects were randomly eliminated to obtain a balanced design. This procedure was followed in both studies, using verbal analogy pretest scores in one case and number series pretest scores in the other, and in each case the final outcome was nine subjects per cell for a total of 72 subjects. The 72 subjects were not the same in each study although there was a considerable overlap.

The series of dependent measures varied on three factors: time of posttest (immediate and delayed), type of item (similar and dissimilar to the coaching material), and testing condition (speeded and power). The three design factors and the three measures factors were all completely crossed. With two levels for each of the three measures factors, there was a total of eight repeated measures or subtests for each study.

Each of the subtests yielded four dependent variables: total score as measured by the number of correct items; test-taking attitude as measured by reaction to solving the items of the subtest; confidence as measured by the number of items estimated to be correct on the subtest; and accuracy of test-taking confidence as measured by the absolute difference between number estimated to be correct and actual number correct. In addition, speed of item solution was measured in two ways: by the number of items attempted on the subtests given under speeded conditions, and by the amount of time spent on the subtests given under power conditions. A final dependent variable was each

subject's evaluation of the effectiveness of the coaching in helping to solve each of the four item types.

The data from the two experiments can be summarized as follows:

1. The group coached in number series solution techniques had a significantly higher mean score on all series items than the control group. The group coached in verbal analogies had a higher mean score on all analogies than the control group. This difference was not statistically significant. However, the F ratio was only .03 below the F required for significance.

2. Coaching on verbal analogies interacted with sex, item type, and test condition in the hypothesized direction on total mean analogy scores. Coaching in number series interacted with item type in the hypothesized direction on total series scores. It interacted with time of posttest in an unhypothesized direction.

3. In both studies coaching interacted with sex on test-taking attitudes. Verbal analogy coaching increased the attitudes of males toward analogy tests, while number series coaching improved the attitudes of females toward series tests.

4. In the verbal analogies study, coaching increased confidence on analogy power tests but decreased confidence on the speeded tests. In the number series study coaching increased confidence on all series tests. It also interacted with sex and item type, resulting in greater confidence for females and greater confidence on number series problems.

5. In both studies coaching improved accuracy of test-taking confidence. In addition, coaching interacted with ability in the analogy study resulting in greater accuracy for the high ability group. In the number series study coaching interacted with sex and item type,

producing greater accuracy for females and on number series items.

6. Verbal analogy coaching increased analogy item solution time as measured both by number of items attempted on speeded tests and time spent on power tests. Significant interactions indicated this effect was strongest on the first posttest and for verbal analogies. Number series coaching decreased the time spent in solving series items as measured by the number of items attempted on speeded tests. This effect, which is the opposite of that hypothesized, was strongest on the delayed posttest and on number series items. Number series coaching also interacted with elapsed time until posttest on amount of time spent on series power tests.

7. The verbal analogy coaching group rated their coaching as most effective for verbal analogies while the number series group evaluated their coaching as most effective for number series problems.

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TO LIZ

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# CHAPTER I

# THE PROBLEM

## NEED FOR THE STUDY

Testing is an integral part of today's society. Everyone in this country is required to take tests beginning in childhood and continuing up through adulthood. These tests play a crucial role for the individual, especially in the areas of education and employment. The amount of formal education an individual can obtain, the kind of education he receives, the kind of occupation he is encouraged to undertake, the decision as to whether he is hired for a particular job, and very often, the decision to promote him are all directly dependent on how he performs on the multitude of tests which he must take.

Due to the great use of tests in decision-making in our society, tests and testing have come under attack from many quarters for many reasons. One assumption on which these attacks are based is that tests are unfair in some ways to certain individuals. It is often argued, for example, that some people lack the test-taking skills that would allow them to reflect an accurate picture of their true ability or achievement level.

In the 1960's in the United States the rise of the civil rights movement and increased concern for disadvantaged sectors of the population led many to question the validity of tests for these groups. This questioning was based in part upon speculation that these groups lack proper test-taking skills and attitudes, and that, therefore, their

obtained scores do not reflect their true aptitude and achievement. This has led to a renewed interest in coaching and its effect on test scores. Also contributing to the reawakening of interest in improving test scores by special training has been the move toward performance contracting by American public schools. The performance which is guaranteed in many cases is usually measured by standardized tests. Large amounts of money ride on small differences in test scores. Therefore, the contractors are interested in the use of coaching to raise test scores, and school systems are concerned with the effect of coaching on the validity of the tests.

Still another contribution to the reawakening of interest in coaching to improve test scores has been the controversy sparked by Jensen (1969) dealing with the hereditability of intelligence. Obviously, if coaching in test-taking skills and item-solving techniques can significantly raise scores on intelligence tests, then environment and past experience must be important determinants of intelligence test scores.

In spite of this renewed interest in coaching, as Stanley (1970, p. 6) points out in discussing coaching to improve test scores, "not enough of this has been done yet in a rigorous way and reported." Connolly and Wantman (1964, p. 64) suggested that "It would be interesting to investigate the effect of specific training on analogies items." To date, the only study in this area was conducted by Moore (1971). He found that coaching could improve analogy test performance. Millman and Pauk (1969, p. 72) state that "the verbal analogy items and the number and configuration series items seem to put the unsophisticated test taker at the greatest disadvantage." However, they do not present any

evidence for this. Thus, it seems clear that there is a need for more studies which investigate the effect of coaching on these specific item types and also which look at other variables in relation to coaching.

Very few studies have focused on the effects of coaching on a particular type of item. Most coaching studies have used as a posttest measure a standardized test containing a number of different item types in different content areas. It may be that the specific effects of the coaching cannot be accurately evaluated by using such general measures.

In addition, a great many coaching studies have ignored important related variables that might either be affected by the coaching or have an effect on the coaching. Four variables that could influence the effectiveness of the coaching are the initial ability level of the person being coached, the sex of the person being coached, the length of time between coaching and testing, and the similarity of the coaching material to the test material. Variables that the coaching itself may influence besides the score on the test are the speed with which the individual solves the items on a power test, the number of items attempted on a speeded test, the attitudes of the person toward the test and the self-confidence of the individual in taking tests. Finally, there is a need for current empirical studies of the effect of coaching on test reliability and validity.

The inconclusive and often contradictory findings of the studies of coaching reported to date and the many variables related to coaching that have been uncontrolled or unexamined speak to the necessity of conducting more carefully controlled and designed experiments in this area.

## PURPOSE OF THE STUDY

It is the purpose of this study to investigate the effects of specific coaching in the solution of two types of items, verbal analogies and number series. The coaching is evaluated with respect to its influence on the number of items solved correctly, the speed of solution, the testee's attitude toward solving the items, his self-confidence in his ability to solve the items, and the accuracy of his self-evaluation of success in solving the items. The possible transfer effects of the coaching to similar item types and the effect of the coaching over time are investigated. The study also examines the possible influences of the entering ability level and sex of the person being coached upon the success of the coaching. Finally, the study determines the effect of coaching on the concurrent validity of verbal analogy and number series tests.

## OBJECTIVES

The major objectives of this study are to:

1. Determine the effect that coaching in item solution techniques has upon subsequent test performance and determine the relationship of such an effect to initial ability, sex, elapsed time until posttest, similarity of the test items to the coached items, and degree of speededness of the test.

2. Determine the effect of coaching on test-taking attitude and the relationship of such an effect to initial ability, sex, elapsed time until posttest, similarity of the test items to the coached items, and degree of speededness of the test.

3. Determine the effect of coaching upon the amount of test-taking confidence and determine the relationship of such an effect to initial ability, sex, elapsed time until posttest, similarity of the test items to the coached items, and degree of speededness of the test.

4. Determine the effect of coaching on accuracy of test-taking confidence and determine the relationship of this effect to initial ability, sex, elapsed time until posttest, similarity of the test items to the coached items, and the degree of speededness of the test.

5. Determine the effect of coaching on the number of items attempted on speeded tests and determine the relationship of this effect to initial ability, sex, elapsed time until posttest, and similarity of the test items to the coached items.

6. Determine the effect of coaching upon time spent on a power test and determine the relationship of such an effect to initial ability, sex, elapsed time until posttest, and similarity of the test items to the coached items.

7. Determine the effect of coaching upon the concurrent validity of the test.

## DEFINITION OF COACHING, VERBAL ANALOGIES AND NUMBER SERIES

The term coaching has had different meanings throughout the history of aptitude testing. In the 1920s coaching often meant teaching the actual items contained on the test. The British in the 1950s used the term to mean familiarizing the testees with the kinds of items and materials contained in the test. The word coaching as used in this study means explaining to the subjects what a verbal analogy or number series item is, showing examples of the type of item, teaching rules that

can be used to solve the item, and giving practice in applying those rules. The coaching does not include teaching solution techniques that would apply solely and specifically to items in the posttests nor does it involve any reference or relation to actual items in the posttests. The coaching was designed to increase scores on all verbal analogy test and all number series tests, and was not pointed toward any specific tests.

A verbal analogy is defined as an item consisting of four words bearing some relationship to each other. Only the first two or three words are supplied. The task is to determine the relationship between the first two words and then pick a word or pair of words from a list of four or five alternatives so that the second pair of words bear the same relationship to each other as do the first pair.

A number series item is defined as a list of numbers which bear some relationship to each other so as to form a definite pattern or series. The task is to determine the pattern involved and then to pick from a list of alternatives the next number or next two numbers that continue the series.

## RATIONALE FOR CHOICE OF ITEMS

This study investigates the effect of coaching upon the ability to solve two types of items, verbal analogies and number series. These two item types were selected for the study for a number of reasons. In the first place, as Millman and Pauk (1969) have pointed out, these two types of items leave the unsophisticated test taker at the greatest disadvantage and would, therefore, be most susceptible to coaching. Secondly, both types of items are found in a wide range of aptitude and intelligence tests used to predict scholastic success. Verbal analogies

are used in the Miller Analogies Test, the Scholastic Aptitude Test, the Graduate Record Examination, the Medical College Admissions Test, the School and College Ability Tests, the Lorge-Thorndike Intelligence Tests, the Otis-Lennon Mental Ability Test, the Henmon-Nelson Tests of Mental Ability, and in many others. Number series items are found in the Lorge-Thorndike Intelligence Tests, the Otis-Lennon Mental Ability Test, the Henmon-Nelson Tests of Mental Ability, the Analysis of Relationships, the Short Form Test of Academic Aptitude, the California Test of Mental Maturity, and in many other tests of intelligence and academic aptitude. A third reason for the choice of these particular item types is that they represent each side of the classical dichotomy between verbal and non-verbal abilities. A comparison of the effect of coaching on each type of item is made. The final reason for making this selection is that for each item type there exists a similar item type which can be used in investigating the breadth of influence of coaching in the solution of a specific item type. This study investigates the effect that coaching in verbal analogies has on the solution of analogies composed of geometric figures and the effect that coaching in number series items has on configuration series items.

## OVERVIEW

In Chapter II most of the previous coaching studies reported in the literature are reviewed. Some coaching studies have considered only the effect of coaching on total test scores. The review in Chapter II discusses these, but it emphasizes those studies which, in addition to looking at total test scores, have considered other variables that could

have an effect on or be affected by the coaching. The literature review is so organized as to focus on the uniqueness of this study.

Sample description and selection procedures, experimental design, hypotheses and statistical analyses are presented in Chapter III. In addition this chapter contains a section explaining the coaching procedures used in the study and a section describing the instruments used to test the effects of the coaching.

The results of the statistical tests are presented in Chapter IV, and in Chapter V the results are discussed and interpreted, implications are considered, and conclusions and summaries are given.

## CHAPTER II

## REVIEW OF THE LITERATURE

### INTRODUCTION

This study, while not a replication of any previous research, is nevertheless based on the findings of other investigators. Although the literature is not saturated with studies investigating the effects of coaching upon test performance, there have been a rather substantial number of investigations in the area. In this chapter the pertinent studies are reviewed and critiqued in order to develop a rationale for the present study.

Previous coaching studies are examined under a number of different topics. In the first section of this chapter a brief history of coaching studies is presented. This is followed by two sections examining previous findings on the relationship of the ability and sex of the person being coached to the efficacy of the coaching. The next two sections deal with the effects of coaching over various lengths of time and the effects of coaching on tests of various degrees of similarity to the coaching material. These are followed by sections relating coaching to speed of item solution, test-taking attitudes and confidence, and test validity. The final section compares test-wiseness studies and coaching studies.

### HISTORICAL VIEW OF COACHING

One of the earliest references to coaching in the literature was in an article by Thorndike in 1919. In this paper, Thorndike discussed

how tests might be misused through coaching, and he presented possible remedies for the situation. At the time of publication of Thorndike's paper, the intelligence testing movement was only 14 years old. Before the development of the first Binet-Simon Scale in 1904, psychologists had concentrated mainly on measuring sensory discrimination and reaction time.

During the first two decades of this century, the various revisions of the Binet-Simon tests attracted wide attention among psychologists. However, interest in coaching to improve scores on the test seems to have been nonexistent during this period. With the onset of World War I, a group of American psychologists was faced with the problem of determining the general intellectual level of a million and a half recruits. The result was the first intelligence test, known as the Army Alpha. After the war, the release of this test for civilian use gave a tremendous spurt to the growth of the testing movement. During the testing boom of the twenties when objective tests were called "new-type" tests, numerous studies on the influence of coaching upon test scores began to appear in the literature.

The coachability of both group and individual intelligence tests was investigated by the early coaching experimenters. They were interested in the lasting effects of coaching over time, the comparative coachability of various types of intelligence tests, and the transfer effects of coaching to other intelligence tests. The findings of these investigators are presented later in the chapter.

Following the great spurt of coaching studies in the twenties, interest in this area began to wane. The next two decades produced very little in the way of coaching studies. However, in the 1950s the

educational system in Great Britain began to use group intelligence tests to determine the educational future of 11-year-old students. Because of the importance of the decision for the individual and the school, both students and educators became interested in the efficacy of coaching to improve test scores. A spate of articles dealing with coaching again began to appear in the literature.

In the United States in the late 1950s and early sixties the increased demand for college acceptance led colleges to rely more heavily on standardized aptitude tests such as the Scholastic Aptitude Test. This in turn led to an interest in whether these tests were susceptible to coaching, and coaching studies again began to appear in the literature. The civil rights movement, increased concern for the disadvantaged, the issue of hereditability of intelligence and the continued proliferation of testing in our society have all combined to keep the issue alive.

Some recent investigations (e.g., Millman, 1966; Juola, 1969; Slakter, et al., 1970; Oakland, 1971) have focused on measuring test-wiseness or test-taking ability, and in determining its influence on aptitude and achievement test scores. Others (Roberts and Oppenheim, 1966; Millman and Pauk, 1969; Juola, 1969; Moore, 1971) have focused their attention on coaching or teaching people how to take tests.

## COACHING AND ABILITY

Some of the first investigators of coaching on aptitude tests speculated that the coaching would actually increase the intelligence or ability of the person being coached, but this view is no longer very popular. The section of this chapter on coaching and validity contains a fuller discussion of the relation between coaching and true ability as

measured by test performance. When the effect of ability on the outcome of coaching is examined, no real consensus is achieved. Many investigators have attempted to determine whether coaching is more effective for high or low ability test-takers, and they have reached varying conclusions.

In 1928 Casey trained a group of first grade pupils for eight hours to solve items similar to those on the Stanford-Binet, and following the training program the Stanford-Binet was administered to all the subjects. The training group scored higher than did the control group, but the students in the training group with lower original mental ages made greater gains than did the higher mental age students. Somewhat different findings were reported by Harter (1928). She trained a group of higher IQ subjects to recognize similarities in pairs of words and a group of lower IQ subjects to recognize differences in pairs of words. The higher IQ group performed significantly better than a control group, but there were no differences for the lower IQ groups. This finding that the higher IQ group benefited most from training is not clear-cut since the nature of the training and the tasks were different for the two groups.

Wiseman and Wrigley (1953) coached a group of British school children in methods of taking the Moray House Tests. The coaching technique was based on a published text containing information on how to take tests. They found that the effect of coaching was dependent on level of initial ability. The lower the initial IQ the greater the gain due to the coaching. James (1953) investigated a school district in Great Britain which introduced official coaching for all students before taking the national examinations. By comparing the distribution of IQ scores

before and after the introduction of the official coaching program he found that the average gain of about five IQ points was evenly distributed across the range of IQs. Low, middle, and high ability students all benefited equally from coaching.

In a study of the effects of coaching on the Moray House Intelligence Tests, Dempster (1954) found pretest-posttest correlations of over .93 for the coached group. He interpreted this as indicating that the coaching was equally effective at all levels of ability. Vernon (1954) at the conclusion of a symposium on the effects of coaching and practice in intelligence tests stated that the evidence showed that bright children benefit more from practice and dull ones improve more from coaching.

Spielberger (1959) studied improvement on the Miller Analogies Test (MAT) due to practice. The correlation of -.50 between initial ability level and gain scores was undoubtedly due to regression. Colver and Spielberger (1961) reported a correlation of .86 between initial and final scores on the MAT, indicating equal gain for all ability levels. Coladarci (1960) analyzed MAT score changes and found that middle ability persons gained more than high or low ability persons.

French (1955) reported a large scale study of the effectiveness of coaching to improve Scholastic Aptitude Test (SAT) scores conducted in three public schools. All the seniors in the schools took the SAT in September and were retested with another form of the test in March. Pupils in school A received no coaching, pupils in school B received a total of three hours of coaching in vocabulary and reading comprehension and one and one half hours practice with sample SAT questions. In school C the pupils received 20 coaching sessions in solving both math and verbal exercises similar to those contained in the SAT. One of the

findings of the study was that in the coached group greater gains were made by those of higher ability.

Schubert (1967) studied the effect of training on the performance on the Block Design Subtest of the Wechsler Intelligence Scale for Children. He found that the gain after training correlated positively with initial IQ.

In summarizing these studies of the effect of coaching on test performance at different ability levels, it should be noted that three investigators found most improvement at high ability levels, one reported greatest improvement at the middle level, three concluded that the low ability levels improved the most, and three investigators found equal improvement at all ability levels. It is clear that no conclusive statement can be made regarding the relationship of entering ability level and the effectiveness of coaching.

## COACHING AND SEX

The earliest studies of the effect of coaching did not control for the sex of the person being coached, and thus no comparison was made as to the relative effectiveness of coaching for boys and girls. In the 1950s the British psychologists who were investigating coaching in relation to their national exams were the first to study the possible interaction effects between coaching and the sex of the individual being coached.

In 1953, James reported on the effects of an official coaching program conducted by a school district in Great Britain. All children who were to take the national examinations received coaching, and the results of the testing were compared with the norms from the previous

year. It was found that all students benefited from the coaching, but that girls gained more than boys. In another study of coaching, Dempster (1954) specifically designed his coaching to improve scores on the Moray House Intelligence Tests. He found that in the two verbal tests the girls gained more than the boys, but on a non-verbal mental ability test, boys gained more than the girls. Dempster did not attempt to explain these mixed findings. In a symposium designed to bring together all the known findings on the effects of coaching, Vernon (1954) concluded that at the time the relationship of coaching and sex had not yet been determined. Some studies showed girls profiting more from coaching and others showed the reverse. In 1957, Heim and Watts conducted a study in which subjects were coached on methods of solving highly speeded spacial problems. They found that the coaching was more effective for girls than for boys. Schubert (1967) conducted a study designed to evaluate the effect of training on performance on the WISC Block Design Subtest. He found equal improvement for both boys and girls.

A study conducted in this country in which the sex of those receiving the coaching was taken into account was conducted by French in 1955. Students in three public schools took one form of the SAT in September of their senior year and received another form in March. Students at school A received no coaching. At school B the students received four and one half hours of coaching in vocabulary, reading comprehension and sample verbal questions from the SAT. At school C the students received 20 periods of coaching using verbal and mathematical items. French found that at both school B and school C the girls gained more than did the boys on SAT verbal scores when compared with their counterparts at school A who received no coaching. For the SAT mathematical scores the

effect of coaching with respect to sex was not so clearcut. The gain scores of the boys and girls at school C, the only school to receive mathematical coaching, were compared to schools A and B. Compared to school A, the girls at school C seemed to benefit more from the mathematical coaching than did the boys. The effect was just the opposite when school C scores were compared to school B. When the scores were broken down both by sex and whether the students had been studying mathematics during the year, an interesting finding was observed. In comparing the gain scores of students in school C to school A and school B, it was found that in both comparisons girls taking mathematics benefited much more from the coaching than did girls not taking mathematics, but that boys not taking mathematics benefited more than boys who were studying math. French did not speculate on the possible causes of these findings or on their significance.

It is interesting to compare French's findings to those of Dyer (1953). Dyer instituted a coaching program using verbal and mathematical materials corresponding to the two sections of the SAT at an independent preparation school for boys. In comparing the scores received by the boys who were coached to scores of the boys in a similar school who received no coaching, Dyer found that the verbal coaching had a minimal effect, but that the mathematical coaching was much more effective for boys who were not taking math courses in their senior year. This finding was similar to what was reported by French (1955).

It seems true that the conclusion reached by Vernon in 1954 that the relationship between coaching and sex had not yet been determined remains valid today.

## THE EFFECTS OF COACHING OVER TIME

Some of the very first investigators of the effects of coaching upon test performance were interested in how well the results of the coaching would hold up over time. In 1928 Casey reported a study in which an experimental group of first grade children were coached on material similar to items on the Stanford-Binet. A control group was not given any coaching. The children were tested before the coaching, immediately after the coaching, and six weeks after the coaching was completed. The coached group showed greater gains than did the control group on the immediate posttest and this effect was not lost after six weeks. In a similar experiment Davidson (1928) found that training on four tasks similar to the Stanford-Binet tests resulted in greater gains in these particular tasks for the coached group over the control. In a follow up test three months afterwards it was found that the results were in evidence to a lesser degree. The effect of the training seemed to diminish over time.

In still another study involving coaching for the Stanford-Binet, Greene (1928) used three groups. One group was coached on the actual items from the Stanford-Binet, a second group received coaching on similar but not identical material, and the third group got no coaching at all. Posttesting took place immediately after the coaching, after three months, after a year, and after three years. The group trained on the actual items obtained the highest scores on the immediate posttest, and the similar group surpassed the control group. After three months the differences were still evident. After one year had elapsed there were only slight differences, and after three years the differences had disappeared entirely.

Dempster (1954) reported finding positive results as a result of coaching to increase scores on the Moray House Intelligence Tests. In evaluating his results he reported that the effect of coaching soon wears off, but he provided no evidence for this and did not give any estimate of the time period in which the effect would disappear.

In summing up these studies on the effect of coaching over time, it would seem reasonable to expect that the effect would begin to diminish with the passage of time. All the available evidence indicates that this is true. However, no recent study of coaching has looked at this variable, and it has never been examined in relation to specific coaching for specific types of items.

## SIMILARITY OF THE COACHING MATERIAL TO THE TEST

The amount of similarity between the material upon which one is coached including any practice items and the actual items making up the criterion test undoubtedly has an effect on the efficacy of the coaching. To look at the extreme cases, one would expect great improvement after coaching on the actual items contained in the posttest. On the other hand, there would be no reason to expect any increase in scores if the coaching material were completely dissimilar from that used in the posttest. The variable of similarity of the coaching material to the test material has been investigated in a number of studies but it is difficult to compare them because of the lack of any common definition of degree of similarity.

In a smaller investigation that grew out of a large scale coaching study, French (1955) examined the effect of coaching students on the identical questions that appeared on the SAT posttest. He found that

coaching on identical items produced an average increase of 47 points higher on the verbal score and 15 points higher on the mathematical score than the average increases produced by coaching without the benefit of identical items.

In 1928 Greene reported the results of a study investigating coaching of seven-year-old children on the Stanford-Binet. She investigated three groups: the coached group was trained on the actual test material; the similar group was trained on material similar, but not identical to the actual test material; the control group received no training at all. The coached group achieved markedly higher scores than the other two groups on an immediate posttest administration of the Stanford-Binet. The similar group had scores falling between the coached group and the control group.

Harter (1928) coached students on identifying similarities of pairs of words presented in a list. The test was composed of pairs of words identical to the training list, pairs of words similar to the training words, and pairs of words bearing no direct similarity to the training list. She found that the effect of the training was greatest on the identical pairs, somewhat less on the similar pairs and least on the pairs having no similarity. Davidson (1928) trained third grade children on tasks similar to the Stanford-Binet test material. She found some indication of a transfer of coaching effect from digit span to memory span for letters.

In the study reported in 1954, Dempster coached a group of boys and girls using materials specifically designed to raise scores on the Moray House Intelligence Tests. As a part of the study he administered verbal and nonverbal tests which were unlike the Moray House Tests. He

found that overall, coaching on dissimilar material is less effective than coaching on similar material.

Roberts and Oppenheim (1966) administered coaching materials specifically designed to increase scores on the Preliminary Scholastic Aptitude Test (PSAT) to a group of educationally disadvantaged high school students in Tennessee. They also administered the Sequential Tests of Educational Progress (STEP) Level 3 Reading and Mathematics tests. The results of the coaching on the PSAT scores tended to be small but statistically significant. The authors did not report the scores on the STEP tests so it was impossible to evaluate the effect of the coaching for a specific test upon a different but similar test.

These studies seem to clearly indicate that coaching is most effective when the coaching material is most similar to the test material. As the coaching material becomes less similar to the test material, the effectiveness of the coaching generally tends to diminish.

## COACHING AND SPEED OF ITEM SOLUTION

The effect of coaching on the speed with which the test-taker solves the items on the test has not yet been systematically investigated and reported in the literature. It certainly is an important variable in view of the rather speeded nature of most current aptitude and intelligence tests.

Two authors in the past decade have to some extent speculated on the role of speed in solving analogies. Willner (1964) investigated the reasoning processes that one undergoes in reaching the correct solution in a verbal analogy. He found that many persons merely choose the alternative most closely associated with the third word of the analogy, and

this often leads to the correct answer. However, he went on to state that to correctly solve analogies, a subject must develop and maintain a complex set. He may be distracted from this set by an association, and this may be especially true in timed tests. Another author who studied speed of solving analogies was Moore (1966). He investigated the relationship between time spent in solving the four sample analogy problems in the Miller Analogy Test (MAT) booklet and the raw score received on the MAT. He found a correlation of -.40 between these variables and speculated that the relationship could be due to the fact that examinees taking longest to complete the sample items are those who have most difficulty in understanding the analogy solving procedure.

French (1955) has been the only researcher to date to report on the effects of coaching on speed. He used the number of items attempted on the SAT as a measure of the student's speed and found that coaching resulted in students working more slowly. He felt that this was a surprising finding and attributed it to the gain of knowledge and confidence which served to increase caution on the part of the coached students and cut down on guessing.

This finding suggests that coaching might have a differential effect on speed and power tests. If coaching increases the time spent per item, but also increases accuracy, it should have its most beneficial effect on a power test where there is enough time to attempt all the items. On a highly speeded test coaching should have a less positive or even a negative effect since the increased accuracy of the coached students could be offset by the greater number of items attempted on the part of the uncoached students.

## COACHING AND TEST-TAKING ATTITUDES AND CONFIDENCE

Psychometricians often speak of the importance of test-taking attitudes and confidence in obtaining high scores on aptitude and achievement tests. Millman and Pauk (1969) implied that positive attitudes and a moderate amount of confidence can result in higher test scores. Anastasi (1969) stated that individuals with prior testing experience have certain advantages which include more self-confidence and better test-taking attitudes. In a study of test-taking attitudes among university and high school students, Cunningham (1966) found that positive test-taking attitudes are related to high achievement.

Even though it is widely accepted that attitudes and confidence are important variables in test-taking, none of the coaching studies to date have systematically investigated the effect of coaching in these areas. However, a number of investigators have speculated on the effect that coaching had on the attitudes of those receiving the coaching. For example, Casey (1928, p. 433) in a study of coaching for the Stanford-Binet reported that, "the training seems to have given the children something in the way of an attitude or interest that enables them to gain in mental age." Harter (1928) also felt that it was possible to impart to children through drill and coaching an attitude or method of approach to the problem which enabled them to perform better. In 1938, Vernon found that a group of students gained eight IQ points after taking a four week testing course. He attributed the increase to greater test sophistication which he defined as including a better subjective attitude. Wiseman (1954) felt that test sophistication is the most important single element involved in improvement from practice or coaching.

In his large scale study on coaching high school students for the SAT, French (1955) implied that the coaching served to increase the amount of confidence the students had in taking tests. Finally, Oakland (1971) reported that teaching test-wiseness skills to preschool disadvantaged children seemed to give them more confidence and better attitudes toward testing, although no formal attempt was made to assess these variables.

In spite of all the speculation, no study to date has attempted to objectively measure the effect that coaching has on test-taking attitudes and confidence.

## COACHING AND TEST VALIDITY

The issue of the effect of coaching upon the validity of the test is a complex one and can be approached from several different angles. Anastasi (1968) introduced the concept of breadth of influence in discussing the problem. She stated that coaching and education both tend to raise scores on a test. However, coaching might merely raise a test score "without appreciably affecting the behavior domain that the test is designed to predict" (Anastasi, 1968, p. 567). Anastasi argues that coaching in this sense tends to invalidate the test.

An alternative argument holds that some persons use highly sophisticated test-taking techniques which give them an advantage over their less sophisticated classmates. Certain persons or groups lack test-taking skills and therefore are unable to perform at the level indicated by their true aptitude and achievement. Those holding this point of view argue that coaching in test-taking skills should actually increase the validity of a test by providing everyone with an opportunity

to demonstrate his competence. Ebel (1965, p. 206) pointed out that "more error in measurement is likely to originate from students who have too little, rather than too much, skill in taking tests." Vernon (1954) stated that the reliability and validity of intelligence tests are lowered when some children have coaching and others do not. He concluded that the available evidence pointed to the fact that coaching and practice for all would make tests more valid and more reliable.

Gulliksen (1950) has suggested the development of tests which have intrinsic validity. He argues that use of such tests would eliminate the problem of coaching and test validity since coaching would improve both test performance and criterion performance, and in fact coaching would be recommended for everyone.

A review of the literature tends to support the view that coaching increases the validity of tests, although this is not because most tests have intrinsic validity. It appears that other factors are operating to produce the phenomenon. Richardson and Robinson (1921) found the correlation between the Army Alpha Test and college grades increased as the subjects had more practice in taking the test. Glick (1925) correlated scores on the Army Alpha Test with semester grades both before and after a coaching and practice session with the test. He found that the correlations were higher for four groups of students after the coaching. The four groups were college students, high school students, junior high school students, and seventh and eighth grade students. Although in no case was the increase in correlation statistically significant, he concluded that performance on an intelligence test after coaching is more predictive of school success than when no practice is given.

Ortar (1960) conducted a unique experiment in which she demonstrated that correlation of scores on a specially devised test with student's grades could be increased by coaching. She was concerned with assessing the educational aptitude of new immigrant children to Israel. These children came from different countries with markedly different social and cultural backgrounds. Most had not had any educational experience, and non of the available tests seemed suitable for measuring their learning potential. She therefore devised a new test utilizing tasks equally unfamiliar to all children. These tasks involved superimposed stencils from which a pattern was to be constructed. The test consisted of three parts. The first one was given and scored like any other test. In the second part a number of specially chosen items were administered and if the subject had difficulty with any one, the examiner explained the principles involved using the subject's own method of approach. The third part of the test, containing items using similar principles, was then administered. Ortar reported that scores on the third part of the test, after coaching, correlated substantially higher with grades in academic subjects than did scores on the first part before the coaching.

The test devised by Ortar actually includes a learning situation. It seems logical that children who could profit most from the coaching on the test would be the ones most likely to gain most from classroom instruction. This viewpoint could explain the higher correlations after coaching. The very qualities that enable one to benefit from the coaching (motivation, intelligence, and docility) are the same qualities that result in high academic achievement.

## COACHING AND TEST-WISENESS

Recently in the literature there has appeared a series of test-wiseness studies which are related to the coaching studies of old, but which approach the problem from a different tack. The concept of test-wiseness has been around for many years. It was first mentioned in print by Vernon in 1938 in an article on intelligence test sophistication. Since then many authors have written of test-sophistication or test-wiseness and the opposite concept of test naiveté or test blindness. Few writers have bothered to define the concept, although it generally means the ability to take tests and to score as high as or even higher than would be warranted by true aptitude or achievement. Lack of test-wiseness could result in a lower score than warranted.

Millman, et al., (1965) attempted to analyze, list, and categorize test-wiseness techniques. They recommended the developing of measures of test-wiseness. A number of investigators (Gibb, 1964; Millman, 1966; Juola, 1969; Slakter, et al., 1970) have attempted to develop and/or validate measures of test-wiseness. Others have attempted to teach test-wiseness principles (Wahlstrom and Boersma, 1968; Wahlstrom, 1968; Moore, et al., 1966). The teaching of test-wiseness principles in order to increase scores on aptitude or achievement tests is not much different from what was called coaching in earlier studies. Some current studies which speak of teaching test-wiseness are really classical coaching studies (Oakland, 1971; Moore, 1971). Those who study test-wiseness and those who are concerned with coaching are both really interested in different ends of the same continuum. Teaching test-wiseness usually refers to imparting techniques useful in a large variety of tests, and coaching generally

refers to teaching test-taking techniques applicable only to a specific test or type of item.

## SUMMARY

In this chapter the effects of coaching have been examined in relation to a series of important variables. No conclusions can be made as to the relationship of entering ability level and the effectiveness of coaching. Three of the studies reviewed showed coaching to be most effective for high ability levels, three others found it most effective for low ability levels, and one reported greatest improvement at middle level. In addition, three studies showed no differential effects of coaching at different ability levels. The findings relating sex to coaching are equally inconclusive; some investigators have found girls most susceptible to coaching, others concluded boys were most coachable, and still others got mixed results or no difference.

There is general agreement in the literature that the effects of coaching tend to diminish with the passage of time. There is also a consensus that coaching is most effective when the coaching material is very similar to the test and becomes less effective as the dissimilarity between the coaching material and the test increases.

No studies have been designed to specifically examine the effect of coaching on speed of taking tests. However, one study indicates that coaching may increase the time spent in solving items. Similarly, no study has examined the effect of coaching upon test-taking attitudes and confidence, although a number of authors have speculated that coaching improves attitudes and confidence.

Several investigations in the 1920s and one recent study in Israel found that coaching improved test validity as measured by the correlation of test scores with school success. There have been no recent empirical studies of the effect of coaching on test validity in this country.

Some recent investigators have been more interested in teaching and measuring test-wiseness. It is felt that there is no clear-cut distinction between the two kinds of studies.

# CHAPTER III

## DESIGN OF THE STUDY

This chapter contains descriptions of the sample, the experimental design, the instrumentation, the procedures followed in collecting and preparing the data for analysis, the research hypotheses, and the statistical analyses.

## SAMPLE

The sample consisted of 88 freshmen students at Michigan State University who had enrolled as first-time freshmen in the fall term of 1970. About 200 potential subjects were randomly selected from the enrollment list and were contacted by mail. They were asked to serve as paid subjects in an experiment to see whether test-taking skills could be taught. Approximately 130 students volunteered to participate. Of these, 88 were selected on the basis of their availability during the time the experiment was conducted.

The subjects had all taken the Scholastic Aptitude Tests and a battery of placement tests as part of the normal procedure for incoming freshmen at MSU. They undoubtedly had taken other aptitude and achievement tests during their high school period, so they could be described as generally sophisticated with respect to test-taking.

## EXPERIMENTAL DESIGN

The 88 subjects were randomly assigned to one of two main groups, one group receiving coaching in verbal analogies and the other receiving

coaching in number series. Each group was pretested and posttested with identical instruments containing both analogy subtests and series subtests. The study could really be viewed as two separate experiments, one examining the effects of coaching on verbal analogies and the other looking at the effects of coaching on number series. In the first experiment the group receiving analogy coaching was the treatment group and the other group was the control; the dependent variables were the scores on all the analogy subtests. In the second experiment the experimental and control groups were reversed and the dependent variables were the scores on the series subtests.

The experimental design for the analogies experiment is presented in Figure 3.1. The design is exactly the same for both experiments except that the experimental and control groups are interchanged. At the time of the pretest, the subjects had already been randomly assigned to one of the two major groups. The grand median for all 88 subjects on the pretest was determined and post hoc blocking was employed to develop the high and low ability groups. Assignment to high and low ability level was based on the grand median of all subjects of both sexes in both groups with scores falling at the grand median equally split between the high and low ability level within each sex in each treatment group. At the completion of this procedure it was found that the smallest cell contained nine subjects. Subjects were randomly eliminated from the other cells to obtain a balanced design with nine subjects per cell. Two subjects per cell or a total of 16 subjects were lost by this procedure. This procedure was repeated for the second experiment on the basis of a number series pretest, and again a balanced design with nine subjects per cell was obtained.

| Design Factors | | | Measures Factors | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Immediate Posttest | | | | Delayed Posttest | | | |
| Group | Sex | Ability | Verbal Analogies | | Figure Analogies | | Verbal Analogies | | Figure Analogies | |
| | | | Power | Speed | Power | Speed | Power | Speed | Power | Speed |
| Coaching in Analogies | Male | High | | | | | | | | |
| | | Low | | | | | | | | |
| | Female | High | | | | | | | | |
| | | Low | | | | | | | | |
| No Coaching in Analogies | Male | High | | | | | | | | |
| | | Low | | | | | | | | |
| | Female | High | | | | | | | | |
| | | Low | | | | | | | | |

FIGURE 3.1 Experimental Design Showing the Independent Factors of Group, Sex and Ability and the Measures Factors

## INSTRUMENTATION

The instruments used in this study consisted of four types of items: verbal analogies, figure analogies, number series, and figure series. The items were all selected from various aptitude, reasoning and intelligence tests, suitable for the college freshmen level. The selection of the verbal analogy items was conditioned upon their not containing words of very difficult vocabulary or specific factual information. Such analogies would not be susceptible to coaching and would, therefore, be of no use to this study. The figure analogy items and the number and figure series items were selected only under the condition that they be of the appropriate difficulty level. The items selected were then randomly assigned to various subtests. An attempt was made to divide items from the same aptitude or intelligence tests equally across all of the newly developed subtests in order to keep the difficulty level and the content areas of the new tests roughly equivalent. Altogether 18 subtests were formed in this way.

The kind and number of items forming the subtests of the pretest and the immediate and delayed posttests are presented in Table 3.1 along with the time limits and the Hoyt internal consistency reliabilities for each subtest. The use of an internal consistency reliability resulted in artificially inflated reliabilities for the speeded tests. The 18 subtests were called forms and were lettered from A to R. Copies of the subtests, reduced in size by 35 percent, and the answer keys can be found in Appendix A.

The time limits for the subtests of the pretest were chosen to approximate the amount of time per item that is generally allowed on a

TABLE 3.1 Type and Number of Items, Time Limits, and Reliabilities of the Subtests of the Pretest, Immediate Posttest and Delayed Posttest

| Form | | Type of Item | Number of Items | Time Limit in Minutes | Hoyt Reliability |
|---|---|---|---|---|---|
| Pretest | A | Verbal Analogies | 16 | 8 | .62 |
| | B | Number Series | 16 | 8 | .77 |
| Immed. Posttest | C | Verbal Analogies - Power | 16 | 12 | .52 |
| | D | Verbal Analogies - Speed | 16 | 5 | .71 |
| | E | Figure Analogies - Power | 10 | 7 | .33 |
| | F | Figure Analogies - Speed | 10 | 3 | .47 |
| | G | Number Series - Power | 16 | 12 | .62 |
| | H | Number Series - Speed | 16 | 5 | .80 |
| | I | Figure Series - Power | 10 | 7 | .42 |
| | J | Figure Series - Speed | 10 | 3 | .52 |
| Delayed Posttest | K | Verbal Analogies - Power | 16 | 12 | .56 |
| | L | Verbal Analogies - Speed | 16 | 5 | .69 |
| | M | Figure Analogies - Power | 10 | 7 | .30 |
| | N | Figure Analogies - Speed | 16 | 3 | .14 |
| | O | Number Series - Power | 16 | 12 | .70 |
| | P | Number Series - Speed | 16 | 5 | .80 |
| | Q | Figure Series - Power | 10 | 7 | .20 |
| | R | Figure Series - Speed | 10 | 3 | .57 |

typical aptitude test. A survey of the time limits on aptitude tests containing verbal analogies and number series indicated for both item types the time limit per item is usually about a half minute. Therefore the time limit was set at eight minutes for each of the 16 item subtests of the pretest.

The time limits for the speed and power subtests of the post-tests were determined after a limited tryout testing. Time limits were set so that under power conditions almost everyone would have a chance to attempt all the items, and under speeded conditions very few persons would reach the last item.

All the items for each subtest were contained on a single page. At the bottom of the page the following two questions were asked:

How many items on this page do you think you answered correctly? _____

How did you feel about answering the items on this page? (check one)

| | | | | | | |
|---|---|---|---|---|---|---|
| Liked Very Much | Liked to Some Extent | Liked a Little | Neutral | Disliked a Little | Disliked to Some Extent | Disliked Very Much |

In addition, on the power tests, the subjects were asked to:

Write the number that is on the board when you finish all the items on this page. _____

This number represented the number of minutes which had elapsed since the beginning of that subtest. This question was not asked on the subtests given under speeded conditions since for these tests it was expected that few, if any, students would complete all the items on the test. Each of the subtests was preceded by a cover sheet containing examples of the type of item to follow so that the subjects would understand what was required of them. Examples of the cover sheets may be found in Appendix A.

## PROCEDURE

The 44 students in the analogies training group reported to a large room in the center of campus at 7 p.m. on a Monday night early in the spring term. The number series group received their training the following night in the same room. When all had arrived, both forms of the pretest were distributed. After the administration of the pretest, the papers were collected and the training program began.

The coaching for each group lasted slightly over one hour. It consisted in each case of an explanation of what a verbal analogy or number series item is, a presentation of some sample items and the rules used to solve them, a demonstration of how the rules are used, practice in applying the rules, and discussion of the correct answers. The rationale for employing both coaching and practice was based on the obvious findings of previous investigators (Dempster, 1954; Vernon, 1954; Heim and Watts, 1957) that a combination of both coaching and practice is more effective than either alone.

### Specific Coaching in Verbal Analogies

The analogies coaching material was developed from the chapter on verbal analogies in Millman and Pauk (1969) supplemented by instructional materials on analogies from Educational Testing Service (1965) and materials used by Moore (1971) in his study of coaching. The analogy coaching material was tried informally on a small group of students and was revised on the basis of the difficulties these students had with a sample test.

The two basic rules for solving verbal analogies presented to the analogy group were: (1) silently verbalize the relationship between

the two words in the stem, and (2) substitute each successive pair of words into the verbalized relationship and select the pair that fits best into the relationship. The rationale behind verbalizing the relationship was to provide an aid in maintaining the "complex set" described by Willner (1964) as being necessary for solving verbal analogies. Ways to sharpen or broaden the relationship, if necessary, to determine the correct answer were also demonstrated. A more specific description of the analogy coaching can be found in Appendix B.

Specific Coaching in Number Series

Rules for solving number series items were initially adapted from Millman and Pauk (1969). An informal tryout of these rules with a group of students indicated the need for some further modification and the inclusion of some more practical hints for obtaining the correct answer. The basic rules for solving number series are similar to the rules for verbal analogies: (1) find the rule and (2) apply it. A set of recommendations in addition to the procedures described by Millman and Pauk was included in the number series coaching. Mistakes commonly made by students in the tryout section were described to the subjects and procedures for guarding against such mistakes were discussed. Appendix B contains a detailed description of the number series coaching.

In both coaching periods an overhead projector was used to present sample items to the whole group. It should be emphasized that the two coaching techniques were designed to improve performance on all verbal analogies, and on all number series, respectively. In no case was any reference made to any specific item contained on any of the posttests.

Posttesting

At the end of the coaching period the students took a short break and then returned to their seats for the first posttest. This test contained verbal analogies, figure analogies, number series, and figure series items. There were two subtests for each item type, one given under power conditions and the other under speeded conditions. Thus, this posttest consisted of four analogy subtests and four series subtests. The total testing time for the first posttest was about one hour and ten minutes. At the end of the first posttest the students were reminded that they should return the following Monday night at the same time for the second posttest and were told that they would be paid at the end of the second testing program. The same procedure was followed for the 44 students in the number series training group except that they reported on two consecutive Tuesday nights.

At the end of the second posttest, the students were asked to fill out an evaluation form containing their reactions to the training that they had received. A copy of this form is contained in Appendix C. For each of the four types of items composing the posttests, the students were asked to check the category that best described their reactions to the training. The categories were: (1) definitely helped to solve that type of item, (2) probably helped to solve that type of item, (3) probably did not help to solve that type of item, and (4) definitely did not help to solve that type of item. The students were asked to be as honest as possible in evaluating their training, and they were told they did not have to identify themselves by writing their names on the evaluation form.

Data Preparation

The tests were scored by placing a scoring stencil over the subtest and counting the number of correct answers. For each individual on each subtest the following dependent variables were generated:

Number correct. This score was simply the total number of items answered correctly on the given subtest.

Attitude toward the test. This variable was developed by taking the response to the question asking how the individual felt about the item on the page and assigning a 7 if he checked Liked Very Much, a 6 for Liked to Some Extent, and so on down to a 1 for Disliked Very Much.

Number estimated correct. This was the response to the question asking how many items on the page the individual thought he got correct, and was used as a measure of confidence in taking the test.

Accuracy of the estimate. This score represented the absolute difference between the number of items estimated to be correct and the actual number of correct items for the individual.

Number of items attempted. This score was useful only for the speeded tests since almost everyone attempted every item on the power tests. It represented the number of items on a given subtest for which an answer was given.

Time spent on power test. This score represented the amount of time spent working on the subtest and was obtained from the response to the question asking the subject to write down the number that was on the board when he finished all the items on the page.

Coaching evaluations. From the responses on the evaluation forms as to whether the coaching helped to solve each item type, four additional scores were developed. For each of the four item types a subject received a 4 if he checked Definitely Helped, 3 for Probably Helped, 2 for Probably Did Not Help, and 1 for Definitely Did Not Help.

These variables plus the other pertinent information such as the kind of coaching received, the sex of the individual, his ability level for each study based upon scores on the pretest, and his cumulative grade point average (GPA) at the end of winter term 1971 were all punched on IBM cards so that a computer could be used to carry out the statistical analyses.

## HYPOTHESES

The major hypotheses of the study, each dealing with one of the dependent variables described in the procedure section, are presented here. Under the first major hypothesis are listed a number of subhypotheses describing expected interactions. Under the subsequent major hypotheses no subhypotheses for interactions are made since there is no empirical or theoretical evidence on which such hypotheses could be based. However, statistical tests for these interactions were applied, and the significant interactions are discussed and interpreted. The first eight hypotheses are the same for both the study investigating the effects of coaching on analogy test performance and the study investigating the effects of coaching on series test performance. Therefore, the hypotheses are presented only once.

1. The group coached in item solution techniques will perform better on subsequent tests as measured by total test score.

1a. There will be an interaction between coaching and initial ability level with the low ability level benefiting more from coaching than the upper ability level.

1b. There will be an interaction between coaching and the sex of the coached individuals.

1c. There will be an interaction between coaching and elapsed time until the posttest with the effects of coaching being greatest on the immediate posttest.

1d. There will be an interaction between coaching and the similarity of the test items to the coaching material with the effects of coaching being greatest for the similar items.

1e. There will be an interaction between coaching and degree of speededness of the test with the coaching being most effective on the power tests.

2. The group coached in item solution techniques will have more positive test-taking attitudes toward those items than the control group.

3. The coached group will have more test-taking confidence than the control group when confidence is measured by the number of items estimated to be correct on the tests.

4. The coached group will exhibit greater accuracy of test-taking confidence than the control group as measured by the absolute difference between the number of items estimated to be correct and the actual number of correct items.

5. The coached group will attempt fewer items on the speeded tests than the control group.

6. The coached group will spend greater time on the power tests than the control group.

7. The correlations between test scores and GPA will be higher for the coached group than the control group.

8. The coached group will evaluate the coaching as being most effective for the item types similar to the coaching material and less effective for the other types of items.

In addition to the above hypotheses which were tested twice, once for the analogies experiment and once for the series experiment, the following hypothesis was tested once for all subjects.

9. There will be a disordinal interaction between the type of coaching received and the evaluations of the effectiveness of the coaching for the different item types with the verbal analogies group rating the coaching most effective for analogy items and the number series group rating the coaching most effective for series items.

## STATISTICAL ANALYSES

A repeated measures analysis of variance with three design factors and three measures factors, all completely crossed, was used to analyze the data for the first four hypotheses. This analysis was used so that possible interactions between the coaching and the other design and measures factors could be tested. The three design factors were the treatment-control dimension, sex, and initial ability level. The three measures factors were the immediate-delayed posttest dimension, the item similarity factor, and the speed-power dimension. This analysis was employed to test the hypotheses dealing with the first four dependent variables for both the analogy and the number series studies.

Hypotheses 5 and 6 were tested by a repeated measures analysis of variance with the same three design factors and only two measures

factors. The speed-power dimension was not included since Hypothesis 5 dealt only with speeded tests and Hypothesis 6 was only concerned with the power tests.

For Hypothesis 7 the differences in the values of the correlations were tested by changing the correlations into Zs through Fisher's Z transformation and testing the difference between the Zs for significance.

Hypothesis 8 for both experiments was tested using a repeated measures analysis of variance. Since this hypothesis dealt solely with the coached groups in each instance, there were only two design factors - sex and ability level. The single measures factor had four levels, one corresponding to each of the four types of items.

Hypothesis 9 was tested using all of the original 88 subjects in a repeated measures analysis of variance. This was possible since ability level was not included in the design for this hypothesis. Hypothesis 9 was concerned with the group coached in verbal analogies compared to the group coached in number series. The ability groups for the analogy experiment were based on analogy pretest scores while in the number series experiment ability levels were determined from number series pretest scores. Since the two ability level groupings were not the same, the two could not be compared directly and therefore ability level was dropped for this hypothesis. The data from all 88 original subjects were then included in this analysis.

In the repeated measures analyses of variance computed in these studies, all the design factors and measures factors were considered to be fixed. In order that the F ratio of the repeated measures analysis of variance actually follow an F distribution, the assumption must be met

that the off-diagonal correlations of the matrix of repeated measures are equal. This assumption is automatically met for every F test involving a single measures factor having only two levels since this results in a single off-diagonal correlation. Adjusting the degrees of freedom by the Greenhouse and Geisser (1959) procedure in these cases does not change the number of degrees of freedom in the numerator and the denominator.

Hypotheses 8 and 9 involved a single measures factor with four levels and in this case the degrees of freedom were adjusted by the Greenhouse and Geisser procedure to account for possible spurious significance caused by unequal off-diagonal correlations.

## SUMMARY

Actually, there were two studies described in this chapter - one designed to examine the effects of coaching in verbal analogy solution techniques on subsequent analogy test performance and the other designed to look at the effects of coaching in number series solution techniques on subsequent series test performance. Eighty-eight subjects were randomly assigned to two groups, one receiving coaching in verbal analogies and the other coaching in number series. In the analogy experiment, the number series coaching group served as the control, while in the number series experiment the analogy coaching group was the control.

In addition to the experimental-control dimension, the design for each study included two other factors - sex and ability level based on pretest scores. The dependent measures varied on three factors: time of posttest (immediate and delayed), type of item (similar and dissimilar to the coaching material), and testing condition (speeded and power).

Examination of the effects of the coaching on the number of correct analogies or series items obtained on the posttests was the main purpose of each study. Also examined, however, were the effects of coaching on test-taking attitudes, test-taking confidence, accuracy of test-taking confidence, speed of item solution, and test validity. Finally, the subjects' own evaluations of the effectiveness of the coaching were analyzed.

# CHAPTER IV

## ANALYSES AND RESULTS

The results of the two studies of coaching will be presented in this chapter. Although the two studies were exactly parallel in design, hypotheses and statistical analyses, they each examined the effect of coaching on a different type of item. Therefore, the analyses and results will be presented separately for each study.

For both studies, Hypotheses 1 through 6 and Hypothesis 8 were tested using a repeated measures analysis of variance (ANOVA). For all hypotheses the .05 alpha level with the appropriate degrees of freedom was used. In each study a total of seven dependent variables were examined. Another ANOVA compared the evaluations of the coaching of the two groups, resulting in a total of fifteen ANOVAs. The complete tables of means for all groups on all variables are presented in Appendix D, and all the ANOVA tables are presented in Appendix E. Hypothesis 7 in each study was tested by transforming the correlations to Fisher Zs.

## COACHING IN VERBAL ANALOGIES

Hypothesis 1. The group coached in solving verbal analogies will perform better on subsequent analogy tests as measured by total test score.

The difference in means between the coached group ($\bar{x}$=9.32) and the control group ($\bar{x}$=8.78) was not found to be statistically significant (F=3.97 df 1,64). Therefore this hypothesis was not accepted although the mean difference of the two groups was in the hypothesized direction and the F ratio was less than .03 below the F value needed for significance at the .05 level.

Hypothesis 1a. There will be an interaction between coaching and initial ability level with the low ability level group benefiting more from coaching than the upper ability level.

The F ratio of .001 (df 1,64) was not statistically significant. The data did not support the hypothesis of an interaction between coaching and ability level.

Hypothesis 1b. There will be an interaction between coaching and the sex of the coached individuals.

This hypothesis was supported by the data (F=4.28 df 1,64). The significant interaction is graphically depicted in Figure 4.1. The coaching was quite effective for the males, but it didn't have any affect on the females.

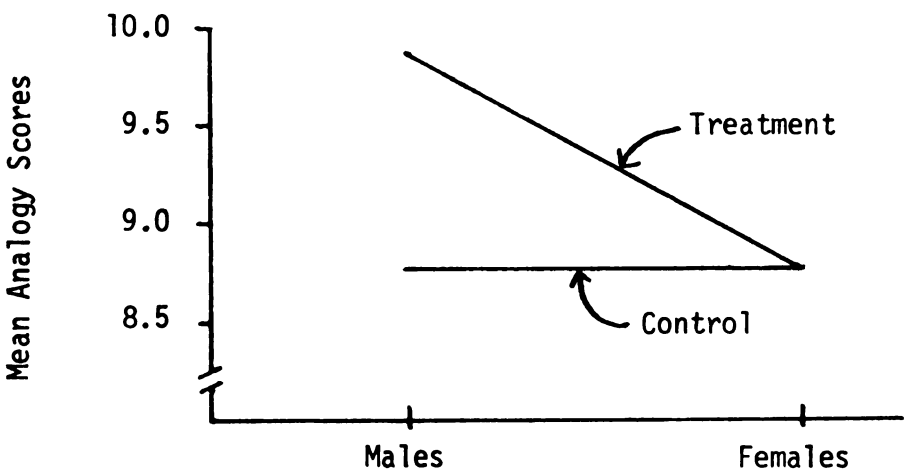


Figure 4.1

Interaction of Analogy Coaching and Sex on Mean Analogy Scores

Hypothesis 1c. There will be an interaction between coaching and elapsed time until the post-test with the effects of the coaching being greatest on the immediate posttest.

This hypothesis was not supported by the data (F=1.90 df 1,64).

Hypothesis 1d. There will be an interaction between coaching and the similarity of the test items to the coaching material with the effects of the coaching being greatest for the similar items.

The obtained F ratio of 5.36 (df 1,64) was statistically significant. The difference between the coached group and the control group was greater for the verbal analogies and less for the figure analogies. This interaction is shown in Figure 4.2.

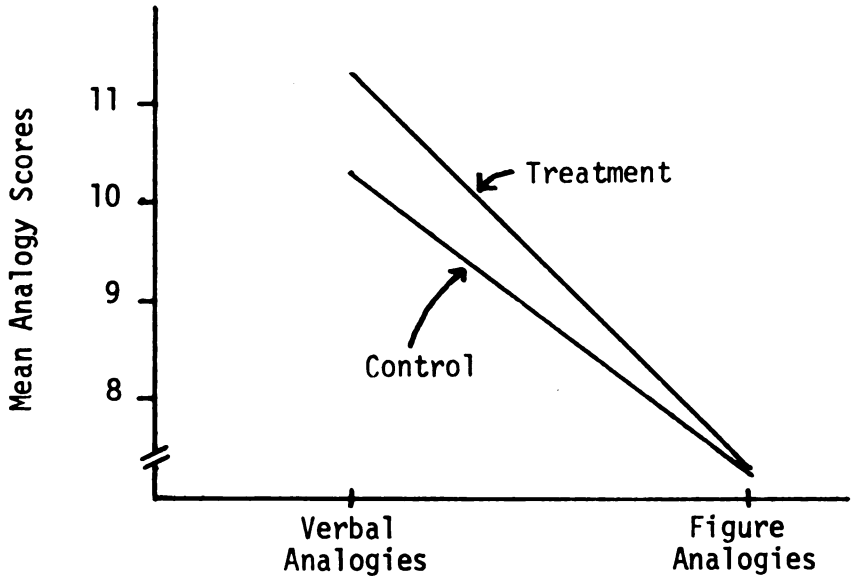


Figure 4.2

Interaction of Analogy Coaching and Item Type on Mean Analogy Scores

Hypothesis 1e. There will be an interaction between coaching and the degree of speededness of the test with the coaching being most effective on the power tests.

The obtained F ratio of 7.87 (df 1,64) was statistically significant, supporting the hypothesis of an interaction between coaching and degree of speededness of the test. Reference to Figure 4.3 which shows the interaction, indicates that the coached group performed at a higher

level on the power tests, but there was no difference on the speeded tests.

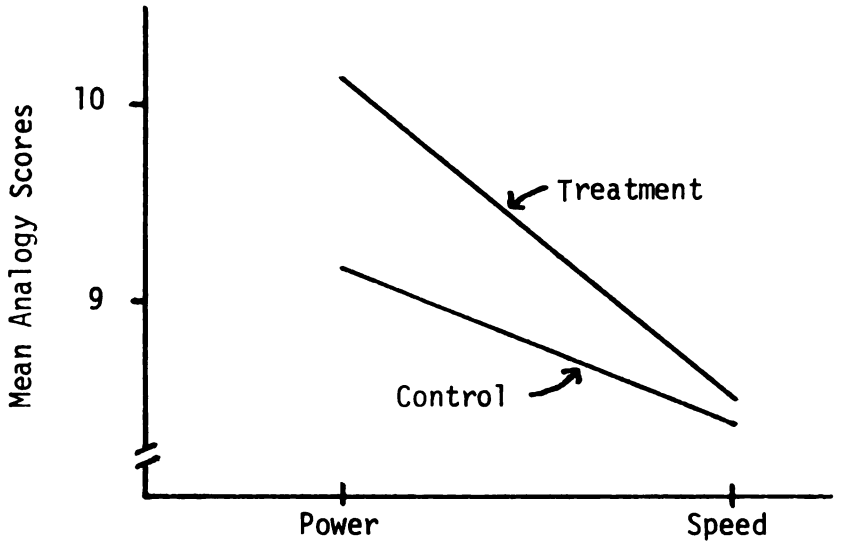


Figure 4.3

Interaction of Analogy Coaching and Degree of Speededness on Mean Analogy Scores

Hypothesis 2. The group coached in solving verbal analogies will have more positive test-taking attitudes toward analogy items.

The means of the two groups on attitudes toward analogy items were very similar (coached group $\bar{x}$=5.05, control group $\bar{x}$=4.83), and the F-ratio was not significant (F=1.26 df 1,64). There was no significant difference in attitudes toward analogies between the coached group and the control group.

However, there was a significant interaction involving coaching. With respect to attitude toward analogies, coaching interacted significantly with the sex of the person being coached (F=4.73 df 1,64). Figure 4.4 depicts the disordinal interaction. For males the treatment

resulted in more positive attitudes, but the effect was reversed for females. As a result of the coaching, females had slightly less positive attitudes than the control group.

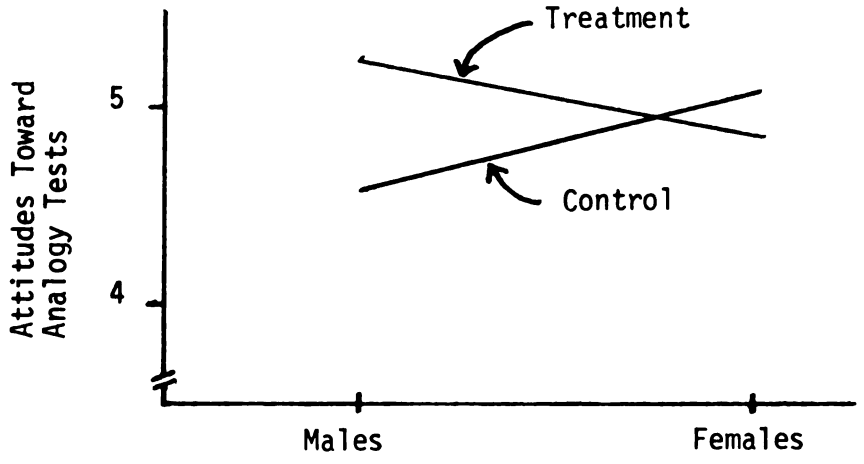


Figure 4.4

Interaction of Analogy Coaching and Sex on Attitudes Toward Analogy Tests

Hypothesis 3. The coached group will have more test-taking confidence as measured by the number of items estimated to be correct on the analogy tests.

The means of the two groups were almost identical (coached group $\bar{x}$=9.50, control group $\bar{x}$=9.48). The difference was not significant (F=.00 df 1,64). However, there was a significant disordinal interaction between coaching and degree of speededness of the tests (F=13.66 df 1,64). As is shown in Figure 4.5, the coaching seems to have increased confidence on power tests while it produced less confidence on speeded tests.

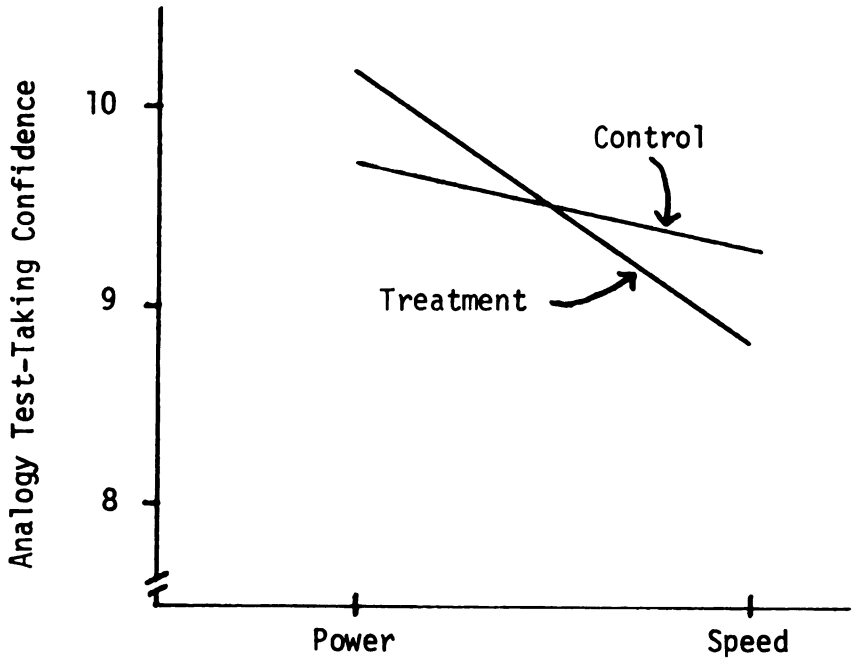


Figure 4.5

Interaction of Analogy Coaching and Degree of Test Speededness on Analogy Test-Taking Confidence

Hypothesis 4. The coached group will exhibit greater accuracy of test-taking confidence as measured by the absolute difference between the number of items estimated to be correct and the actual number of correct items.

The group receiving coaching in verbal analogies had a lower mean score ($\bar{x}$=1.53) than the control group ($\bar{x}$=1.84). This significant difference (F=4.30 df 1,64) indicates that the coached group was more accurate in their test-taking confidence since low scores indicate greater accuracy. There also was a significant interaction, shown in Figure 4.6, between coaching and ability levels with respect to accuracy of test-taking confidence (F=5.12 df 1,64). Coaching improved the accuracy of

the high ability group, but it had little effect on those of low analogy ability.

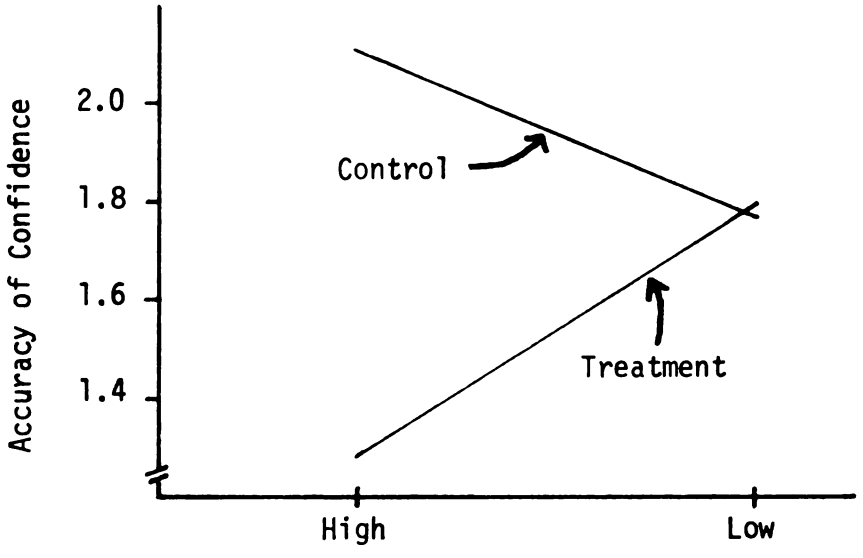


Figure 4.6

Interaction of Analogy Coaching and Ability on Accuracy of Analogy Test-Taking Confidence

Hypothesis 5. The coached group will attempt fewer items on the speeded tests.

For the coached group the mean number of items attempted on the speeded tests was 10.72, while the mean for the uncoached group was 12.13. The F ratio of 28.59 (df 1,64) indicated that this was a significant difference and the hypothesis was supported.

In addition, there were two significant interactions for the number of items attempted on speeded tests. Coaching interacted with the elapsed time until posttest (F=11.15 df 1,64) as indicated in Figure 4.7 and with the similarity of test items to the coaching material

(F=20.80 df 1,64) as is indicated in Figure 4.8. Figure 4.7 shows that on the immediate posttest the coached group attempted about two fewer items per speeded test, but that on the delayed posttest the effect had begun to diminish and the difference between the two groups was less than one item per test.

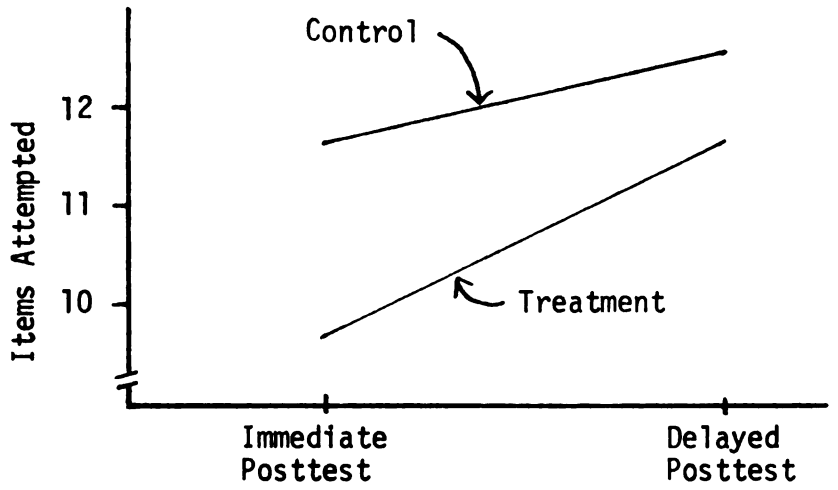


Figure 4.7

Interaction of Analogy Coaching and Time of Posttest on Number of Speeded Analogy Items Attempted

Examination of Figure 4.8 indicates that the effect of coaching on number of items attempted was greater on tests of verbal analogies than on tests of figure analogies.

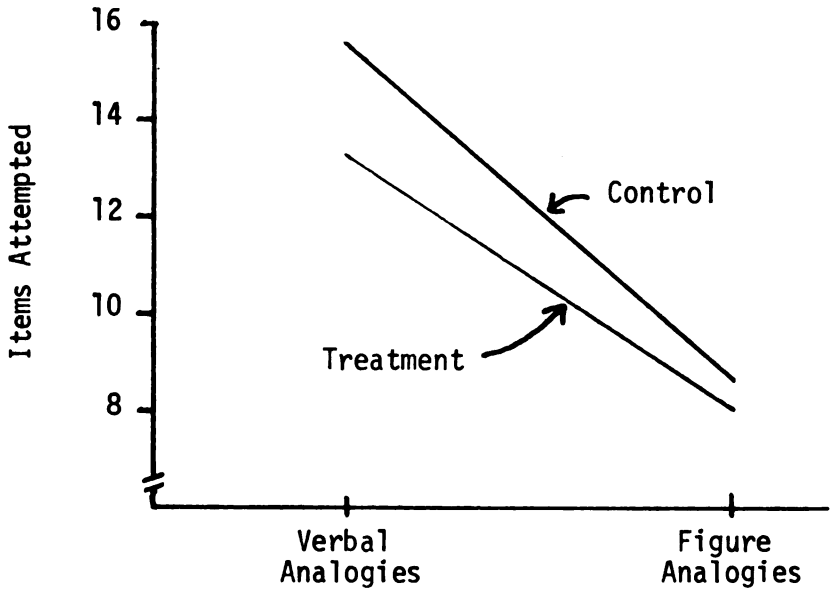


Figure 4.8

Interaction of Analogy Coaching and Item Type on Number of Speeded Analogy Items Attempted

Hypothesis 6. The coached group will spend greater time on the power tests.

The coached group spent an average of 5.56 minutes on the power tests and the control group averaged 4.16 minutes. This difference was statistically significant (F=35.70, df 1,64).

For this variable the coaching interacted with elapsed time until posttest (F=13.57 df 1,64) and also with similarity of test items to the coaching material (F=27.93 df 1,64). As is shown in Figure 4.9, the treatment group spent an average of almost two minutes more than the control group on each power test of the immediate posttest. On the delayed posttest the difference had narrowed to less than one minute per test.

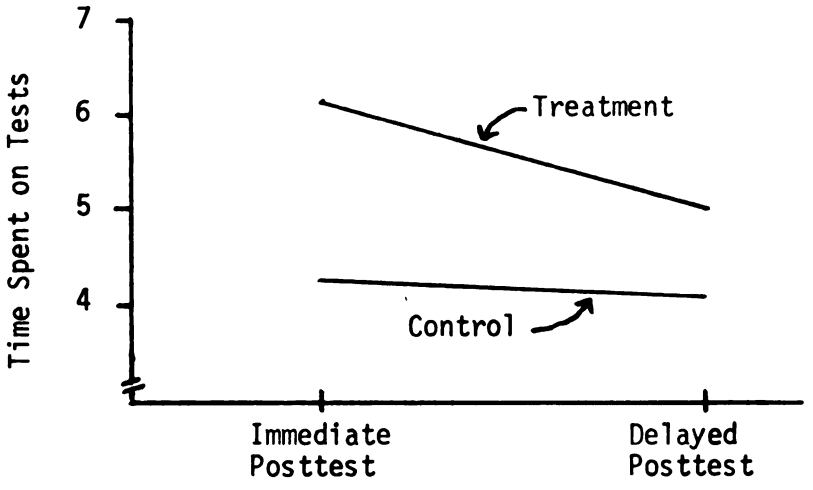


Figure 4.9

Interaction of Analogy Coaching and Time of Posttest on Time Spent on Analogy Power Tests

Figure 4.10 shows that the effect of the coaching in increasing time spent on power tests was greater on the verbal analogy tests than on the figure analogy tests.

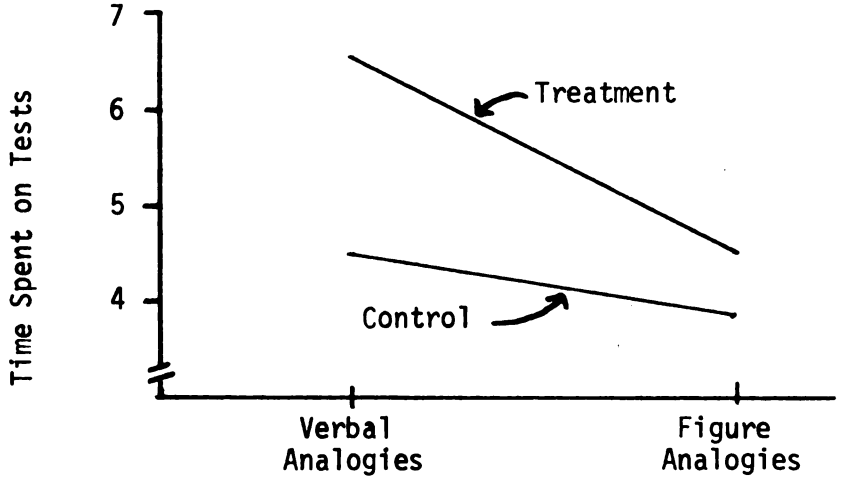


Figure 4.10

Interaction of Analogy Coaching and Item Type on Time Spent on Analogy Power Tests

Hypothesis 7. The correlations between GPA and verbal and figure analogy test scores will be higher for the group coached in verbal analogies than for the control group.

Table 4.1 shows the correlations for both groups and the direction of the differences between the correlations for all the analogy subtests and for some combinations of the subtests. In only one case, the figure analogy subtest given under power conditions in the immediate posttest, was the difference between the correlations statistically significant, and this test involved a probably spurious negative correlation for the control group. The pattern of differences in the correlations for the two groups indicates higher correlations for the coached group in two-thirds of the cases, but this pattern is not consistent enough to conclude that coaching increased the correlations between the analogy tests and GPA.

Hypothesis 8. The coached group will evaluate the coaching as being most effective for the item types similar to the coaching material and less effective for the other types of items.

The data showed that there were significant differences in the evaluations of the different item types by the analogy coaching group ($F=24.59$ df 3,96). Table 4.2 shows that the analogy coaching was related most effective for verbal analogies and least effective for series items.

No significant differences were found between high and low ability groups and males and females in their evaluations of the effectiveness of the coaching.

TABLE 4.1 Correlations between Analogy Test Scores and GPAs for the Group Coached in Verbal Analogies and the Control Group

| | Item Type | Condition | Form | Coaching Group | Control Group | Difference Direction |
|---|---|---|---|---|---|---|
| Immed. | Verbal Analogies | Power | C | .16 | .40 | - |
| | | Speed | D | .33 | .27 | + |
| Posttest | Figure Analogies | Power | E | .36 | -.16 | + * |
| | | Speed | F | .13 | .01 | + |
| Delayed | Verbal Analogies | Power | K | .24 | .27 | - |
| | | Speed | L | .33 | .24 | + |
| Posttest | Figure Analogies | Power | M | -.20 | .09 | - |
| | | Speed | N | -.04 | -.20 | + |
| All Analogies Tests | | | | .34 | .27 | + |
| All Verbal Analogies | | | | .36 | .35 | + |
| Verbal Analogies Power | | | | .24 | .39 | - |
| Verbal Analogies Speed | | | | .37 | .28 | + |
| Verbal Analogies Immediate Posttest | | | | .32 | .37 | - |
| Verbal Analogies Delayed Posttest | | | | .33 | .28 | + |

* Sig. at .05

TABLE 4.2 Mean Evaluation by the Analogy Group of the Effectiveness of their Coaching

| | Type of Item | | | |
|---|---|---|---|---|
| | Verbal Analogies | Figure Analogies | Number Series | Figure Series |
| Mean Evaluation Score | 3.4 | 2.7 | 2.4 | 2.4 |

## COACHING IN NUMBER SERIES

Hypothesis 1. The group coached in solving number series will perform better on subsequent tests as measured by total test score.

The difference in means between the coached group ($\bar{x}$=10.10) and the control group ($\bar{x}$=8.86) was found to be statistically significant (F=21.51 df 1,64). Thus, this hypothesis was accepted and it was concluded that the coaching improved scores on series tests.

Hypothesis 1a. There will be an interaction between coaching and initial ability level with the low ability level group benefiting more from coaching than the upper ability level.

The F ratio of .162 (df 1,64) was not significant. This hypothesis was not accepted and it was concluded that the coaching was equally effective for both the high and low ability groups.

Hypothesis 1b. There will be an interaction between coaching and the sex of the coached individuals.

This hypothesis was not supported by the data (F=3.08 df 1,64). It can be concluded that coaching on number series did not have a significantly different effect on males and females.

Hypothesis 1c. There will be an interaction between coaching and elapsed time until the posttest with the effects of coaching being greatest on the immediate posttest.

This hypothesis of a significant interaction was supported by the data (F=5.46 df 1,64). The interaction is presented graphically in Figure 4.11. Contrary to what was hypothesized, the effects of the coaching were greater on the delayed posttest than on the immediate posttest. Possible interpretations of this surprising finding are given in Chapter V.

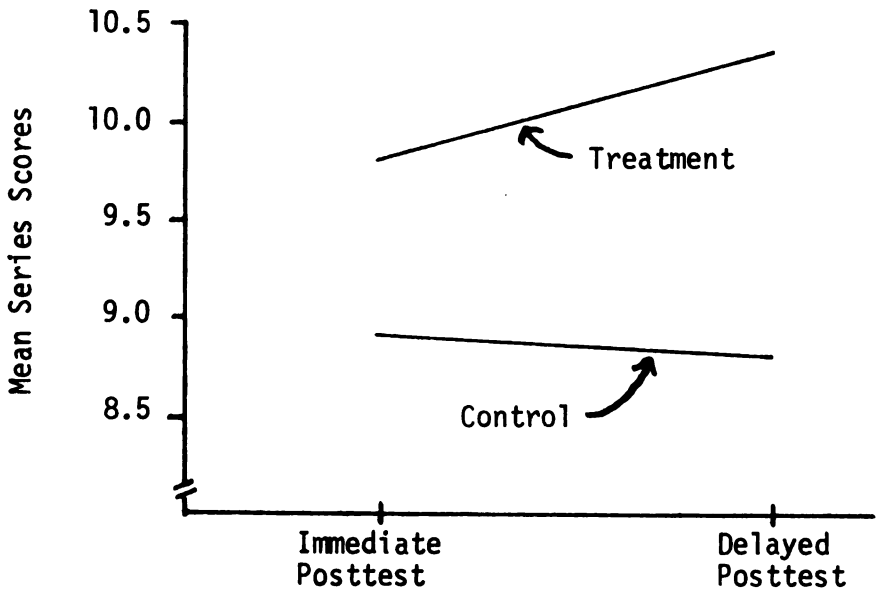


Figure 4.11

Interaction of Number Series Coaching and Time of Posttest on Mean Series Scores

Hypothesis 1d. There will be an interaction between coaching and the similarity of the test items to the coaching material with the effects of the coaching being greatest for the similar items.

The obtained F ratio of 29.37 (df 1,64) was statistically significant and the hypothesis was accepted. As is shown in Figure 4.12, the effect of the coaching on the number series items was quite strong, but

there was no difference between the groups on the figure series items.

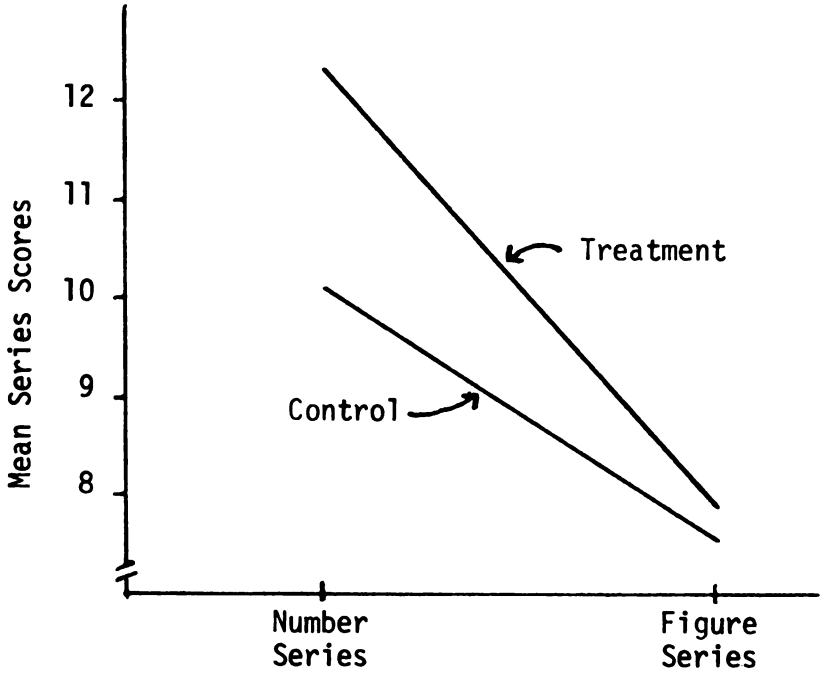


Figure 4.12

Interaction of Number Series Coaching and Item Type on Mean Series Scores

Hypothesis 1e. There will be an interaction between coaching and the degree of speededness of the tests with the coaching being most effective on the power tests.

The F ratio of .19 (df 1,64) was not significant. This hypothesis was not supported by the data and it is concluded that the coaching was equally effective for both speed and power tests.

Hypothesis 2. The group coached in solving number series will have more positive attitudes toward series items.

The means of the two groups (coached group $\bar{x}$=5.21, control group $\bar{x}$=4.94) differed only slightly and the difference was not significant (F=1.50 df 1,64). This hypothesis was not accepted.

There was a significant interaction (F=8.15 df 1,64) between coaching and sex of those being coached. This disordinal interaction is presented in Figure 4.13. Coaching produced more positive attitudes toward series items for females who received coaching and it resulted in less favorable attitudes for males.

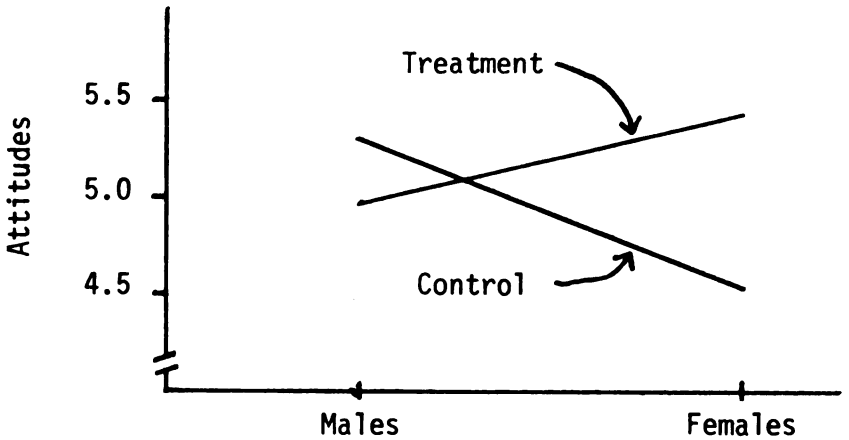


Figure 4.13

Interaction of Number Series Coaching and Sex on Attitudes toward Series Tests

Hypothesis 3. The coached group will have more test-taking confidence as measured by the number of items estimated to be correct on the series items.

The difference between the means of the coached group ($\bar{x}$=10.17) and the control group $\bar{x}$=8.94) was found to be significant (F=14.28 df 1,64). The hypothesis that coaching in number series produces greater test-taking confidence was supported by the data.

There was a significant interaction (F=4.63 df 1,64) between coaching and sex of the person coached for the variable of test-taking confidence. Figure 4.14 indicates that although coaching had little

effect on the test-taking confidence of male subjects, it did significantly increase the confidence of females.

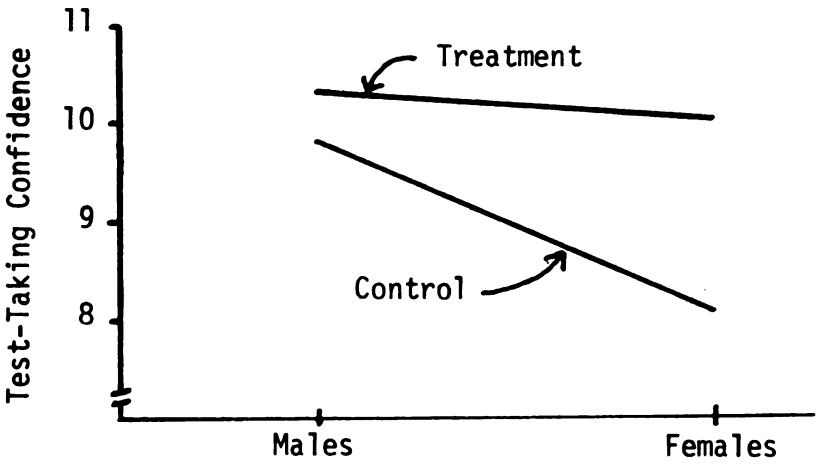


Figure 4.14

Interaction of Number Series Coaching and Sex on Series Test-Taking Confidence

Another significant interaction (F=18.67 df 1,64) for this variable is presented in Figure 4.15. Coaching had a significant effect in raising confidence on number series items but it had only a minimal effect on confidence on figure series items.

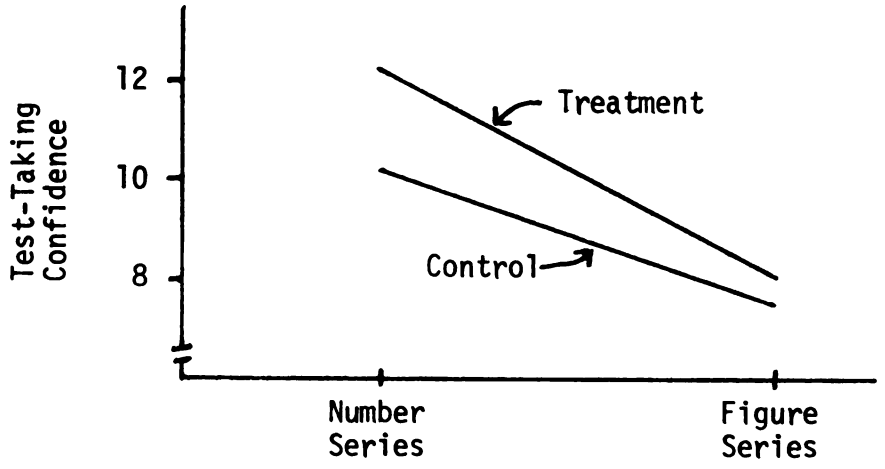


Figure 4.15

Interaction of Number Series Coaching and Item Type on Series Test-Taking Confidence

Hypothesis 4. The coached group will exhibit greater accuracy of test-taking confidence as measured by the absolute difference between the number of items estimated to be correct and the actual number of correct items.

This hypothesis was supported by the data ($F=4.66$ df 1,64). The mean of the group coached in number series was 1.00, while the uncoached group had a mean of 1.32. Since low scores indicate greater accuracy it can be concluded that coaching significantly improved accuracy of test-taking confidence.

The interaction of coaching and sex of the person being coached was also significant ($F=4.07$ df 1,64). The graphic depiction of this interaction in Figure 4.16 shows that the coaching had little effect on the accuracy of the test-taking confidence of the males, but it significantly improved the accuracy of the females.

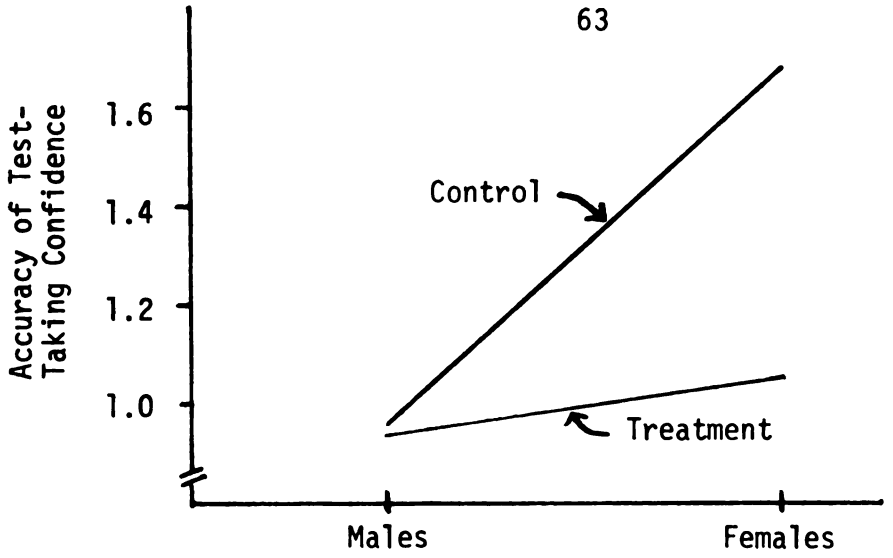


Figure 4.16

Interaction of Number Series Coaching and Sex on Accuracy of Series Test-Taking Confidence

Coaching made little change in the accuracy of test-taking confidence for figure series, but it had a strong effect on number series items. This significant interaction (F=8.50 df 1,64) is presented in Figure 4.17.

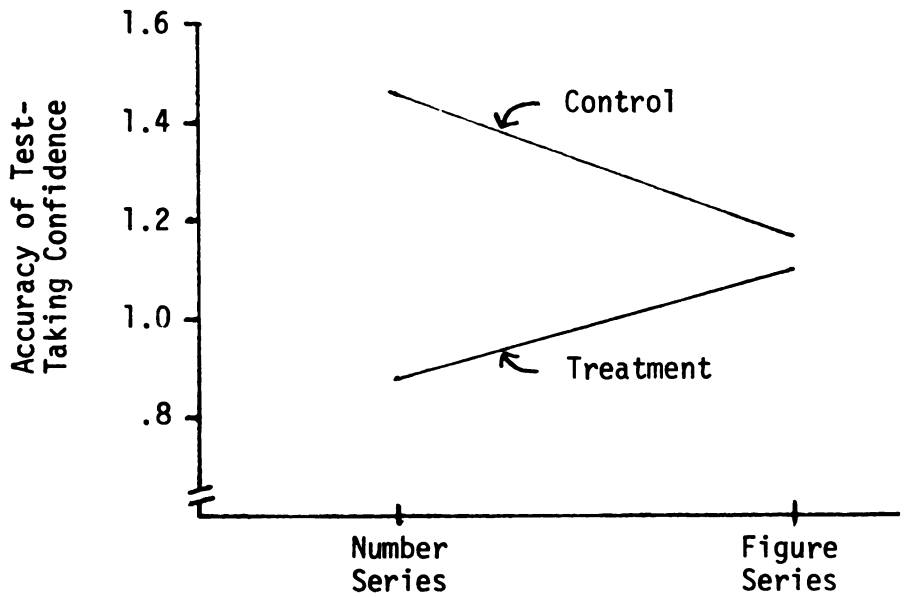


Figure 4.17

Interaction on Number Series Coaching and Item Type on Accuracy of Series Test-Taking Confidence

Hypothesis 5. The coached group will attempt fewer items on the speeded tests.

The F ratio for the test of this hypothesis was significant (F=9.00 df 1,64). However, examination of the means (coached group $\bar{x}$=10.06, control group $\bar{x}$=9.10) indicates that contrary to the hypothesis the coached group actually attempted more items than the control group. The possible explanations and implications of this unexpected finding are discussed in Chapter V.

There were two significant interactions for this variable. Figure 4.18 depicts the interaction of coaching and elapsed time until posttest (F=7.24 df 1,64). On the immediate posttest the difference between the coached and the control groups was not large, but on the delayed posttest the coached group attempted significantly more items.

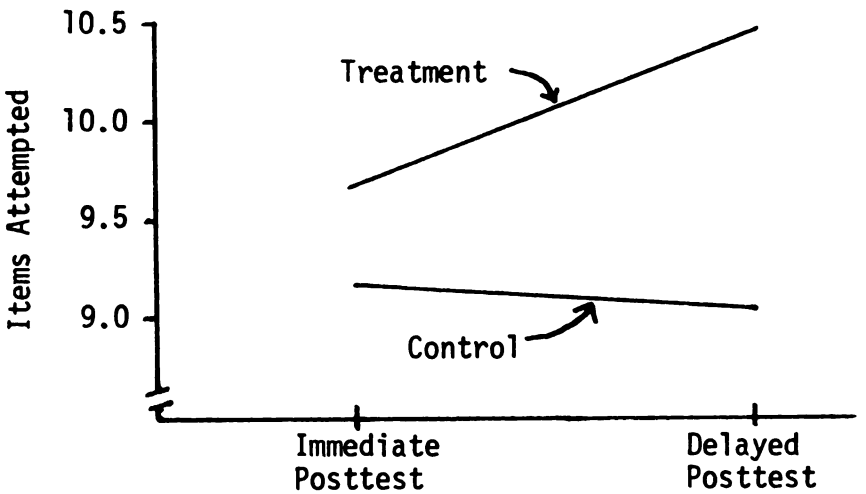


Figure 4.18

Interaction of Number Series Coaching and Time of Posttest on Number of Speeded Series Items Attempted

Figure 4.19 shows the significant interaction between coaching and type of item (F=7.40 df 1,64). The coaching produced a significant difference in the number of number series items attempted but it had little effect on the figure series.

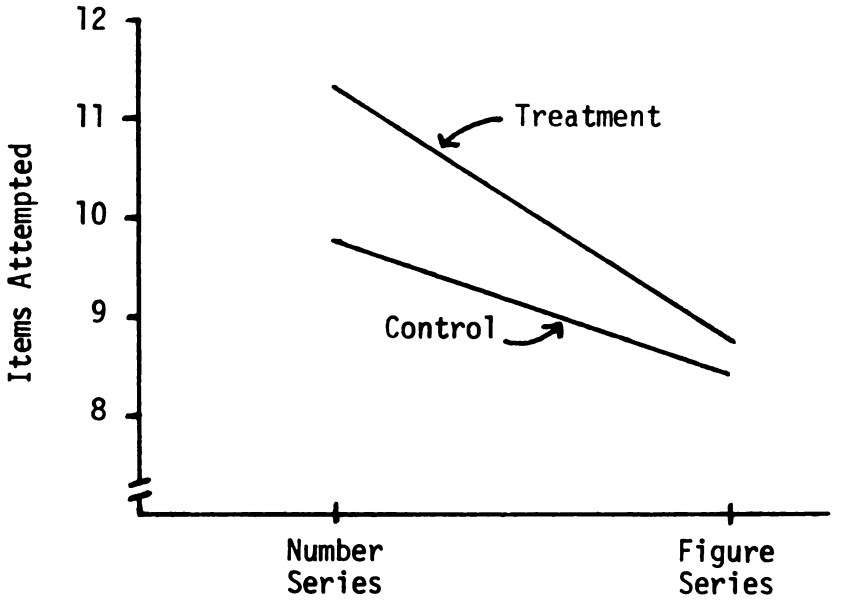


Figure 4.19

Interaction of Number Series Coaching and Item Type on Number of Speeded Items Attempted

Hypothesis 6. The coached group will spend greater time on the power tests.

The F ratio of 3.49 (df 1,64) was not significant and this hypothesis was not accepted. There was a significant interaction (F=6.76 df 1,64) between coaching and elapsed time until posttest for this variable which is presented in Figure 4.20. No differences between the treatment and control groups were manifested on the immediate post-test. On the delayed posttest the coached group spent significantly less time on the power test than did the control group.

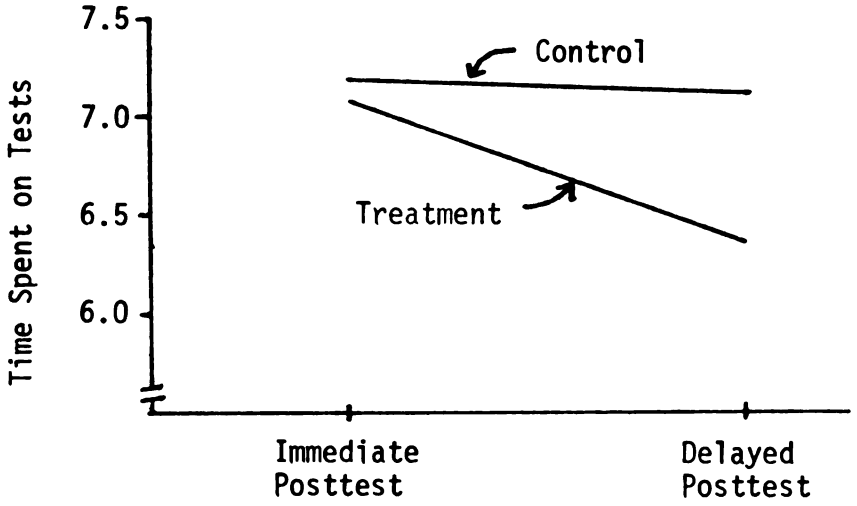


Figure 4.20

Interaction of Number Series Coaching and Time of Posttest on Time Spent on Series Power Tests

Hypothesis 7. The correlations between GPA and number and figure series test scores will be higher for the group coached in number series than for the control group.

None of the differences between the correlations for the two groups were found to be statistically significant. In Table 4.3 the correlations for both groups and the direction of the differences between the correlations are presented for all the series subtests as well as for the combinations of them. In only four cases was the correlation between GPA and test scores higher for the coached group. It is concluded that coaching in number series does not increase the correlations of series tests with GPA.

Hypothesis 8. The coached group will evaluate the coaching as being most effective for the item types similar to the coaching material and less effective for the other types of items.

The test of this hypothesis showed that there were significant differences in the number series group's evaluations of the effectiveness

TABLE 4.3 Correlations between Series Test Scores and GPAs for the Group Coached in Number Series and the Control Group

| | Item Type | Condition | Form | Coaching Group | Control Group | Difference Direction |
|---|---|---|---|---|---|---|
| Immed. Posttest | Number Series | Power | C | -.07 | .24 | - |
| | | Speed | H | .29 | .10 | + |
| | Figure Series | Power | I | .10 | .11 | - |
| | | Speed | J | -.17 | .04 | - |
| Delayed Posttest | Number Series | Power | O | .06 | .14 | - |
| | | Speed | P | .24 | .16 | + |
| | Figure Series | Power | Q | -.09 | -.02 | - |
| | | Speed | R | .14 | .38 | - |
| All Series Tests | | | | .07 | .23 | - |
| All Number Series | | | | .18 | .20 | - |
| Number Series Power | | | | -.01 | .21 | - |
| Number Series Speed | | | | .28 | .16 | + |
| Number Series Immediate Posttest | | | | .16 | .18 | - |
| Number Series Delayed Posttest | | | | .19 | .17 | + |

of the coaching for the different types of items (F=42.25 df 3,96). Table 4.4 shows that the coaching was rated most effective for number series items and least effective for verbal analogies.

TABLE 4.4 Mean Evaluations by the Series Group of the Effectiveness of Their Coaching

| | Type of Item | | | |
|---|---|---|---|---|
| | Verbal Analogies | Figure Analogies | Number Series | Figure Series |
| Mean Evaluation Score | 1.9 | 2.3 | 3.5 | 2.4 |

There were no significant differences between the high and low ability groups and between males and females with regard to evaluation of the effectiveness of the coaching.

Hypothesis 9. There will be a disordinal interaction between the types of coaching received and the evaluations of the effectiveness of the coaching for the different item types with the verbal analogies group rating the coaching most effective for analogy items and the number series group rating the coaching most effective for series items.

This hypothesis was supported. The significant interaction (F=82.43 df 3,252) is shown in Figure 4.21. No significant difference was found between the verbal analogies group and the number series group when the evaluations for all four item types were combined, but the significant interaction shows that each group rated its coaching most effective for the type of item it was coached on. No sex differences in evaluation of the coaching were found.

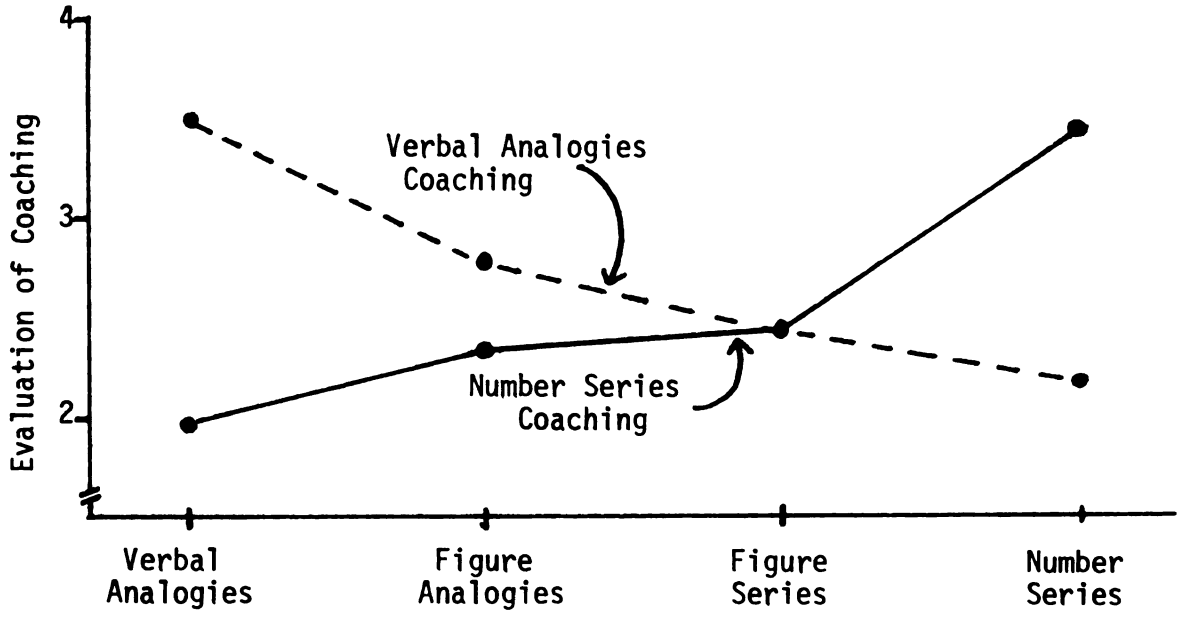


Figure 4.21

Interaction of Type of Coaching and Item Type on Evaluations of the Effectiveness of the Coaching

## SUMMARY

The tests of all the hypotheses and the significant first order interactions involving the coaching dimension are presented in Table 4.5.

### Analogy Results

In the analogy experiment coaching produced significant main effects in the hypothesized direction on accuracy of test-taking confidence, number of analogies attempted on speeded tests, and time spent on power tests. Coaching and ability interacted on accuracy of test-taking confidence. Coaching and sex interacted on number of correct analogies and on test-taking attitudes. Coaching and elapsed time until posttest interacted on number of analogies attempted on speeded tests and time spent on analogy power tests. There were interactions of coaching and

TABLE 4.5 Summary of the Significant Main Effects and Interactions on All Dependent Variables for the Analogy and Series Experiments

| Hypothesis | Dependent Variable | Effect | Analogies Experiment | Series Experiment |
|---|---|---|---|---|
| 1 | Test Score | Coaching | N.S. | Sig. |
| 1a | | Coaching by Ability | N.S. | N.S. |
| 1b | | Coaching by Sex | Sig. | N.S. |
| 1c | | Coaching by Time of Posttest | N.S. | Sig.[a] |
| 1d | | Coaching by Item Type | Sig. | Sig. |
| 1e | | Coaching by Condition | Sig. | N.S. |
| 2 | Test-Taking Attitudes | Coaching | N.S. | N.S. |
| | | Coaching by Sex | Sig. | Sig. |
| 3 | Test-Taking Confidence | Coaching | N.S. | Sig. |
| | | Coaching by Sex | N.S. | Sig. |
| | | Coaching by Item Type | N.S. | Sig. |
| | | Coaching by Condition | Sig. | N.S. |
| 4 | Accuracy of Test-Taking Confidence | Coaching | Sig. | Sig. |
| | | Coaching by Ability | Sig. | N.S. |
| | | Coaching by Sex | N.S. | Sig. |
| | | Coaching by Item Type | N.S. | Sig. |
| 5 | Number of Items Attempted on Speeded Tests | Coaching | Sig. | Sig.[a] |
| | | Coaching by Time of Posttest | Sig. | Sig. |
| | | Coaching by Item Type | Sig. | Sig. |

TABLE 4.5 (cont'd.)

| Hypothesis | Dependent Variable | Effect | Analogies Experiment | Series Experiment |
|---|---|---|---|---|
| 6 | Time Spent on Power Tests | Coaching | Sig. | N.S. |
| | | Coaching by Time of Posttest | Sig. | Sig. |
| | | Coaching by Item Type | Sig. | N.S. |
| 8 | Evaluation of Effectiveness of Coaching | Item Type | Sig. | Sig. |
| 9 | Evaluation of Effectiveness of Coaching | Coaching by Item Type | | Sig. |

Sig. = Significant at .05 level
N.S. = Not significant at .05 level
[a] These hypotheses were significant in a direction opposite to the hypothesized direction.

item type (verbal and figure analogy) on number of correct analogies, number of analogies attempted on speeded tests, and time spent on power tests. Coaching and test condition (speeded and power) interacted on number of correct analogies and analogy test-taking confidence.

Number Series Results

The number series coaching produced a significant main effect in the hypothesized direction on number of correct series items, series test-taking confidence, and accuracy of test-taking confidence. On number of series items attempted on speeded tests, coaching produced a significant main effect opposite to the hypothesized direction. Number series and sex interacted on series test-taking attitudes, series test-taking confidence and accuracy of test-taking confidence. The significant interaction between coaching and elapsed time until posttest on number of correct series items was in a direction other than hypothesized. Coaching and elapsed time until posttest also interacted on number of speeded items attempted on series tests and on time spent on series power tests. There were significant interactions of coaching and item type (number series and figure series) on number of correct series items, series test-taking confidence, accuracy of test-taking confidence, and number of series items attempted on speeded tests.

Neither verbal analogy nor number series coaching appeared to have any consistent effect on the correlations between GPA and analogy and series tests, respectively.

The subjects in each group rated the coaching they received as most effective for the items most similar to the coaching material. There were no sex and ability level effects on the evaluations of the efficacy of the coaching.

# CHAPTER V

# SUMMARY AND CONCLUSIONS

Currently there is some interest among psychometricians in the effects of coaching in test-taking skills to improve test scores. This interest has been generated in a number of ways. Increased concern for disadvantaged persons who may lack test-taking skills has led some to question the validity of tests for these individuals. Performance contracting by public schools has contributed to the interest in coaching to improve test scores. The controversy over the hereditability of intelligence has resulted in discussions of the influence of special training or coaching upon aptitude test scores.

## PURPOSE

This study was conducted to systematically investigate the effects of coaching to improve scores on two item types commonly used in reasoning tests, namely, verbal analogies and number series. The coaching was evaluated with respect to its effect on number of items solved correctly, the speed of solution, the testee's attitude toward the items, his test-taking confidence, the accuracy of this confidence, and the testee's own subjective evaluation of the coaching. The effects of the coaching on items dissimilar to the coaching material and the effects of the coaching over time were investigated. Also examined were the influences of initial ability level and sex of the person being coached upon the effectiveness of the coaching. The influence of coaching on test validity was also investigated.

## LITERATURE REVIEW

The review of the coaching studies in the literature indicated the general consensus that coaching is most effective when the coaching material is very similar to the test and becomes less effective as the coaching material and test become less similar. It is also generally agreed that the effects of coaching tend to diminish with the passage of time. There have been mixed findings on the relationship of sex and entering ability level to the effectiveness of coaching. Some investigators find females benefit most from coaching while others reach the opposite conclusion. Some reports indicate coaching is most beneficial for low ability persons, others say those of high ability benefit most, and still others find that coaching benefits all ability levels equally. There is little current data in this country on the effects of coaching on test validity.

## DESIGN

Eighty-eight college freshmen were randomly assigned to one of two treatment groups. One group received coaching in verbal analogy solution techniques; the other was coached in solving number series problems. There were actually two experiments with each group serving as the control group for the other. The design for each study included the factors of sex and ability level based on pretest scores. At the time of the pretest the subjects had already been randomly assigned to one of the two major groups. Assignment to high and low ability level was based on the grand median of all subjects of both sexes in both groups with scores at the grand median equally split between the high

and low ability level within each sex in each treatment group. The post hoc blocking procedure resulted in unequal cell sizes so subjects were randomly eliminated to obtain a balanced design. This procedure was followed in both studies, using verbal analogy pretest scores in one case and number series pretest scores in the other, and in each case the final outcome was nine subjects per cell for a total of 72 subjects. The 72 subjects were not the same in each study although there was a considerable overlap.

The series of dependent measures varied on three factors: time of posttest (immediate and delayed), type of item (similar and dissimilar to the coaching material), and testing condition (speeded and power). The three design factors and the three measures factors were all completely crossed. With two levels for each of the three measures factors, there was a total of eight repeated measures or subtests for each study.

Each of the subtests yielded four dependent variables: total score as measured by the number of correct items; test-taking attitude as measured by reaction to solving the items of the subtest; confidence as measured by the number of items estimated to be correct on the subtest; and accuracy of test-taking confidence as measured by the absolute difference between number estimated to be correct and actual number correct. In addition, speed of item solution was measured in two ways: by the number of items attempted on the subtests given under speeded conditions, and by the amount of time spent on the subtests given under power conditions. A final dependent variable was each subject's evaluation of the effectiveness of the coaching in helping to solve each of the four item types.

# RESULTS

The data from the two experiments can be summarized as follows:

1. The group coached in number series solution techniques had a significantly higher mean score on all series items than the control group. The group coached in verbal analogies had a higher mean score on all analogies than the control group. This difference was not statistically significant. However, the F ratio was only .03 below the F required for significance.

2. Coaching on verbal analogies interacted with sex, item type, and test condition in the hypothesized direction on total mean analogy scores. Coaching in number series interacted with item type in the hypothesized direction on total series scores. It interacted with time of posttest in an unhypothesized direction.

3. In both studies coaching interacted with sex on test-taking attitudes. Verbal analogy coaching increased the attitudes of males toward analogy tests, while number series coaching improved the attitudes of females toward series tests.

4. In the verbal analogies study, coaching increased confidence on analogy power tests but decreased confidence on the speeded tests. In the number series study coaching increased confidence on all series tests. It also interacted with sex and item type, resulting in greater confidence for females and greater confidence on number series problems.

5. In both studies coaching improved accuracy of test-taking confidence. In addition, coaching interacted with ability in the analogy study resulting in greater accuracy for the high ability group. In the number series study coaching interacted with sex and item type, producing greater accuracy for females and on number series items.

6. Verbal analogy coaching increased analogy item solution time as measured both by number of items attempted on speeded tests and time spent on power tests. Significant interactions indicated this effect was strongest on the first posttest and for verbal analogies. Number series coaching decreased the time spent in solving series items as measured by the number of items attempted on speeded tests. This effect, which is the opposite of that hypothesized, was strongest on the delayed posttest and on number series items. Number series coaching also interacted with elapsed time until posttest on amount of time spent on series power tests.

7. The verbal analogy coaching group rated their coaching as most effective for verbal analogies while the number series group evaluated their coaching as most effective for number series problems.

## DISCUSSION

In spite of the significant differences found between the two groups in both studies, the results did not provide clearcut evidence that coaching can substantially raise scores on standardized aptitude tests. There was only an average of one point difference between the treatment and control groups on each 16 item verbal analogy test. Even on the tests given under power conditions where the coaching had its strongest effect the difference was only 1.6 points. Number series coaching produced somewhat greater results. The mean difference between the treatment and control group on all number series tests was over two points per 16 item test. On the second posttest, where the treatment effect was greatest the difference between the two groups was almost three points.

Recognizing that the verbal analogy tests were composed of items not containing difficult vocabulary, and thus apt to be more susceptible to coaching, one might conclude that coaching produced statistically significant but not educationally significant results in the case of verbal analogies. However, there are some arguments on the other side. In the first place, the subjects were college freshmen who had all taken the Scholastic Aptitude Tests which contain verbal analogies, and probably most of them had encountered verbal analogies on other aptitude tests. Conceivably some of the subjects might have actually been previously instructed in how to take verbal analogy tests. At any rate, none of them could be described as naive in solving verbal analogies. A second factor to be considered in evaluating the coaching is the probable warm-up effects of the pretest. The mean of all subjects on the verbal analogy pretest was 9.2 while the mean of the control group on the immediate verbal analogy subtests of the posttest was almost two points higher. A third consideration is that the test results were of no consequence to the subjects. More highly motivated subjects might have benefited more from the coaching. Finally, there is the question of whether the number series coaching may have improved performance on verbal analogies. While it seems unlikely that this happened it is true that the basic rule, "determine the relationship and apply it," is the same for both item types. The factors of previous verbal analogy experience, pretest warm-up, lack of motivation and coaching transfer effects may have combined to vitiate the verbal analogy coaching.

The greater effectiveness of the number series coaching was probably due in part to the fact that the subjects were less familiar with this item type. However, the number series pretest seemed to

familiarize all subjects with number series items. On the pretest the mean score for all subjects was 9.5, while the control group scored 1.3 points higher on the immediate posttests. On the delayed number series posttest, the control group dropped .6 points but the treatment group gained almost a full point in direct contrast to the hypothesis that the effects of the coaching would be greatest on the immediate posttest. The decrease in the control group means is easily explainable by the loss of the warm-up effect after a week. The only plausible explanation for the increase in the scores of the treatment group is that the treatment effects persisted strongly during the week and the delayed posttests by chance happened to contain less difficult items. It doesn't seem likely that the treatment effects would increase after a week's time.

The effects of both verbal analogy and number series coaching were not as great as was expected. However, the fact that about an hour's coaching did produce a significant increase in scores despite the test sophistication of the subjects and the other factors mentioned above suggests that coaching might have a more powerful effect in other circumstances.

The lack of a significant interaction between coaching and ability level on total scores in both experiments could lead to the conclusion that coaching is equally effective for all ability levels. A more plausible explanation is that the subjects were selected from a rather homogeneous population and that persons in the "low ability" group were in reality persons of not quite so high ability. A true test of the effects of coaching on different ability levels would require a more heterogeneous population.

The finding in both studies that coaching was most effective for items similar to the coaching material was not unexpected in view of the results of previous studies.

The most discrepant results of the two studies dealt with speed of item solution. Verbal analogy coaching increased the amount of time spent solving each analogy item; number series coaching seemed to produce the opposite effect for series items. These divergent effects of coaching on the two types of items can be explained by analyzing the reasoning process used to solve each item. As Willner (1964) pointed out, many people employ mere association to solve verbal analogies. They read all the alternatives and pick the one that sounds best. This is a fast way to get an answer. The teaching of rules that aid the individual in developing and maintaining a complex set results in his taking longer to solve the analogy as well as his getting more correct answers. On the other hand, it is unlikely that people use associations to solve number series problems. Unlike analogies, in a number series problem it is obvious when the correct answer is found. People tend to persevere at a number series problem for longer periods of time without guessing. Therefore any coaching that helped determine the correct answer would likely increase rather than decrease the speed of solution for number series items.

Coaching interacted with sex to produce differential effects on test-taking attitudes for both males and females in both studies. In the analogy coaching study the coached males and the uncoached females had the most positive attitudes. In the number series study the effect was reversed. The uncoached males and the coached females had the most positive attitudes. It is well known that there are sex differences on

aptitude tests (cf. Anastasi, 1958). Females usually excel on verbal tasks while males are generally superior on numerical problems. It could be argued that attitudes parallel performance and that therefore females prefer verbal activities while males are partial to numerical tasks. Coaching seems to have reversed this general rule in each case.

For the most part the effects of the coaching on test-taking confidence tended to parallel the effects on total test scores. This result was not surprising considering that test-taking confidence was measured by the number of items estimated to be correct. As the number of items answered correctly was increased by the coaching, the number estimated correct could also be expected to increase.

In each study, coaching increased the accuracy of test-taking confidence. This means that coaching made the subjects more aware of whether they were getting the correct answer. The improvement in accuracy of test-taking confidence implies that there was less guessing, although this was not tested directly in either study.

The effects of coaching on the validity of the analogy and series tests as measured by their correlations with GPAs were neither strong nor consistent. However, there is just enough of a hint in the data that coaching increased validity on speeded tests and decreased it on power tests to warrant further study of this effect.

In summary, it can be concluded that coaching is by no means a dead issue. Further study of the effects of coaching in specific item solution techniques could provide useful insights into the reasoning processes used in solving various types of items. In addition, it is felt that the variables of test-taking attitudes, confidence, and

accuracy of confidence as used in this study could prove to be valuable constructs in future investigations of the effects of coaching on test-taking skills.

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# APPENDICES

# Appendix A: Instrument

**ANALOGIES EXAMPLES**

In the following test a pair of words that are related in some way is presented. Your task is to check the answer that expresses a similar relation among a second pair of words.

Here is a completed example:

A) BIG : LITTLE :: LARGE :
___late
___huge
_✓_small
___man

"Small" is checked because the relationship of "big" to "little" is the same as the relationship of "large" to "small".

Now try these examples:

B) FIRE : HOT ::
___book : green
___table : chair
___ice : cold

C) DRINK : MILK :: EAT :
___hungry
___bread
___fast

You should have checked "ice : cold" for example B and "bread" for example C.

When the signal is given, turn the page, read the directions, and begin.

FORM A

Check the correct answer for each item, working as quickly as you can.
Do not spend too long on any one item.
If you are not sure of the answer, make your best guess.

1. SLED : RUNNERS ::
   ___cart : wheels
   ___snowshoe : skates
   ___bicycle : pedals
   ___ski : poles

2. SECRET : CONCEAL :: INFORMATION :
   ___invent
   ___acknowledge
   ___transpire
   ___disclose
   ___concede

3. ICE : WATER :: WATER :
   ___freeze
   ___liquid
   ___land
   ___thirst
   ___steam

4. CAMPAIGN : OBJECTIVE ::
   ___motivation : goal
   ___talent : success
   ___victory : triumph
   ___mislead : consequence
   ___voyage : destination

5. PACIFIST : WAR ::
   ___moralist : virtue
   ___prohibitionist : alcohol
   ___nutritionist : health
   ___anarchist : terror

6. WANDER : TRESPASS ::
   ___eat : gorge
   ___recline : sprawl
   ___mar : destroy
   ___narrate : perjure
   ___glance : examine

7. COLLEAGUE : PROFESSION ::
   ___laborer : union
   ___patient : hospital
   ___compatriot : country
   ___accomplice : crime

8. STRAP : PARTS :: STINK :
   ___knits
   ___pants
   ___points
   ___knees

9. RECEIVER : TELEPHONE :: ARC :
   ___point
   ___cube
   ___dot
   ___curve
   ___circle

10. SORROW : MISFORTUNE :: JOY :
    ___grief
    ___success
    ___happiness
    ___hatred
    ___pride

11. ISLAND : WATER ::
    ___sand : desert
    ___mountain : ocean
    ___city : meadows
    ___lake : land
    ___river : banks

12. VISION : FOG ::
    ___touch : darkness
    ___reason : prejudice
    ___distance : proximity
    ___hearing : comprehension

13. SURPRISE : UNEXPECTED ::
    ___antique : old
    ___service : free
    ___rarity : valuable
    ___guest : uninvited
    ___event : anticipated

14. SCALE : SUMMIT ::
    ___rise : fall
    ___try : overcome
    ___side : edge
    ___climb : top
    ___measure : guess

15. IMPASSIVE : EMOTION ::
    ___fatigued : sleep
    ___ambiguous : meaning
    ___neuter : gender
    ___impartial : prejudice
    ___ambivalent : decision

16. REPETITION : MONOTONY ::
    ___familiarity : recognition
    ___interest : boredom
    ___dissipation : depravity
    ___attempt : achievement
    ___callowness : inexperience

Write the number that is on the board when you finish all the items on this page. _____

How many items on this page do you think you answered correctly? _____

How did you feel about answering the items on this page? (check one)

| Liked Very Much | Liked To Some Extent | Liked A Little | Neutral | Disliked A Little | Disliked To Some Extent | Disliked Very Much |
|---|---|---|---|---|---|---|

DO NOT TURN PAGE UNTIL TOLD TO DO SO

## NUMBER SERIES EXAMPLES

In the following test a series of numbers is presented followed by a question mark. Your task is to circle the number among the choices at the right that should come next in the series.

Here is a completed example:

A) 1 2 3 4 ? 2 3 (5) 7

The number 5 is circled because in the series in example A, 5 logically follows after 1 2 3 4.

In some of the items, the series will be followed by two question marks and the answers will be pairs of numbers. This means that your task is to circle the pair of numbers that should come next in the series.

Now try these examples:

B) 2 4 6 8 10 ? ? 12 13 11 12 12 14

C) 9 8 7 6 5 ? 3 4 5 6

In example B, you should have circled the pair 12 14. The two question marks indicate that you must circle a pair of numbers, and 12 14 logically follow in the series.

In example C, you should have circled the number 4 since it follows in the series.

When the signal is given, turn the page, read the directions, and begin.

FORM B

Circle the correct answer for each item, working as quickly as you can.
Do not spend too long on any one item.
If you are not sure of the answer, make your best guess.

1) 5 7 10 14 19 ? 24 25 26 27 28

2) 2 8 13 17 20 ? 22 23 24 25 26

3) 9.5 9.7 9.4 9.8 9.3 9.9 ? 10 9.5 9.2 10.1 9.3

4) 3 18 6 36 12 ? ? 72 9 72 26 72 36 72 24 72 432

5) 1 1 2 2 4 4 8 8 ? 8 9 10 12 16

6) 7 4 6 11 8 10 ? 5 13 15 10 12

7) 4 2 10 8 40 38 190 ? 93 95 188 192 950

8) 3 4 7 12 19 28 ? 35 36 37 38 39

9) 11 16 22 27 33 38 ? ? 44 49 44 50 43 48 45 50 42 47

10) 1529 1478 1427 1376 1325 ? 1274 1275 1254 1225 1224

11) 0 3 8 15 24 35 ? 40 42 44 46 48

12) 5 17 6 17 8 18 11 20 ? 14 15 16 22 23

13) 3 9 12 36 39 117 ? ? 120 360 120 234 234 236 351 354 121 363

14) 1512 378 126 ? 42 252 62 63 96

15) 1 3 7 15 31 ? 47 53 57 61 63

16) 62 37 52 47 40 59 26 73 ? 8 10 20 85 89

Write the number that is on the board when you finish all the items on this page. _____

How many items on this page do you think you answered correctly? _____

How did you feel about answering the items on this page? (check one)

| Liked Very Much | Liked To Some Extent | Liked A Little | Neutral | Disliked A Little | Disliked To Some Extent | Disliked Very Much |
|---|---|---|---|---|---|---|

DO NOT TURN PAGE UNTIL TOLD TO DO SO

FORM C

Check the correct answer for each item.

You should have enough time to attempt every item, but do not spend too long on any one.

If you are not sure of the answer, make your best guess.

1. BEE : SWARM ::
   ___hive : honey
   ___mammal : herd
   ___sheep : flock
   ___bird : nest

2. FEDERAL : CONGRESS :: STATE :
   ___house
   ___senate
   ___representatives
   ___constitution
   ___legislature

3. SLEEP : PEEL :: SPOOL
   ___thread
   ___needle
   ___loop
   ___orange

4. JANUARY : FEBRUARY ::
   ___month : year
   ___calendar : season
   ___cold : mild
   ___June : summer
   ___two : three

5. SPY : OBSERVE ::
   ___wander : travel
   ___eavesdrop : listen
   ___laugh : play
   ___consider : decide
   ___ask : investigate

6. GLIDER : AIRPLANE ::
   ___hawk : eagle
   ___discuss : hurdle
   ___raft : steamship
   ___draft : hurricane

7. TORCH : LIBERTY ::
   ___tray : waiter
   ___scales : justice
   ___candle : poverty
   ___bars : punishment
   ___lever : power

8. HARVEST : NOURISHMENT ::
   ___energy : life
   ___fabric : clothing
   ___water : thirst
   ___wheel : motion

9. PERSON : CROWD :: FISH :
   ___city
   ___class
   ___farmer
   ___school
   ___sailor

10. MISTAKE : REGRET ::
    ___illness : medicine
    ___youth : fun
    ___fire : danger
    ___success : satisfaction
    ___sin : absolution

11. HEREDITY : MUTATION ::
    ___authority : leadership
    ___tradition : innovation
    ___religion : heresy
    ___obstinacy : persuasion
    ___surprise : exclamation

12. SEAM : GARMENT ::
    ___margin : book
    ___hem : fabric
    ___corner : street
    ___joint : pipe

13. WATER : RESERVOIR ::
    ___village : city
    ___merchandise : warehouse
    ___book : chapter
    ___bird : tree
    ___house : hotel

14. DIAMOND : JEWEL :: GOLD :
    ___ring
    ___silver
    ___element
    ___mine
    ___plentiful

15. RAZE : LEVELED ::
    ___fade : dead
    ___gag : silenced
    ___lose : hidden
    ___vacate : absent
    ___boil : evaporated

16. SNUB : CONTEMPT ::
    ___praise : understanding
    ___applause : approval
    ___injury : retaliation
    ___scorn : superiority
    ___grimace : amusement

Write the number that is on the board when you finish all the items on this page. ____

How many items on this page do you think you answered correctly? ____

How did you feel about answering the items on this page? (check one)

| Liked Very Much | Liked To Some Extent | Liked A Little | Neutral | Disliked A Little | Disliked To Some Extent | Disliked Very Much |
|---|---|---|---|---|---|---|

DO NOT TURN PAGE UNTIL TOLD TO DO SO

FORM D

Check the correct answer for each item.

Work as quickly as you can - you may not have time to complete all the items.

If you are not sure of an item, make your best guess.

1. PRESIDENT : CABINET ::
   ___king : nation
   ___general : staff
   ___major : company
   ___executive : aristocracy

2. AUTOMOBILE : MANUFACTURE :: HOME :
   ___rent
   ___buy
   ___build
   ___mortgage
   ___own

3. SNAKE : HISS :: SAW :
   ___whine
   ___hammer
   ___cut
   ___board
   ___blade

4. TREE : FOREST ::
   ___flower : plant
   ___chair : room
   ___cloth : fiber
   ___voice : chorus
   ___mistake : life

5. LAUGHTER : MIRTH ::
   ___applause : praise
   ___hunger : pain
   ___avarice : shame
   ___respect : concern

6. KNIFE : INCISION ::
   ___bulldozer : excavation
   ___tool : operation
   ___pencil : calculation
   ___hose : irrigation
   ___plow : agriculture

7. CENTAUR : HORSE ::
   ___unicorn : zebra
   ___dragon : serpent
   ___mermaid : fish
   ___cupid : child

8. DEODORIZE : ODOR :: DEHYDRATE ::
   ___air
   ___fire
   ___hydrate
   ___sight
   ___water

9. SUNDIAL : CLOCK :: CATAPULT :
   ___rock
   ___army
   ___cannon
   ___bow
   ___slingshot

10. ODOR : DOOR :: EVER :
    ___always
    ___veer
    ___window
    ___never

11. ERASER : MARK ::
    ___calendar : time
    ___memory : debt
    ___tongue : saliva
    ___time : grief
    ___attack : offense

12. SIEVE : STRAIN ::
    ___mortar : grind
    ___butter : churn
    ___pulley : revolve
    ___wedge : pound

13. DIMINUTIVE : SIZE ::
    ___scarce : value
    ___internal : time
    ___simple : problem
    ___conservative : belief
    ___trivial : importance

14. WEEK : SEVEN :: SCORE :
    ___count
    ___fourteen
    ___goal
    ___grade
    ___twenty

15. FAMINE : FOOD ::
    ___anemia : health
    ___rain : umbrella
    ___drought : water
    ___disease : sanitation
    ___crime : punishment

16. RUT : VEHICLE ::
    ___habit : personality
    ___obstacle : path
    ___victim : crime
    ___current : river
    ___fate : opportunity

How many items on this page do you think you answered correctly? _____

How did you feel about answering the items on this page? (check one)

| Liked Very Much | Liked To Some Extent | Liked A Little | Neutral | Disliked A Little | Disliked To Some Extent | Disliked Very Much |
|---|---|---|---|---|---|---|

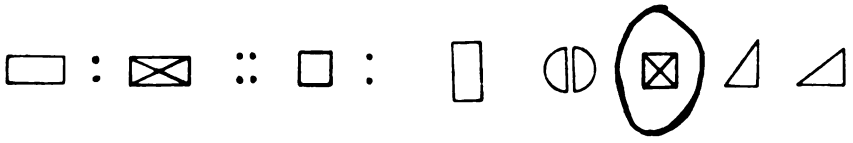
DO NOT TURN PAGE UNTIL TOLD TO DO SO

## FIGURE ANALOGIES EXAMPLES

In the following test a pair of figures that are related in some way is presented, followed by a third figure. Your task is to circle the figure in the choices at the right that goes with the third figure in the same way that the second figure goes with the first.

Here is a completed example:

A)



The square with the X is circled because it goes with the blank square in the same way that the rectangle with the X goes with the blank rectangle.

Now try the following example:

B)

You should have circled the smaller square.

When the signal is given, turn the page, read the directions and begin.

FORM E

Circle the correct answer for each item. You should have enough time to attempt every item, but don't spend too long on any one. If you are not sure of the answer, make your best guess.

1. 

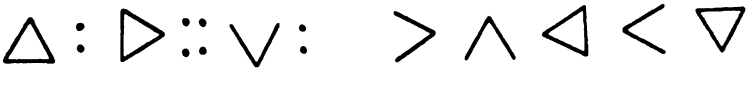
2. 

3. 

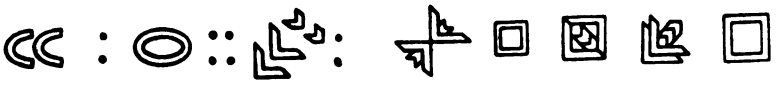
4. 

5. 

6. 

7. 

8. 

9. 

10. 

Write the number that is on the board when you finish all the items on this page. _____

How many items on this page do you think you answered correctly? _____

How did you feel about answering the items on this page? (check one)

| Liked Very Much | Liked To Some Extent | Liked A Little | Neutral | Disliked A Little | Disliked To Some Extent | Disliked Very Much |
|---|---|---|---|---|---|---|

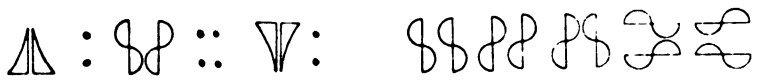
DO NOT TURN PAGE UNTIL TOLD TO DO SO!

FORM F

Circle the correct answer for each item. Work as quickly as you can - you may not have time to complete all the items. If you are not sure of an item, make your best guess.

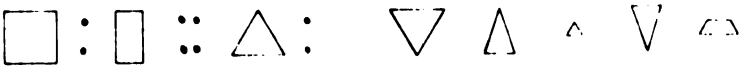
1. 

2. 

3. 

4. 

5. 

6. 

7. 

8. 

9. 

10. 

How many items on this page do you think you answered correctly? _____

How did you feel about answering the items on this page? (check one)

| Liked Very Much | Liked To Some Extent | Liked A Little | Neutral | Disliked A Little | Disliked To Some Extent | Disliked Very Much |
|---|---|---|---|---|---|---|

DO NOT TURN PAGE UNTIL TOLD TO DO SO!

FORM G

Circle the correct answer for each item.
You should have enough time to attempt every item, but do not spend too long on any one.
If you are not sure of the answer, make your best guess.

1) 1 3 7 13 21 ? 29 31 33 35 37

2) 1 5 8 10 11 ? 10 11 12 13 14

3) 25 24 22 21 19 18 ? ? 15 14 20 23 17 16 16 13 16 15

4) 9 10 5 6 3 4 ? ? 3 5 1 2 2 3 8 9 5 2

5) 2 5 3 6 ? 1 8 7 4 9

6) 1 7 19 43 ? 91 86 62 89 96

7) 36 35 32 27 26 23 18 13 14 15 16 17

8) 64 32 16 8 4 ? 0 1 2 3 4

9) 4 8 10 20 22 44 ? ? 88 90 88 176 46 58 46 92 24 48

10) 88 76 74 62 60 48 ? 36 50 52 98 46

11) 42 38 35 34 30 27 26 ? 22 23 24 25 26

12) 4 4 5 5 7 7 10 10 ? 11 12 13 14 15

13) 16 4 1 6 24 6 3 8 32 ? ? 8 13 8 4 8 5 29 34 8 2

14) 1 3 6 4 6 12 10 ? ? 12 6 12 15 12 24 12 14 20 18

15) 81 27 9 3 ? ? 1 0 1 3 1 $\frac{1}{3}$ 0 0 3 1

16) 25 25 22 23 19 21 ? 16 17 21 22 24

Write the number that is on the board when you finish all the items on this page. _____

How many items on this page do you think you answered correctly? _____

How did you feel about answering the items on this page? (check one)

| Liked Very Much | Liked To Some Extent | Liked A Little | Neutral | Disliked A Little | Disliked To Some Extent | Disliked Very Much |
|---|---|---|---|---|---|---|

DO NOT TURN THE PAGE UNTIL TOLD TO DO SO

FORM H

Circle the correct answer for each item.
Work as quickly as you can - you may not have time to complete all the items.
If you are not sure of an item, make your best guess.

1) 23 20 17 14 11 8 ? 3 5 6 7 9

2) 1024 512 256 128 64 ? 16 24 32 40 48

3) 21 18 16 15 12 10 ? ? 7 5 9 6 7 6 8 5 11 9

4) 19 16 14 11 9 6 ? ? 3 0 3 1 4 1 8 11 5 2

5) 0 1 3 6 10 15 21 28 ? 32 35 36 42 54

6) 2 4 12 48 240 ? 480 720 960 1200 1440

7) 2 8 5 20 17 68 65 ? 61 62 65 195 260

8) 112 56 28 14 7 ? 0 1 $1\frac{1}{2}$ $2\frac{1}{2}$ $3\frac{1}{2}$

9) 2 5 10 13 26 ? ? 29 58 28 56 29 32 39 28 39 53

10) 20 18 24 8 6 12 4 ? ? 2 8 6 12 2 4 8 16 2 6

11) 40 6 32 8 24 10 ? 12 14 16 18 20

12) 54 81 18 27 6 9 ? 2 3 4 12 15

13) 1 5 2 3 15 12 13 ? 14 10 60 65 45

14) 12 14 13 15 14 16 ? ? 17 19 15 17 18 17 17 18 15 16

15) 6 3 4 16 8 5 6 24 12 ? ? 9 10 15 16 9 36 13 52 6 7

16) 40 39 41 37 45 29 ? -3 13 45 53 61

How many items on this page do you think you answered correctly? _____

How did you feel about answering the items on this page? (check one)

| Liked Very Much | Liked To Some Extent | Liked A Little | Neutral | Disliked A Little | Disliked To Some Extent | Disliked Very Much |
|---|---|---|---|---|---|---|

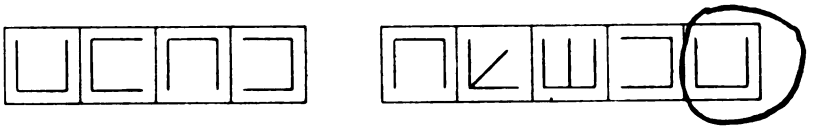
DO NOT TURN PAGE UNTIL TOLD TO DO SO

## FIGURE SERIES EXAMPLES

In the following test a series of figures is presented. Your task is to circle the figure at the right that should come next in the series.

Here is a completed example:

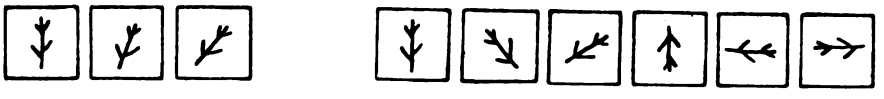
A)



The last figure is circled because it logically follows the series of figures presented at the left.

Now try these examples:

B)



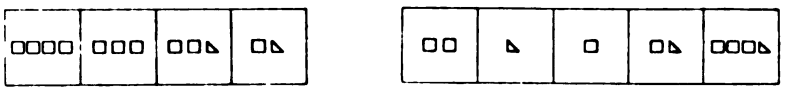
C)

For example B you should have circled the third figure, and for example C you should have circled the last figure.

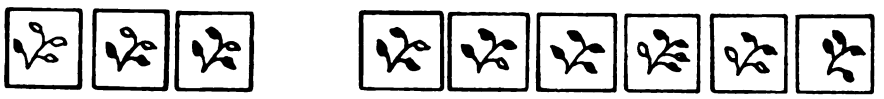
When the signal is given, turn the page, read the directions, and begin.

FORM I

Circle the correct answer for each item. You should have enough time to attempt every item, but don't spend too long on any one. If you are not sure of the answer, make your best guess.

1. 

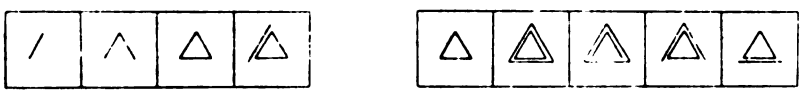
2. 

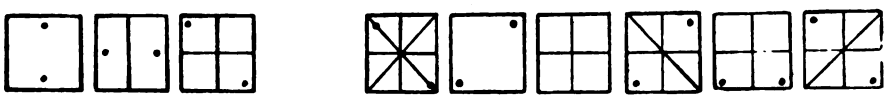
3. 

4. 

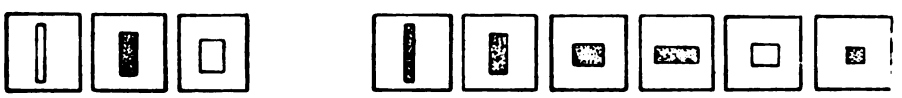
5. 

6. 

7. 

8. 

9. 

10. 

Write the number that is on the board when you finish all the items on this page _____.

How many items on this page do you think you answered correctly? _____

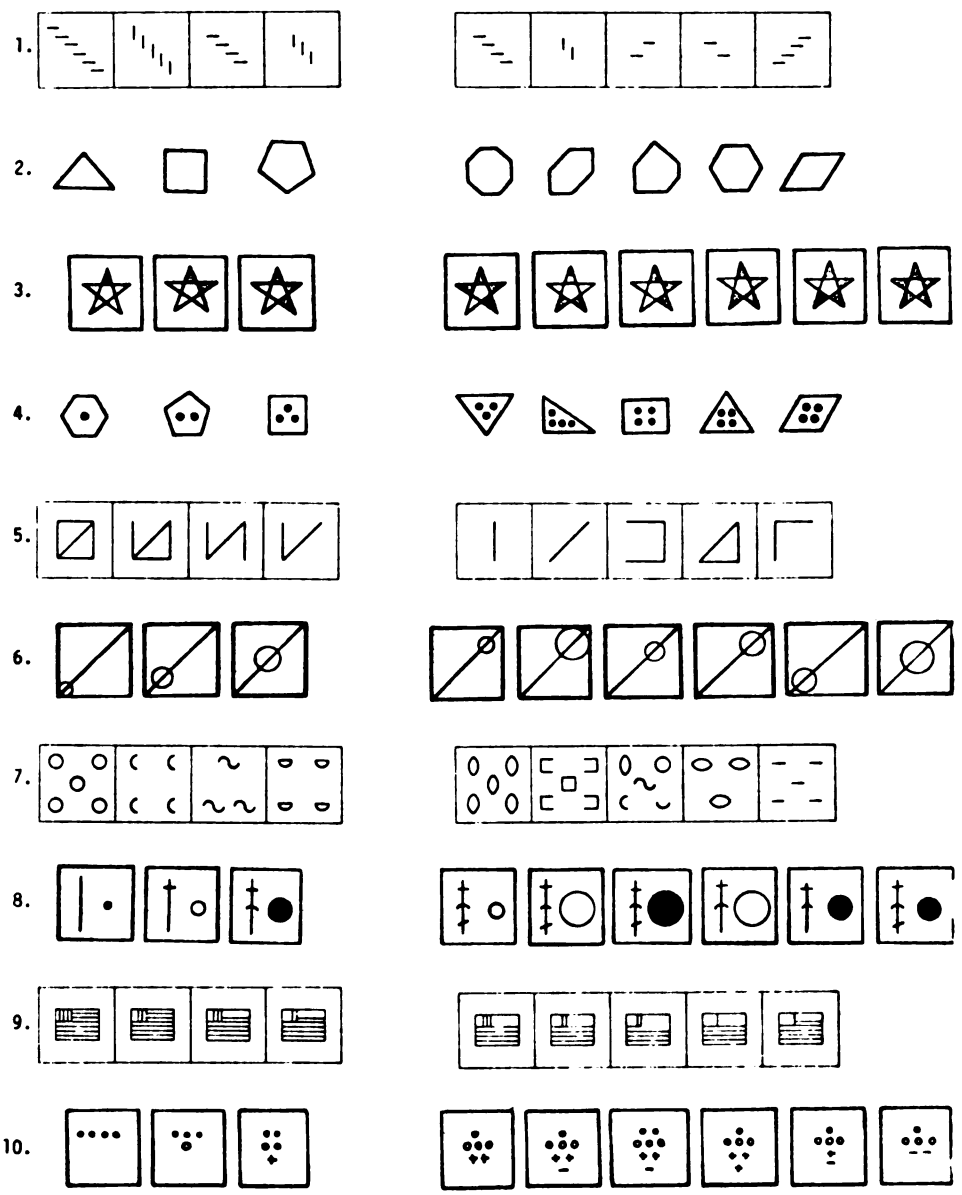
How did you feel about answering the items on this page? (check one)

| Liked Very Much | Liked To Some Extent | Liked A Little | Neutral | Disliked A Little | Disliked To Some Extent | Disliked Very Much |
|---|---|---|---|---|---|---|

DO NOT TURN PAGE UNTIL TOLD TO DO SO!

FORM J

Circle the correct answer for each item. Work as quickly as you can - you may not have time to complete all the items. If you are not sure of an item, make your best guess.



How many items on this page do you think you answered correctly? _____

How did you feel about answering items on this page? (check one)

| Liked Very Much | Liked To Some Extent | Liked A Little | Neutral | Disliked A Little | Disliked To Some Extent | Disliked Very Much |
|---|---|---|---|---|---|---|

DO NOT TURN PAGE UNTIL TOLD TO DO SO!

FORM K

Check the correct answer for each item.

You should have enough time to attempt every item, but do not spend too long on any one.

If you are not sure of the answer, make your best guess.

1. GLARE : BLINK ::
   ___pain : wince
   ___assent : nod
   ___obstacle : prevent
   ___slight : ignore

2. VANISH : FADE :: APPEAR :
   ___vision
   ___materialize
   ___incarnate
   ___flesh
   ___embody

3. BOOK : READER :: PICTURE :
   ___artist
   ___frame
   ___viewer
   ___painter
   ___movie

4. CISTERN : WATER ::
   ___shower : cold
   ___official : power
   ___science : matter
   ___museum : antiques
   ___vault : valuables

5. GASP : BREATHE ::
   ___jerk : grab
   ___clutch : hold
   ___lope : sprint
   ___chew : digest

6. PART : PRATE :: GILD :
   ___glade
   ___gilded
   ___gold
   ___glide

7. BICYCLE : LOCOMOTION ::
   ___canoe : paddle
   ___hero : worship
   ___hay : horse
   ___spectacles : vision
   ___statement : contention

8. EXPLOSION : DEBRIS ::
   ___fire : ashes
   ___flood : water
   ___catastrophe : destruction
   ___paper : scraps

9. DEFRAY : EXPENSE :: DISCHARGE ::
   ___cancel
   ___obligation
   ___salary
   ___weapons
   ___surface

10. DUBIOUS : DUBIOUSNESS :: FLEET :
    ___fleetness
    ___fleetly
    ___ship
    ___swift
    ___rapidly

11. TESTIMONY : OATH ::
    ___advertisement : quality
    ___decision : judgment
    ___product : guarantee
    ___confidence : promise
    ___future : prediction

12. USURP : POWER ::
    ___threaten : defiance
    ___exploit : error
    ___liberate : freedom
    ___rob : possession

13. DUKE : ARISTOCRACY ::
    ___telescope : magnification
    ___bachelor : matrimony
    ___govern : authority
    ___twin : similarity
    ___priest : clergy

14. CRAMP : MUSCLE ::
    ___throb : pain
    ___jam : machine
    ___cancel : order
    ___crack : stone

15. ELECTORATE : VOTER ::
    ___curriculum : student
    ___government : district
    ___property : resident
    ___inmate : institution
    ___population : inhabitant

16. GROVE : TREE ::
    ___monastery : monk
    ___pond : stream
    ___illumination : watt
    ___peninsula : isthmus
    ___archipelago : island

Write the number that is on the board when you finish all the items on this page. ____

How many items on this page do you think you answered correctly? ____

How did you feel about answering the items on this page? (check one)

| Liked Very Much | Liked To Some Extent | Liked A Little | Neutral | Disliked A Little | Disliked To Some Extent | Disliked Very Much |
|---|---|---|---|---|---|---|

DO NOT TURN PAGE UNTIL TOLD TO DO SO

FORM L

Check the correct answer for each item.

Work as quickly as you can - you may not have time to complete all the items.

If you are not sure of an item, make your best guess.

1. INTERESTED : ENGROSSED ::
   ___doubtful : curious
   ___enthusiastic : fanatical
   ___simple : complicated
   ___ecstatic : depressed

2. PLAY : AUTHOR :: MACHINE :
   ___producer
   ___manufacturer
   ___inventor
   ___publisher
   ___driver

3. SUN : EARTH :: EARTH :
   ___stars
   ___rotation
   ___universe
   ___moon
   ___orbit

4. SMILE : LAUGH ::
   ___grin : frown
   ___smirk : blink
   ___punish : yell
   ___whimper : wail
   ___cry : weep

5. ALOOF : SYMPATHY ::
   ___concerned : consolation
   ___bored : indifference
   ___inhumane : kindliness
   ___restrained : inhibition

6. GLAND : GRAND :: PLANK :
   ___board
   ___blank
   ___plant
   ___lank
   ___prank

7. TRIGGER : BULLET ::
   ___handle : drawer
   ___holster : gun
   ___bulb : light
   ___switch : current
   ___pulley : rope

8. FIRE : ASHES ::
   ___tree : leaves
   ___winter : ice
   ___Christmas : holly
   ___event : memories

9. ANGER : VIOLENCE :: LOVE :
   ___caress
   ___hate
   ___temper
   ___hope
   ___happiness

10. FEAR : ANTICIPATION :: REGRET :
    ___memory
    ___hope
    ___sorrow
    ___hate
    ___forget

11. ADVERTISEMENT : PURCHASE ::
    ___defense : conquest
    ___attitude : conviction
    ___electioneering : vote
    ___offer : force
    ___attempt : achievement

12. UNIFORM : CLOTHING ::
    ___shade : tone
    ___drum : orchestra
    ___dialect : language
    ___nationality : race

13. DECADE : YEAR ::
    ___side : square
    ___dawn : dusk
    ___dime : cent
    ___fortnight : week
    ___grade : class

14. DISSENT : PROTEST :: AGREEMENT :
    ___acquiesce
    ___coincide
    ___admit
    ___reject
    ___ratify

15. PHILOSOPHY : LOGIC ::
    ___reason : emotion
    ___literature : poetry
    ___melody : lyrics
    ___fact : fiction

16. HYBRID : SPECIES ::
    ___alloy : metal
    ___chip : block
    ___flower : plant
    ___blend : mixture
    ___metal : rock

How many items on this page do you think you answered correctly? _____

How did you feel about answering the items on this page? (Check one)

| Liked Very Much | Liked To Some Extent | Liked A Little | Neutral | Disliked A Little | Disliked To Some Extent | Disliked Very Much |
|---|---|---|---|---|---|---|

DO NOT TURN PAGE UNTIL TOLD TO DO SO

FORM M

Circle the correct answer for each item. You should have enough time to attempt every item, but don't spend too long on any one. If you are not sure of the answer, make your best guess.

1. 

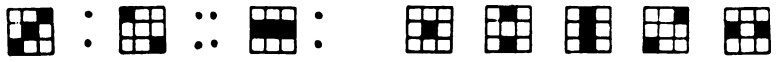
2. 

3. 

4. 

5. 

6. 

7. 

8. 

9. 

10. 

Write the number that is on the board when you finish all the items on this page _____.

How many items on this page do you think you answered correctly? _____

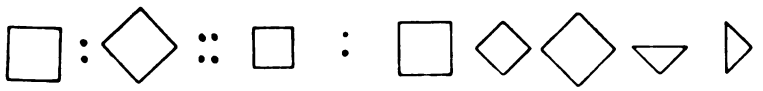
How did you feel about answering the items on this page? (check one)

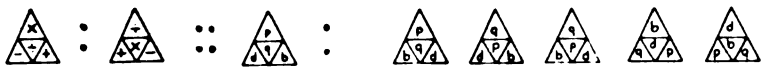
| Liked Very Much | Liked To Some Extent | Liked A Little | Neutral | Disliked A Little | Disliked To Some Extent | Disliked Very Much |
|---|---|---|---|---|---|---|

DO NOT TURN PAGE UNTIL TOLD TO DO SO!

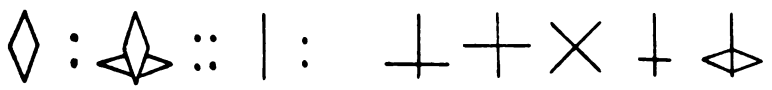
FORM N

Circle the correct answer for each item. Work as quickly as you can - you may not have time to complete all the items. If you are not sure of an item, make your best guess.

1. 

2. 

3. 

4. 

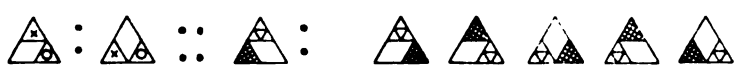
5. 

6. 

7. 

8. 

9. 

10. 

How many items on this page do you think you answered correctly? _____

How did you feel about answering the items on this page? (check one)

| Liked Very Much | Liked To Some Extent | Liked A Little | Neutral | Disliked A Little | Disliked To Some Extent | Disliked Very Much |
|---|---|---|---|---|---|---|

DO NOT TURN PAGE UNTIL TOLD TO DO SO!

FORM O

Circle the correct answer for each item.
You should have enough time to attempt every item, but do not spend too long on any one.
If you are not sure of the answer, make your best guess.

1) 9 8 7 8 7 6 ? 4 5 6 7 8

2) 5 7 10 12 20 22 ? 24 26 40 42 44

3) 6 4 7 5 8 6 9 ? 11 12 7 15 3

4) 1 2 4 8 16 32 ? ? 36 40 58 59 33 34 48 64 64 128

5) 23 30 38 47 ? 67 55 57 83 70

6) 1 5 3 7 5 ? 3 9 7 11 10

7) 16 28 8 14 4 7 ? $\frac{1}{2}$ 1 $1\frac{1}{2}$ 2 $3\frac{1}{2}$

8) 2 4 5 10 ? ? 20 40 15 20 12 24 18 24 11 22

9) 19 22 25 19 22 25 ? ? 28 31 21 24 22 25 28 22 19 22

10) 1 4 9 16 25 36 ? ? 48 61 49 64 39 54 41 46 49 65

11) 6 7 9 8 12 9 ? 10 12 14 15 18

12) 58 78 60 75 62 72 64 ? 60 63 66 69 72

13) 3 6 8 24 27 108 ? 432 112 132 216 324

14) 8 16 8 10 20 12 14 ? ? 28 14 6 8 24 16 28 20 7 9

15) 32 36 9 12 4 6 ? 1 2 3 4 8

16) 30 30 26 25 22 20 ? 14 15 16 17 18

Write the number that is on the board when you finish all the items on this page. _____

How many items on this page do you think you answered correctly? _____

How did you feel about answering the items on this page? (check one)

| Liked Very Much | Liked To Some Extent | Liked A Little | Neutral | Disliked A Little | Disliked To Some Extent | Disliked Very Much |
|---|---|---|---|---|---|---|

DO NOT TURN PAGE UNTIL TOLD TO DO SO

FORM P

Circle the correct answer for each item.
Work as quickly as you can - you may not have time to complete all the items.
If you are not sure of an item, make your best guess.

1) 46 40 35 31 ? 27 28 29 30 31

2) 5 15 30 4 12 24 3 ? 2 6 9 12 18

3) 7 31 55 79 ? 103 55 93 105 107

4) 9 18 15 30 27 ? ? 24 21 64 61 54 108 54 51 36 33

5) 0 2 1 3 2 4 3 ? ? 1 2 2 4 4 6 5 4 6 5

6) 2 5 11 20 ? 25 38 54 32 9

7) 2 6 4 12 6 18 ? 8 10 12 24 54

8) 3 6 5 8 7 ? 8 9 10 11 12

9) 6 5 9 8 12 11 15 ? ? 16 20 14 13 19 18 14 18 14 17

10) 11 7 10 12 24 20 23 25 ? 21 50 28 27 5

11) 5 12 9 16 13 20 ? 14 17 20 21 24

12) 57 53 48 53 49 44 49 45 ? 40 42 44 45 48

13) 7 4 8 5 10 7 ? ? 4 8 11 8 13 11 12 8 14 11

14) 3 6 4 12 9 36 ? 33 180 10 144 32

15) 58 49 40 31 22 ? 12 13 14 15 16

16) 3 4 6 10 18 ? 24 26 30 32 34

How many items on this page do you think you answered correctly? _____

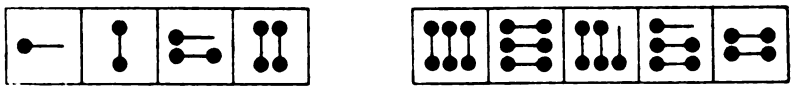
How did you feel about answering the items on this page? (check one)

| Liked Very Much | Liked To Some Extent | Liked A Little | Neutral | Disliked A Little | Disliked To Some Extent | Disliked Very Much |
|---|---|---|---|---|---|---|

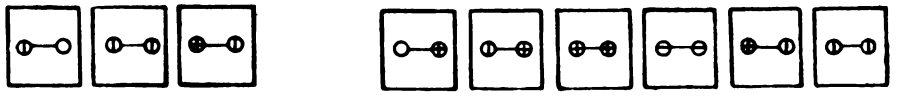
DO NOT TURN PAGE UNTIL TOLD TO DO SO

FORM Q

Circle the correct answer for each item. You should have enough time to attempt every item but don't spend too long on any one. If you are not sure of the answer, make your best guess.

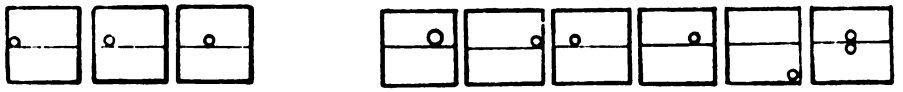
1. 

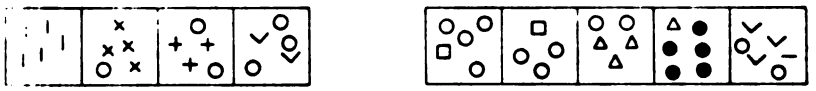
2. 

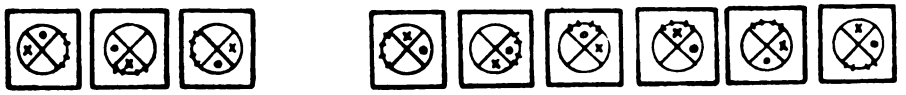
3. 

4. 

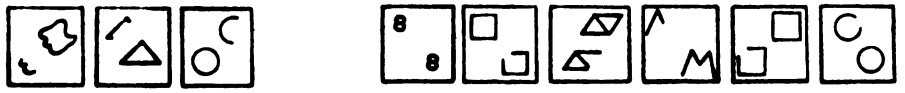
5. 

6. 

7. 

8. 

9. 

10. 

Write the number that is on the board when you finish all the items on this page _____.

How many items on this page do you think you answered correctly? _____

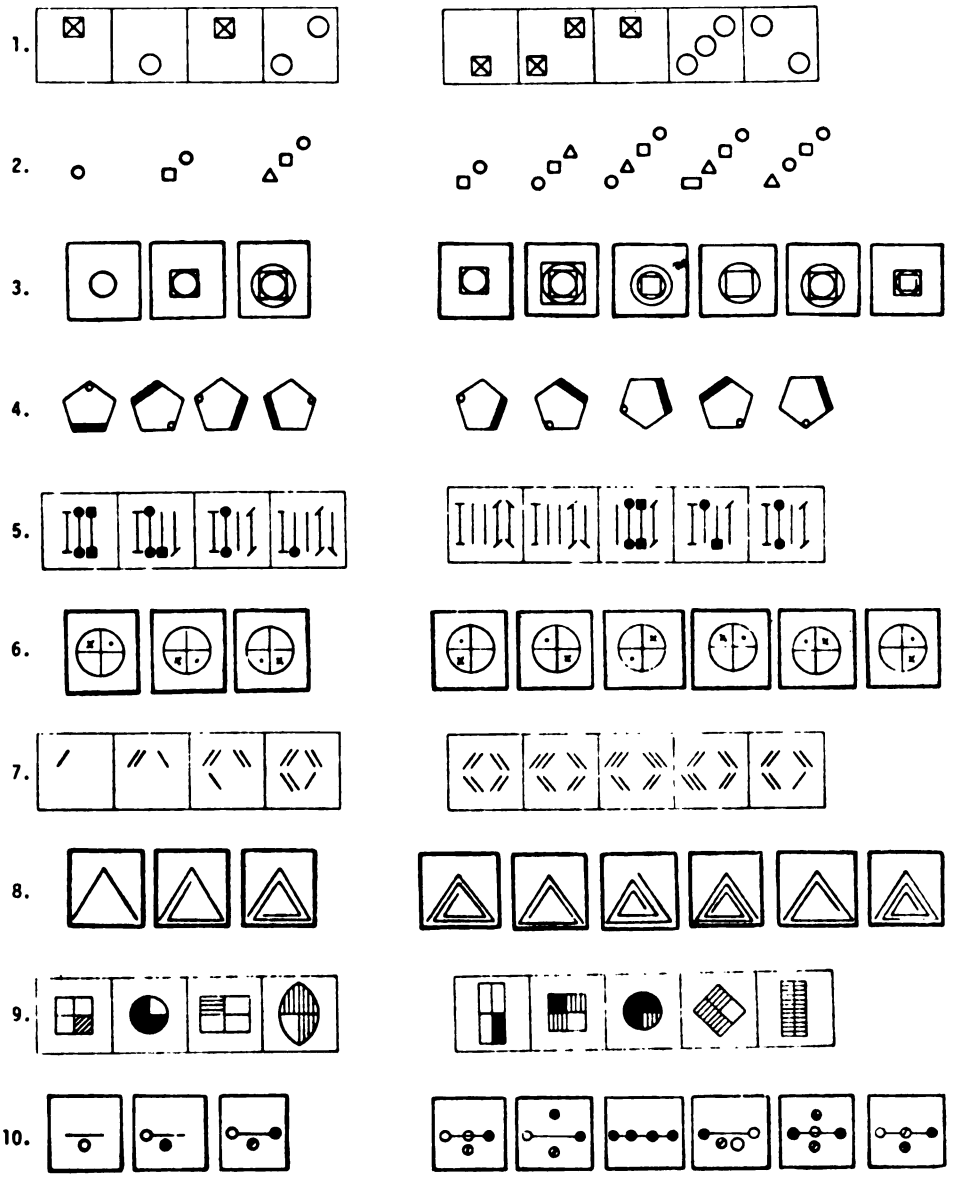
How did you feel about answering the items on this page? (check one)

| Liked Very Much | Liked To Some Extent | Liked A Little | Neutral | Disliked A Little | Disliked To Some Extent | Disliked Very Much |
|---|---|---|---|---|---|---|

DO NOT TURN PAGE UNTIL TOLD TO DO SO!

FORM R

Circle the correct answer for each item. Work as quickly as you can - you may not have time to complete all the items. If you are not sure of an item, make your best guess.



How many items on this page do you think you answered correctly? _____

How did you feel about answering the items on this page? (check one)

| Liked Very Much | Liked To Some Extent | Liked A Little | Neutral | Disliked A Little | Disliked To Some Extent | Disliked Very Much |
|---|---|---|---|---|---|---|

DO NOT TURN PAGE UNTIL TOLD TO DO SO!

Answer Key for Forms A to R

| Forms \ Items | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| A | 1 | 4 | 5 | 5 | 2 | 4 | 3 | 1 | 5 | 2 | 4 | 2 | 1 | 4 | 4 | 3 |
| B | 2 | 1 | 3 | 4 | 5 | 3 | 3 | 5 | 1 | 1 | 5 | 2 | 1 | 4 | 5 | 2 |
| C | 3 | 5 | 3 | 5 | 2 | 1 | 2 | 2 | 4 | 4 | 2 | 4 | 2 | 3 | 2 | 2 |
| D | 2 | 3 | 1 | 4 | 1 | 1 | 3 | 5 | 3 | 2 | 4 | 1 | 5 | 5 | 3 | 1 |
| E | 5 | 3 | 2 | 1 | 3 | 1 | 4 | 2 | 5 | 5 | | | | | | |
| F | 3 | 1 | 3 | 1 | 4 | 2 | 5 | 3 | 5 | 3 | | | | | | |
| G | 2 | 2 | 5 | 3 | 4 | 1 | 5 | 3 | 4 | 5 | 1 | 4 | 3 | 3 | 3 | 1 |
| H | 2 | 3 | 2 | 3 | 3 | 5 | 5 | 5 | 1 | 1 | 3 | 1 | 4 | 2 | 1 | 5 |
| I | 3 | 3 | 3 | 5 | 4 | 5 | 4 | 4 | 1 | 3 | | | | | | |
| J | 4 | 4 | 4 | 4 | 2 | 2 | 1 | 2 | 2 | 2 | | | | | | |
| K | 1 | 2 | 3 | 5 | 2 | 4 | 4 | 1 | 2 | 1 | 3 | 4 | 5 | 2 | 5 | 5 |
| L | 2 | 3 | 4 | 4 | 3 | 5 | 4 | 4 | 1 | 1 | 3 | 3 | 3 | 1 | 2 | 1 |
| M | 5 | 4 | 5 | 2 | 3 | 3 | 2 | 4 | 5 | 3 | | | | | | |
| N | 2 | 3 | 5 | 1 | 5 | 2 | 4 | 1 | 2 | 4 | | | | | | |
| O | 4 | 3 | 3 | 5 | 3 | 2 | 4 | 5 | 5 | 2 | 4 | 4 | 2 | 4 | 3 | 5 |
| P | 2 | 3 | 1 | 4 | 4 | 4 | 1 | 3 | 4 | 2 | 2 | 1 | 5 | 5 | 2 | 5 |
| Q | 4 | 3 | 3 | 1 | 4 | 4 | 1 | 4 | 5 | 2 | | | | | | |
| R | 3 | 4 | 2 | 2 | 1 | 5 | 2 | 6 | 1 | 6 | | | | | | |

# Appendix B

## SPECIFIC COACHING IN VERBAL ANALOGIES

The coaching in verbal analogies solution techniques began with a definition of a verbal analogy. It was defined as an item consisting of two pairs of words bearing some relationship to each other. The subjects were told that their task was to determine the relationship between the first two words and then pick a word or pair of words from a list of four or five alternatives so that the second pair of words bear the same relationship to each other as do the first pair.

The subjects were told that the two basic rules for solving verbal analogies were: (1) Verbalize the relationship between the first pair of words and (2) Substitute the second pair of words into this verbalized relation until you find the pair that makes the most sense. It was explained that the first rule means putting the two words into a sentence that expresses the relationship between the two words. The second rule was explained to mean substituting into the verbalized sentences each alternative pair of words where the first words were, and seeing which pair makes the most sense.

In verbalizing the relationship between the first two words, the subjects were told that they might have to change the tense, form or part of speech of one of the words. This was encouraged but they were warned to make exactly the same changes in the second pairs of words.

The importance of verbalizing the relationship was explained to the subjects. It was demonstrated that verbalizing the relationship

forces one to be explicit about the relationship, it prevents mere association, and it helps prevent forgetting of a complex relationship when applying it to all the possible answers.

The subjects were told that the verbalized relationship could be too general resulting in more than one of the alternatives appearing correct, or the verbalized relationship might be too specific resulting in none of the alternatives appearing correct. Examples of each of these possibilites were demonstrated and ways of making the verbalized relationships more exact or more general were discussed. Flexibility in adapting the initial relationship was stressed.

The subjects were allowed to practice applying the analogy solving rules on a number of verbal analogies. After the subjects had attempted to solve each analogy, various possible verbalizations of the relationship were presented and solution techniques were discussed. The practice session was followed by a general review of the rules and hints for solving verbal analogies that had been given during the coaching period.

## SPECIFIC COACHING IN NUMBER SERIES

The coaching in number series items solution techniques began with a definition of a number series item. A number series item was defined as a list of numbers which bear some relationship to each other so as to form a definite pa-tern or series. The subjects were told that their task was to determine the pattern involved and then to pick from a list of alternatives the next number or next two numbers that continued the series.

The two basic rules in solving a number series item that were explained were: (1) find the rule and (2) apply it. The subjects were told to read through the series of numbers to see if they could intuitively determine the desired relationship. They were told to test the relationship if they found one. If no relationship was readily apparent they were taught to determine how to get from each number to the next one in the series and to write this connector (eg., +2) in the space above the two numbers. The subjects were then told that merely reading these connectors from left to right would usually give a regular pattern leading to the correct answer. They were told to compute the answer on the basis of the determined relationship before looking at the alternatives presented for the given problem.

If this failed, the subjects were told to look for other possible connectors for getting from each number to the next. For example, if two consecutive numbers in the series were 4 8, the rule could be +4 or x2. If looking for alternative rules didn't give the correct answer, it was explained that the subjects should check for two interwoven or alter-

nating series, one consisting of the first, third, fifth and seventh numbers in the series and the other consisting of the second, fourth and sixth numbers.

If the preceding techniques all failed to give the answer, the subjects were told to try the following techniques: to compare the rules for getting from one number to the next with the numbers in the series; calculate the differences of the rules; look for mathematical relationships such as squares, square roots and cubes; and be alert for visual cues.

All of the above techniques, many of which are described in greater detail in Chapter 10 of How to Take Tests by Millman and Pauk (1969), were demonstrated using appropriate number series examples. The subjects were given a chance to apply each technique by themselves, and then the correct application was demonstrated and discussed.

The following rules summarize the number series coaching:

1. Determine how to get from each number to the next.

2. Do not look for complex relationships. Keep it simple.

3. Before trying the problem, read the numbers through to yourself to see if you can intuitively get the answer. If you think you see the rule, apply it.

4. Do not look at the answers until you have computed one you think is right. Looking at the answers before hand can only distract you.

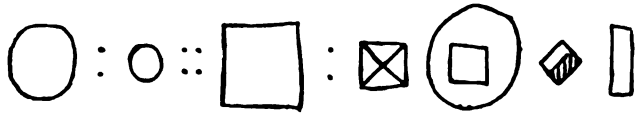
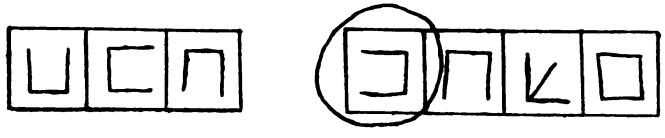
5. Write the connectors down on the page between the numbers. When you have found all the connectors, read them to yourself as a series and the relationship should become obvious.

6. Be aware that some relationships can be both x and + or both ÷ and -. When this is the case, try the x or ÷ first, but write both down.

7. If no relationship seems obvious among the connectors see if it is an alternating series. Look at every other number in the series and compute the connectors.

8. If you still can't get the answer, make your best guess and mark the item to return to if you have time. Don't spend too long on any given item.

# Appendix C: Evaluation Form

| Type of Item with Examples | Your honest reaction to how your training helped you to solve <u>each</u> type of item. Check the appropriate space for each type of item. | | | |
|---|---|---|---|---|
| **VERBAL ANALOGIES**<br>BIG : LITTLE :: LARGE :<br>__late<br>__huge<br>✓ small<br>__man | Definitely Helped to Solve Verbal Analogies | Probably Helped to Solve Verbal Analogies | Probably Did Not Help to Solve Verbal Analogies | Definitely Did not Help to Solve Verbal Analogies |
| **FIGURE ANALOGIES**<br>  | Definitely Helped to Solve Figure Analogies | Probably Helped to Solve Figure Analogies | Probably Did not Help to Solve Figure Analogies | Definitely Did not Help to Solve Figure Analogies |
| **NUMBER SERIES**<br>1 2 3 4 ?  2 3 (5) 7 | Definitely Helped to Solve Number Series | Probably Helped to Solve Number Series | Probably Did not Help to Solve Number Series | Definitely Did not Help to Solve Number Series |
| **FIGURE SERIES**<br>  | Definitely Helped to Solve Figure Series | Probably Helped to Solve Figure Series | Probably Did not Help to Solve Figure Series | Definitely Did not Help to Solve Figure Series |

# Appendix D : Tables of Means

TABLE D1 Mean Number of Correct Items on the Analogy Posttests

| Design Factors | | | Measures Factors | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Immediate Posttest | | | | Delayed Posttest | | | |
| Group | Sex | Abil. | Verb. Anal. | | Fig. Anal. | | Verb. Anal. | | Fig. Anal. | |
| | | | Power | Speed | Power | Speed | Power | Speed | Power | Speed |
| Coach. in Anal. | Male | High | 13.67 | 12.22 | 8.89 | 7.22 | 13.56 | 12.67 | 8.00 | 8.00 |
| | | Low | 13.44 | 9.44 | 7.56 | 5.56 | 11.00 | 10.33 | 8.22 | 8.22 |
| | Female | High | 12.44 | 10.00 | 7.67 | 5.78 | 11.89 | 10.22 | 8.00 | 7.33 |
| | | Low | 12.22 | 8.78 | 8.33 | 4.44 | 10.22 | 8.67 | 6.89 | 7.33 |
| No Coach. in Anal. | Male | High | 11.44 | 11.89 | 8.00 | 6.67 | 12.67 | 11.33 | 7.67 | 7.67 |
| | | Low | 10.56 | 8.22 | 7.44 | 6.56 | 8.22 | 8.00 | 7.00 | 7.22 |
| | Female | High | 12.11 | 9.33 | 8.11 | 6.00 | 10.33 | 10.33 | 7.89 | 7.44 |
| | | Low | 11.00 | 10.11 | 8.00 | 6.44 | 9.56 | 9.78 | 6.89 | 7.22 |

TABLE D2 Mean Attitude Scores on the Analogy Posttests

| Design Factors | | | Measures Factors | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Immediate Posttest | | | | Delayed Posttest | | | |
| Group | Sex | Abil. | Verb. Anal. | | Fig. Anal. | | Verb. Anal. | | Fig. Anal. | |
| | | | Power | Speed | Power | Speed | Power | Speed | Power | Speed |
| Coach. in Anal. | Male | High | 5.22 | 5.44 | 5.00 | 5.00 | 5.11 | 5.22 | 5.56 | 5.78 |
| | | Low | 5.56 | 4.89 | 5.56 | 5.33 | 4.22 | 5.00 | 5.56 | 5.33 |
| | Female | High | 5.11 | 4.67 | 5.33 | 4.89 | 4.22 | 4.56 | 4.44 | 4.67 |
| | | Low | 5.22 | 4.89 | 6.00 | 4.33 | 4.56 | 4.56 | 5.22 | 5.22 |
| No Coach. in Anal. | Male | High | 5.22 | 4.89 | 5.33 | 5.22 | 4.78 | 5.11 | 5.22 | 5.33 |
| | | Low | 4.00 | 3.67 | 5.00 | 3.89 | 2.67 | 3.78 | 4.78 | 4.44 |
| | Female | High | 4.78 | 4.78 | 6.11 | 5.22 | 4.56 | 4.89 | 5.78 | 5.56 |
| | | Low | 4.78 | 4.22 | 5.67 | 5.11 | 4.33 | 4.78 | 5.22 | 5.44 |

TABLE D3 Mean Number of Items Estimated Correct on the Analogy Posttests

| Design Factors | | | Measures Factors | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Immediate Posttest | | | | Delayed Posttest | | | |
| Group | Sex | Abil. | Verb. Anal. | | Fig. Anal. | | Verb. Anal. | | Fig. Anal. | |
| | | | Power | Speed | Power | Speed | Power | Speed | Power | Speed |
| Coach. in Anal. | Male | High | 14.33 | 13.33 | 9.22 | 7.67 | 14.11 | 13.00 | 9.22 | 9.22 |
| | | Low | 12.78 | 9.67 | 8.44 | 6.33 | 11.44 | 11.56 | 8.78 | 8.67 |
| | Female | High | 12.33 | 9.67 | 8.33 | 6.00 | 11.56 | 10.11 | 8.22 | 8.33 |
| | | Low | 10.56 | 7.56 | 7.33 | 4.00 | 9.56 | 9.22 | 6.89 | 6.67 |
| No Coach. in Anal. | Male | High | 13.00 | 12.44 | 8.44 | 6.33 | 12.33 | 12.56 | 8.44 | 8.56 |
| | | Low | 11.89 | 10.33 | 7.89 | 6.22 | 10.22 | 11.11 | 7.33 | 8.56 |
| | Female | High | 12.67 | 11.89 | 8.22 | 6.22 | 11.00 | 11.33 | 8.44 | 8.22 |
| | | Low | 11.22 | 9.78 | 7.78 | 6.22 | 9.11 | 9.56 | 7.78 | 8.33 |

TABLE D4 Mean Absolute Difference between Number of Items Estimated Correct and Actual Number of Correct Items on the Analogy Posttests

| Design Factors | | | Measures Factors | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Immediate Posttest | | | | Delayed Posttest | | | |
| Group | Sex | Abil. | Verb. Anal. | | Fig. Anal. | | Verb. Anal. | | Fig. Anal. | |
| | | | Power | Speed | Power | Speed | Power | Speed | Power | Speed |
| Coach. in Anal. | Male | High | 1.11 | 1.11 | .56 | .67 | .56 | 1.22 | 1.22 | 1.22 |
| | | Low | .89 | 1.78 | 1.33 | .78 | 1.67 | 2.78 | .78 | .67 |
| | Female | High | 1.44 | 1.89 | 1.78 | .67 | 2.33 | 2.11 | 1.11 | 1.44 |
| | | Low | 3.00 | 3.00 | 2.11 | 1.78 | 2.89 | 2.78 | .67 | 1.78 |
| No Coach. in Anal. | Male | High | 2.67 | 1.00 | 1.56 | .78 | 1.00 | 1.67 | 1.44 | .89 |
| | | Low | 2.22 | 2.78 | 1.89 | .78 | 2.22 | 3.33 | 1.67 | 1.78 |
| | Female | High | 2.33 | 3.89 | 1.00 | 1.78 | 4.44 | 3.00 | 1.44 | 1.67 |
| | | Low | 1.33 | 2.33 | .89 | .89 | 2.89 | 2.00 | 1.11 | 1.11 |

TABLE D5 Mean Number of Items Attempted on the Speeded Analogy Posttests

| Design Factors | | | Measures Factors | | | |
|---|---|---|---|---|---|---|
| | | | Immediate Posttest | | Delayed Posttest | |
| Group | Sex | Abil. | Verb.Anal. | Fig. Anal. | Verb. Anal. | Fig. Anal. |
| Coach. in Anal. | Male | High | 13.78 | 7.89 | 15.22 | 9.89 |
| | | Low | 12.22 | 6.89 | 14.56 | 9.33 |
| | Female | High | 12.78 | 6.67 | 13.11 | 9.22 |
| | | Low | 11.78 | 5.67 | 13.22 | 9.22 |
| No Coach. in Anal. | Male | High | 15.89 | 7.44 | 15.89 | 9.22 |
| | | Low | 15.22 | 7.56 | 16.00 | 10.00 |
| | Female | High | 15.89 | 7.22 | 15.44 | 9.44 |
| | | Low | 15.78 | 8.22 | 15.00 | 9.78 |

TABLE D6 Mean Length of Time in Minutes Spent on the Analogy Power Posttests

| Design Factors | | | Measures Factors | | | |
|---|---|---|---|---|---|---|
| | | | Immediate Posttest | | Delayed Posttest | |
| Group | Sex | Abil. | Verb.Anal. | Fig. Anal. | Verb. Anal. | Fig. Anal. |
| Coach. in Anal. | Male | High | 7.00 | 4.56 | 4.78 | 4.56 |
| | | Low | 7.67 | 5.00 | 6.44 | 4.00 |
| | Female | High | 7.22 | 4.78 | 6.11 | 4.22 |
| | | Low | 7.56 | 5.00 | 5.78 | 4.22 |
| No Coach. in Anal. | Male | High | 4.44 | 3.67 | 4.44 | 4.00 |
| | | Low | 4.78 | 4.33 | 4.11 | 3.78 |
| | Female | High | 4.56 | 4.11 | 4.44 | 3.78 |
| | | Low | 4.67 | 3.33 | 4.33 | 3.78 |

Table D7 **Mean Rating of the Coaching Effectiveness for the Four Item Types by the Verbal Analogies Coaching Group**

| | | Verb. Anal. | Fig. Anal. | Number Series | Figure Series |
|---|---|---|---|---|---|
| Males | High Ability | 3.33 | 2.67 | 2.33 | 2.22 |
| | Low Ability | 3.56 | 3.00 | 2.56 | 2.56 |
| Females | High Ability | 3.44 | 2.78 | 2.33 | 2.56 |
| | Low Ability | 3.44 | 2.44 | 2.22 | 2.44 |

TABLE D8 Mean Number of Correct Items on the Number Series Posttests

| Design Factors | | | Measures Factors | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Immediate Posttest | | | | Delayed Posttest | | | |
| Group | Sex | Abil. | Numb. Ser. | | Fig. Ser. | | Numb. Ser. | | Fig. Ser. | |
| | | | Power | Speed | Power | Speed | Power | Speed | Power | Speed |
| Coach. in Number Series | Male | High | 14.78 | 10.67 | 9.00 | 8.00 | 15.22 | 14.11 | 9.00 | 7.44 |
| | | Low | 13.56 | 9.22 | 8.33 | 6.33 | 13.11 | 9.33 | 7.78 | 7.44 |
| | Female | High | 14.33 | 12.00 | 9.00 | 7.00 | 14.11 | 12.89 | 8.67 | 8.22 |
| | | Low | 12.56 | 8.11 | 8.00 | 6.22 | 13.33 | 10.00 | 8.78 | 6.56 |
| No Coach. Number Series | Male | High | 14.22 | 9.22 | 8.11 | 7.78 | 12.22 | 10.22 | 8.67 | 8.33 |
| | | Low | 12.56 | 8.33 | 8.44 | 6.67 | 10.89 | 8.67 | 9.22 | 7.44 |
| | Female | High | 13.22 | 9.67 | 7.89 | 6.56 | 11.56 | 9.67 | 8.11 | 7.44 |
| | | Low | 10.44 | 5.56 | 8.44 | 5.44 | 9.44 | 6.33 | 7.11 | 5.56 |

TABLE D9 Mean Attitude Scores on the Number Series Posttests

| Design Factors | | | Measures Factors | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Immediate Posttest | | | | Delayed Posttest | | | |
| Group | Sex | Abil. | Numb. Ser. | | Fig. Ser. | | Numb. Ser. | | Fig. Ser. | |
| | | | Power | Speed | Power | Speed | Power | Speed | Power | Speed |
| Coach. in Number Series | Male | High | 5.56 | 5.22 | 5.56 | 5.22 | 4.78 | 5.00 | 4.56 | 4.67 |
| | | Low | 4.44 | 4.56 | 5.44 | 5.11 | 4.89 | 4.00 | 5.22 | 5.33 |
| | Female | High | 5.89 | 5.78 | 5.33 | 5.22 | 5.44 | 5.67 | 5.11 | 4.89 |
| | | Low | 5.11 | 5.11 | 5.89 | 5.89 | 5.44 | 5.33 | 5.33 | 5.56 |
| No Coach. Number Series | Male | High | 5.67 | 5.33 | 5.44 | 5.67 | 5.00 | 4.78 | 5.44 | 5.11 |
| | | Low | 5.67 | 5.11 | 5.78 | 5.11 | 5.00 | 4.67 | 5.89 | 5.44 |
| | Female | High | 4.78 | 4.67 | 4.78 | 4.56 | 4.67 | 4.78 | 4.67 | 4.89 |
| | | Low | 4.00 | 3.78 | 5.33 | 5.11 | 3.22 | 3.44 | 5.44 | 5.00 |

TABLE D10 Mean Number of Items Estimated Correct on the Number Series Posttests

| Design Factors | | | Measures Factors | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Immediate Posttest | | | | Delayed Posttest | | | |
| Group | Sex | Abil. | Numb. Ser. | | Fig. Ser. | | Numb. Ser. | | Fig. Ser. | |
| | | | Power | Speed | Power | Speed | Power | Speed | Power | Speed |
| Coach. in Number Series | Male | High | 14.22 | 10.78 | 9.33 | 8.22 | 15.00 | 13.67 | 9.00 | 7.89 |
| | | Low | 13.78 | 8.78 | 8.78 | 6.89 | 13.67 | 9.11 | 8.11 | 7.89 |
| | Female | High | 14.00 | 11.89 | 8.22 | 7.78 | 13.89 | 13.11 | 8.11 | 7.67 |
| | | Low | 13.11 | 8.11 | 8.78 | 7.89 | 13.33 | 9.33 | 8.33 | 6.67 |
| No Coach. Number Series | Male | High | 14.11 | 9.89 | 8.44 | 8.67 | 13.56 | 10.78 | 9.44 | 8.11 |
| | | Low | 13.00 | 8.56 | 8.56 | 7.22 | 11.78 | 8.67 | 8.89 | 7.00 |
| | Female | High | 13.33 | 8.89 | 7.56 | 7.00 | 11.89 | 9.00 | 8.22 | 7.00 |
| | | Low | 9.33 | 6.22 | 6.89 | 6.44 | 8.00 | 6.67 | 7.56 | 5.44 |

TABLE D11 Mean Absolute Difference between Number if Items Estimated Correct and Actual Number of Correct Items on the Series Posttests

| Design Factors | | | Measures Factors | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Immediate Posttest | | | | Delayed Posttest | | | |
| Group | Sex | Abil. | Numb. Ser. | | Fig. Ser. | | Numb. Ser. | | Fig. Ser. | |
| | | | Power | Speed | Power | Speed | Power | Speed | Power | Speed |
| Coach. in Number Series | Male | High | .78 | .56 | 1.44 | .67 | .89 | .78 | .89 | 1.11 |
| | | Low | .67 | .78 | .89 | .56 | 1.44 | .67 | 1.67 | 1.33 |
| | Female | High | 1.00 | .78 | 1.00 | 1.67 | 1.11 | 1.11 | 1.00 | 1.22 |
| | | Low | 1.22 | .67 | 1.22 | 1.67 | .89 | .89 | .89 | .56 |
| No Coach. Number Series | Male | High | 1.22 | .89 | 1.00 | 1.11 | 1.33 | .78 | 1.22 | .22 |
| | | Low | .89 | .44 | 1.22 | .78 | 1.78 | .89 | 1.00 | .67 |
| | Female | High | 1.00 | .78 | 1.44 | 1.78 | 1.67 | 1.11 | 1.00 | .89 |
| | | Low | 2.44 | 2.44 | 2.22 | 1.67 | 3.44 | 2.33 | 1.33 | 1.22 |

TABLE D12 Mean Number of Items Attempted on the Speeded Series Posttests

| Design Factors | | | Measures Factors | | | |
|---|---|---|---|---|---|---|
| | | | Immediate Posttest | | Delayed Posttest | |
| Group | Sex | Abil. | Numb. Ser. | Fig. Ser. | Numb. Ser. | Fig. Ser. |
| Coach. in Number Series | Male | High | 11.22 | 9.44 | 14.56 | 8.67 |
| | | Low | 9.56 | 8.00 | 10.00 | 9.00 |
| | Female | High | 12.67 | 9.56 | 13.89 | 9.44 |
| | | Low | 8.56 | 8.44 | 10.33 | 7.67 |
| No Coach. Number Series | Male | High | 10.78 | 10.00 | 11.33 | 8.56 |
| | | Low | 9.00 | 8.44 | 9.44 | 8.11 |
| | Female | High | 10.22 | 8.78 | 10.33 | 8.22 |
| | | Low | 8.00 | 8.11 | 9.11 | 7.22 |

TABLE D13 Mean Length of Time in Minutes Spent on the Series Power Posttests

| Design Factors | | | Measures Factors | | | |
|---|---|---|---|---|---|---|
| | | | Immediate Posttest | | Delayed Posttest | |
| Group | Sex | Abil. | Numb. Ser. | Fig. Ser. | Numb. Ser. | Fig. Ser. |
| Coach. in Number Series | Male | High | 9.33 | 3.89 | 7.78 | 4.00 |
| | | Low | 10.89 | 3.89 | 9.00 | 3.78 |
| | Female | High | 9.44 | 4.00 | 7.78 | 3.56 |
| | | Low | 11.00 | 4.22 | 10.44 | 4.56 |
| No Coach. Number Series | Male | High | 8.67 | 4.22 | 8.44 | 4.00 |
| | | Low | 10.22 | 4.56 | 10.67 | 4.11 |
| | Female | High | 9.89 | 4.44 | 9.89 | 4.67 |
| | | Low | 10.89 | 4.67 | 10.78 | 4.44 |

Table D14 Mean Rating of the Coaching Effectiveness for the Four Item Types by the Number Series Coaching Group

| | | Verb. Anal. | Fig. Anal. | Number Series | Figure Series |
|---|---|---|---|---|---|
| Males | High Ability | 1.89 | 2.22 | 3.22 | 2.33 |
| | Low Ability | 2.11 | 2.22 | 3.67 | 2.78 |
| Females | High Ability | 1.78 | 2.33 | 3.33 | 2.22 |
| | Low Ability | 2.00 | 2.44 | 3.67 | 2.44 |

Table D 15 Mean Rating of the Coaching Effectiveness for the Four Item Types by Both Groups

| | | Verb. Anal. | Fig. Anal. | Number Series | Figure Series |
|---|---|---|---|---|---|
| Verbel Analogies Coaching | Males | 3.50 | 2.82 | 2.18 | 2.27 |
| | Females | 3.50 | 2.73 | 2.18 | 2.55 |
| Number Series Coaching | Males | 2.00 | 2.18 | 3.32 | 2.41 |
| | Females | 1.91 | 2.46 | 3.55 | 2.41 |

# Appendix E: ANOVA Tables

Table E1 Analysis of Variance Tables for the Four Dependent Variables of the Full Design of the Analogies Experiment

| | | Number Correct | | Attitude | | Number Estimated Correct | | Accuracy of the Estimate | |
|---|---|---|---|---|---|---|---|---|---|
| Effects | df | Mean Square | F | Mean Square | F | Mean Square | F | Mean Square | F |
| Bet. Subj. | | | | | | | | | |
| T | 1 | 41.17 | 3.97 | 7.11 | 1.26 | .06 | .00 | 13.14 | 4.30 |
| G | 1 | 44.44 | 4.28 | .56 | .10 | 217.56 | 8.56 | 45.00 | 14.71 |
| TG | 1 | 44.44 | 4.28 | 26.69 | 4.73 | 78.03 | 3.07 | 6.89 | 2.25 |
| A | 1 | 158.34 | 15.26 | 13.44 | 2.38 | 248.06 | 9.76 | 4.88 | 1.59 |
| TA | 1 | .01 | .00 | 21.01 | 3.72 | 10.03 | .39 | 15.67 | 5.12 |
| GA | 1 | 34.03 | 3.28 | 13.44 | 2.38 | .00 | .00 | 12.54 | 4.10 |
| TGA | 1 | 8.03 | .77 | 2.01 | .36 | .06 | .00 | 27.13 | 8.87 |
| S:TGA | 64 | 10.37 | | 5.64 | | 25.42 | | 3.06 | |
| Within Subj. | | | | | | | | | |
| P | 1 | .01 | .00 | 2.78 | 3.89 | 18.06 | 7.40 | 4.88 | 2.88 |
| TP | 1 | 4.34 | 1.90 | .56 | .79 | 6.25 | 2.56 | 1.46 | .86 |
| GP | 1 | .44 | .19 | .44 | .62 | .69 | .28 | .04 | .03 |
| TGP | 1 | .03 | .01 | 2.01 | 2.82 | 1.56 | .64 | 2.64 | 1.56 |
| AP | 1 | 6.67 | 2.92 | .34 | .48 | .69 | .28 | .09 | .05 |
| TAP | 1 | 4.34 | 1.90 | .03 | .04 | 2.51 | 1.02 | 5.25 | 3.10 |
| GAP | 1 | 1.00 | .44 | 2.51 | 3.51 | .06 | .03 | 6.04 | 3.57 |
| TGAP | 1 | 3.36 | 1.47 | 1.00 | 1.40 | .44 | .18 | .00 | .00 |
| PS:TGA | 64 | 2.29 | | .71 | | 2.44 | | 1.69 | |
| I | 1 | 1764.00 | 312.85 | 40.11 | 19.20 | 1856.17 | 243.96 | 139.04 | 50.28 |
| TI | 1 | 30.25 | 5.36 | 7.56 | 3.62 | .00 | .00 | 7.79 | 2.82 |
| GI | 1 | 4.34 | .77 | .44 | .21 | 30.25 | 3.98 | 12.54 | 4.54 |
| TGI | 1 | 5.84 | 1.04 | .56 | .27 | .17 | .02 | .14 | .05 |
| AI | 1 | 53.78 | 9.54 | 3.67 | 1.76 | 46.69 | 6.14 | 5.64 | 2.04 |
| TAI | 1 | 1.36 | .24 | .00 | .00 | 2.51 | .33 | 3.84 | 1.39 |
| GAI | 1 | 21.01 | 3.73 | 2.51 | 1.20 | 2.51 | .33 | 8.27 | 2.99 |
| TGAI | 1 | 7.56 | 1.34 | .69 | .33 | 6.25 | .82 | 5.64 | 2.04 |
| IS:TGA | 64 | 5.64 | | 2.09 | | 7.61 | | 2.77 | |
| PI | 1 | 38.03 | 16.77 | 4.34 | 8.12 | 72.25 | 38.61 | .77 | 1.31 |
| TPI | 1 | 2.25 | .99 | .69 | 1.30 | 5.06 | 2.71 | 1.67 | .94 |
| GPI | 1 | .56 | .25 | 2.01 | 3.74 | 1.56 | .83 | 3.84 | 2.19 |
| TGPI | 1 | .06 | .03 | .00 | .00 | 1.78 | .91 | .92 | .52 |
| API | 1 | 11.11 | 4.90 | .44 | .82 | .17 | .09 | 2.13 | 1.21 |
| TAPI | 1 | 2.78 | 1.22 | .01 | .01 | .11 | .05 | 2.92 | 1.67 |
| GAPI | 1 | 7.56 | 3.33 | .00 | .00 | .11 | .05 | 2.13 | 1.21 |
| TGAPI | 1 | .06 | .03 | 1.56 | 2.92 | .17 | .09 | 2.38 | 1.36 |
| PIS:TGA | 64 | 2.27 | | .53 | | 1.87 | | 1.75 | |
| C | 1 | 207.84 | 67.68 | 2.25 | 4.47 | 128.44 | 63.64 | 1.09 | .67 |
| TC | 1 | 24.17 | 7.87 | .01 | .01 | 27.56 | 13.66 | .39 | .24 |
| GC | 1 | 5.44 | 1.77 | 1.36 | .27 | 4.34 | 2.15 | .00 | .00 |
| TGC | 1 | 1.00 | .33 | .56 | 1.12 | 1.36 | .67 | 2.13 | 1.31 |
| AC | 1 | .56 | .18 | 1.17 | 2.33 | .01 | .00 | 3.21 | 1.98 |
| TAC | 1 | 6.67 | 2.17 | .69 | 1.38 | 2.25 | 1.11 | .21 | .13 |
| GAC | 1 | 4.00 | 1.30 | .01 | .01 | .03 | .01 | 2.64 | 1.63 |
| TGAC | 1 | 1.78 | .57 | .44 | .87 | .34 | .17 | 4.52 | 2.78 |
| CS:TGA | 64 | 3.07 | | .50 | | 2.02 | | 1.62 | |
| PC | 1 | 95.06 | 60.46 | 16.67 | 45.57 | 138.06 | 108.06 | .21 | .18 |
| TPC | 1 | 4.34 | 2.76 | .11 | .30 | .11 | .09 | 4.17 | 3.51 |
| GPC | 1 | 4.00 | 2.54 | .34 | .93 | .25 | .20 | 8.75 | 7.37 |
| TGPC | 1 | 2.25 | 1.43 | .69 | 1.89 | 2.51 | 1.96 | 13.14 | 11.06 |
| APC | 1 | 12.84 | 8.17 | 2.25 | 6.15 | 12.25 | 9.59 | .04 | .04 |
| TAPC | 1 | 3.67 | 2.34 | .01 | .02 | .84 | .66 | .09 | .07 |
| GAPC | 1 | 2.25 | 1.43 | .25 | .68 | 1.17 | .14 | 2.13 | 1.79 |
| TGAPC | 1 | 5.44 | 3.46 | .01 | .02 | .03 | .02 | 1.27 | 1.06 |
| PCS:TGA | 64 | 1.57 | | .37 | | 1.28 | | 1.19 | |
| IC | 1 | 8.03 | 3.94 | 5.06 | 9.99 | .01 | .01 | 2.92 | 2.19 |
| TIC | 1 | 4.00 | 1.96 | .44 | .88 | 5.44 | 4.31 | .63 | .47 |
| GIC | 1 | .56 | .28 | .01 | .01 | .00 | .00 | 4.88 | 3.65 |
| TGIC | 1 | .34 | .17 | .25 | .49 | .06 | .05 | .02 | .01 |
| AIC | 1 | 1.78 | .87 | 1.00 | 1.97 | .44 | .32 | .92 | .69 |
| TAIC | 1 | .03 | .01 | .06 | .12 | 4.34 | 3.46 | .63 | .47 |
| GAIC | 1 | 3.67 | 1.80 | 1.00 | 1.87 | .84 | .67 | 2.64 | 1.98 |
| TGAIC | 1 | .17 | .09 | 2.51 | 4.94 | .69 | .55 | 1.89 | 1.42 |
| ICS:TGA | 64 | 2.04 | | .51 | | 1.25 | | 1.33 | |
| PIC | 1 | 2.78 | 1.09 | .11 | .27 | 3.36 | 2.04 | 3.52 | 2.09 |
| TPIC | 1 | .11 | .04 | .17 | .42 | .06 | .04 | .21 | 1.68 |
| GPIC | 1 | .06 | .02 | 1.78 | 4.13 | .01 | .00 | 17.02 | 10.13 |
| TGPIC | 1 | 4.34 | 1.70 | .17 | .42 | .69 | .42 | .92 | .55 |
| APIC | 1 | 1.00 | .39 | .17 | .42 | 3.67 | 2.23 | .39 | .23 |
| TAPIC | 1 | .44 | .17 | .03 | .07 | .69 | .42 | .09 | .05 |
| GAPIC | 1 | 15.34 | 6.02 | 1.17 | .42 | 1.00 | .61 | 2.13 | 1.27 |
| TGAPIC | 1 | .34 | .13 | 1.78 | 4.13 | .34 | .21 | .09 | .05 |
| PICS:TGA | 64 | 2.55 | | .41 | | 1.65 | | 1.68 | |

Code: T = Treatment, G = Gender, A = Ability, S = Subjects, P = Time of Posttest, I = Item Type, C = Condition (Speed or Power)

F ratios of 4.00 or above are significant at p=.05

Table E2 Analysis of Variance Tables for Number of Items Attempted on the Speeded Tests and Time Spent on the Power Tests of the Analogies Experiment

| | | Number of Items Attempted | | Time Spent on Power Tests | |
|---|---|---|---|---|---|
| Effects | df | Mean Square | F | Mean Square | F |
| Bet. Subj. | | | | | |
| T | 1 | 143.09 | 28.59 | 140.28 | 35.70 |
| G | 1 | 20.59 | 4.11 | .03 | .01 |
| TG | 1 | 16.53 | 3.30 | .59 | .15 |
| A | 1 | 5.84 | 1.17 | 1.25 | .32 |
| TA | 1 | 12.92 | 2.58 | 2.17 | .55 |
| GA | 1 | 1.53 | .31 | 2.92 | .74 |
| TGA | 1 | .59 | .12 | .17 | .04 |
| S:TGA | 64 | 5.01 | | 3.93 | |
| Within Subj. | | | | | |
| P | 1 | 157.53 | 85.28 | 27.50 | 23.95 |
| TP | 1 | 20.59 | 11.15 | 15.59 | 13.57 |
| GP | 1 | 2.17 | 1.17 | .17 | .15 |
| TGP | 1 | 1.25 | .68 | .03 | .03 |
| AP | 1 | 4.25 | 2.30 | 1.00 | .87 |
| TAP | 1 | 2.53 | 1.37 | .00 | .00 |
| GAP | 1 | .78 | .42 | .42 | .37 |
| TGAP | 1 | 2.92 | 1.58 | 2.53 | 2.20 |
| PS:TGA | 64 | 1.85 | | 1.15 | |
| I | 1 | 2707.25 | 974.64 | 126.67 | 99.88 |
| TI | 1 | 57.78 | 20.80 | 35.42 | 27.93 |
| GI | 1 | 2.53 | .91 | .78 | .62 |
| TGI | 1 | .03 | .01 | .03 | .02 |
| AI | 1 | 4.25 | 1.53 | 1.84 | 1.44 |
| TAI | 1 | 2.17 | .78 | 1.00 | .79 |
| GAI | 1 | .03 | .01 | .59 | .46 |
| TGAI | 1 | .42 | .15 | 4.25 | 3.35 |
| IS:TGA | 64 | 2.78 | | 1.27 | |
| PI | 1 | 50.84 | 26.94 | 7.03 | 8.36 |
| TPI | 1 | 3.34 | 1.77 | 2.53 | 3.01 |
| GPI | 1 | 7.67 | 4.06 | .17 | .20 |
| TGPI | 1 | 1.25 | .66 | .28 | .33 |
| API | 1 | .28 | .15 | .17 | .20 |
| TAPI | 1 | .00 | .00 | 1.53 | 1.82 |
| GAPI | 1 | .00 | .00 | 3.78 | 4.49 |
| TGAPI | 1 | .09 | .05 | .42 | .50 |
| PIS:TGA | 64 | 1.89 | | .84 | |

Code: T = Treatment, G = Gender, A = Ability, S = Subjects, P = Time of Posttest, I = Item Type

F ratios of 4.00 or above are significant at p=.05

Table E3 Analysis of Variance Table for Evaluation of Coaching Effectiveness for the Four Item Types by the Verbal Analogy Coaching Group

| Effects | df | Mean Square | F |
|---|---|---|---|
| Bet. Subjects | | | |
| G | 1 | .17 | .11 |
| A | 1 | .17 | .11 |
| GA | 1 | 1.56 | .99 |
| S:GA | 32 | 1.57 | |
| Within Subjects | | | |
| M | 3 | 8.73 | 24.59* |
| GM | 3 | .21 | .59 |
| AM | 3 | .03 | .07 |
| GAM | 3 | .08 | .23 |
| MS:GAM | 96 | .36 | |

Code: G = Gender S = Subjects *Sig. at p=.05
A = Ability M = Measures

Table E4 Analysis of Variance Tables for the Four Dependent Variables of the Full Design of the Series Experiment

| | | Number Correct | | Attitude | | Number Estimated Correct | | Accuracy of the Estimate | |
|---|---|---|---|---|---|---|---|---|---|
| Effects | df | Mean Square | F | Mean Square | F | Mean Square | F | Mean Square | F |
| Bet. Subj. | | | | | | | | | |
| T | 1 | 221.27 | 21.51 | 9.77 | 1.50 | 216.34 | 14.28 | 14.69 | 4.66 |
| G | 1 | 68.75 | 6.68 | 2.92 | .45 | 145.00 | 9.57 | 24.17 | 7.67 |
| TG | 1 | 31.64 | 3.08 | 53.17 | 8.16 | 70.14 | 4.63 | 12.84 | 4.07 |
| A | 1 | 325.50 | 31.65 | 1.67 | .26 | 296.13 | 19.55 | 7.56 | 2.40 |
| TA | 1 | 1.67 | .16 | .09 | .01 | 4.17 | .28 | 7.56 | 2.40 |
| GA | 1 | 10.84 | 1.05 | .09 | .01 | 3.52 | .23 | 4.69 | 1.49 |
| TGA | 1 | 13.14 | 1.28 | 2.92 | .45 | 11.39 | .75 | 12.25 | 3.89 |
| S:TGA | 64 | 10.29 | | 6.52 | | 15.15 | | 3.15 | |
| Within Subj. | | | | | | | | | |
| P | 1 | 7.34 | 2.56 | 7.79 | 6.41 | .63 | .32 | .03 | .03 |
| TP | 1 | 15.67 | 5.46 | .09 | .07 | 5.64 | 2.84 | .25 | .31 |
| GP | 1 | .04 | .01 | 1.09 | .89 | 2.92 | 1.47 | 3.67 | 4.53 |
| TGP | 1 | 2.38 | .83 | .02 | .02 | .21 | .11 | 1.17 | 1.45 |
| AP | 1 | .39 | .14 | 1.27 | 1.04 | 4.88 | 2.46 | .56 | .69 |
| TAP | 1 | .00 | .00 | 1.67 | 1.37 | .21 | .11 | .17 | .21 |
| GAP | 1 | 2.64 | .92 | 2.38 | 1.96 | .92 | .46 | 4.00 | 4.93 |
| TGAP | 1 | 5.64 | 1.97 | .09 | .07 | .00 | .00 | .44 | .55 |
| PS:TGA | 64 | 2.87 | | 1.21 | | 1.98 | | .81 | |
| I | 1 | 1781.54 | 398.55 | 17.71 | 8.47 | 1623.42 | 344.76 | .17 | .16 |
| TI | 1 | 131.29 | 29.37 | 6.89 | 3.29 | 87.89 | 18.66 | 9.51 | 8.50 |
| GI | 1 | 2.38 | .53 | .04 | .02 | 5.64 | 1.20 | 1.36 | 1.22 |
| TGI | 1 | .04 | .01 | 6.89 | 3.29 | 7.34 | 1.56 | .69 | .62 |
| AI | 1 | 89.46 | 20.01 | 31.64 | 15.14 | 104.21 | 22.13 | 3.36 | 3.01 |
| TAI | 1 | .21 | .05 | .02 | .01 | .39 | .08 | 2.25 | 2.01 |
| GAI | 1 | 2.92 | .65 | 4.52 | 2.16 | 12.54 | 2.66 | 3.67 | 3.29 |
| TGAI | 1 | 2.92 | .65 | 4.17 | 1.99 | 1.09 | .23 | 3.67 | 3.29 |
| IS:TGA | 64 | 4.47 | | 2.09 | | 4.71 | | 1.12 | |
| PI | 1 | .50 | .20 | .39 | .44 | 3.21 | .31 | 10.56 | 10.57 |
| TPI | 1 | 19.14 | 7.60 | 4.17 | 4.74 | 22.17 | 9.11 | 3.67 | 3.68 |
| GPI | 1 | .14 | .06 | .50 | .57 | .14 | .06 | 3.36 | 3.36 |
| TGPI | 1 | 4.17 | 1.65 | .00 | .00 | .29 | .12 | .03 | .03 |
| API | 1 | .04 | .02 | .14 | .16 | .77 | .31 | .00 | .00 |
| TAPI | 1 | 6.04 | 2.40 | .92 | 1.04 | 1.27 | .52 | .44 | .44 |
| GAPI | 1 | 19.14 | 7.60 | .63 | .71 | 10.84 | 4.45 | .06 | .06 |
| TGAPI | 1 | .92 | .37 | .63 | .71 | 1.89 | .78 | 1.17 | 1.17 |
| PIS:TGA | 64 | 2.52 | | .88 | | 2.43 | | 1.00 | |
| C | 1 | 763.14 | 379.43 | 3.21 | 7.26 | 669.52 | 367.36 | 9.51 | 6.20 |
| TC | 1 | .39 | .19 | .50 | 1.13 | .41 | .08 | 2.51 | 1.63 |
| GC | 1 | .50 | .25 | 1.46 | 3.30 | 5.25 | 2.88 | 2.25 | 1.47 |
| TGC | 1 | 1.09 | .54 | .09 | 1.92 | .04 | .02 | .11 | .07 |
| AC | 1 | 35.50 | 17.65 | .77 | 1.73 | 23.77 | 13.04 | 1.36 | .89 |
| TAC | 1 | .14 | .07 | .39 | .88 | 19.88 | 10.91 | .00 | .00 |
| GAC | 1 | 4.88 | 2.43 | .39 | .88 | .39 | .21 | .34 | .22 |
| TGAC | 1 | .02 | .01 | .02 | .04 | 8.75 | 4.80 | .00 | .00 |
| CS:TGA | 64 | 2.01 | | .44 | | 1.82 | | 1.53 | |
| PC | 1 | 48.42 | 32.73 | .39 | .84 | 7.79 | 4.65 | 1.56 | 1.60 |
| TPC | 1 | .92 | .62 | .00 | .00 | 2.38 | 1.42 | 1.17 | 1.20 |
| GPC | 1 | .09 | .06 | .09 | .18 | .77 | .46 | .03 | .03 |
| TGPC | 1 | .50 | .34 | .14 | .30 | 1.27 | .76 | .11 | .11 |
| APC | 1 | .77 | .52 | .21 | .45 | .14 | .08 | .11 | .11 |
| TAPC | 1 | .63 | .43 | .63 | 1.36 | .21 | .13 | 1.36 | 1.40 |
| GAPC | 1 | .00 | .00 | .00 | .00 | 1.09 | .65 | .17 | .78 |
| TGAPC | 1 | 1.89 | 1.28 | 1.09 | 2.35 | .04 | .03 | 1.17 | 1.78 |
| TCS:TGA | 64 | 1.48 | | .46 | | 1.67 | | .98 | |
| IC | 1 | 121.92 | 50.45 | .00 | .01 | 183.38 | 97.33 | 1.78 | 1.55 |
| TIC | 1 | 1.09 | .45 | .09 | .34 | .09 | .05 | .03 | .02 |
| GIC | 1 | 4.88 | 2.02 | .29 | 1.16 | 2.64 | 1.40 | 1.17 | 1.02 |
| TGIC | 1 | .21 | .09 | .02 | .06 | .21 | .11 | .17 | .15 |
| AIC | 1 | .77 | .32 | .00 | .01 | 2.38 | 1.26 | .01 | .01 |
| TAIC | 1 | 11.96 | 4.95 | 1.09 | 4.30 | 29.79 | 15.81 | .01 | .01 |
| GAIC | 1 | 1.27 | .53 | .00 | .01 | .92 | .49 | .44 | .39 |
| TGAIC | 1 | 2.13 | .88 | .00 | .01 | .39 | .21 | .03 | .02 |
| ICS:TGA | 64 | 2.42 | | .25 | | 1.88 | | 1.15 | |
| PIC | 1 | 13.75 | 7.28 | .00 | .00 | 29.79 | 19.74 | .11 | .10 |
| TPIC | 1 | 1.09 | .57 | .77 | 1.89 | 6.04 | 4.00 | .25 | .23 |
| GPIC | 1 | 3.52 | 1.86 | .21 | .52 | 1.27 | .84 | .56 | .51 |
| TGPIC | 1 | .77 | .41 | .39 | .97 | .29 | .19 | 4.34 | 3.97 |
| APIC | 1 | 2.64 | 1.40 | .63 | 1.55 | 1.09 | .72 | .84 | .77 |
| TAPIC | 1 | .14 | .07 | .92 | 2.72 | 1.27 | .84 | 2.01 | 1.83 |
| GAPIC | 1 | 6.89 | 3.65 | .77 | 1.89 | 5.25 | 3.48 | .03 | .03 |
| TGAPIC | 1 | 5.64 | 2.98 | .09 | .21 | .29 | .19 | .11 | .10 |
| PICS:TGA | 64 | 1.89 | | .40 | | 1.51 | | 1.09 | |

Code: T = Treatment, G = Gender, A = Ability, S = Subjects, P = Time of Posttest, I = Item Type, C = Condition (Speed or Power)

F ratios of 4.00 or above are significant at p=.05

Table E5 Analysis of Variance Tables for Number of Items Attempted on the Speeded Tests and Time Spent on the Power Tests of the Series Experiment

| | | Number of Items Attempted | | Time Spent on Power Tests | |
|---|---|---|---|---|---|
| Effects | df | Mean Square | F | Mean Square | F |
| Bet. Subj. | | | | | |
| T | 1 | 66.13 | 9.00 | 13.78 | 3.49 |
| G | 1 | 8.68 | 1.38 | 14.67 | 3.72 |
| TG | 1 | 9.39 | 1.49 | 1.53 | .38 |
| A | 1 | 231.13 | 36.62 | 56.00 | 14.19 |
| TA | 1 | 14.22 | 2.25 | 1.00 | .25 |
| GA | 1 | 2.00 | .32 | .09 | .02 |
| TGA | 1 | 4.01 | .64 | 7.67 | 1.94 |
| S:TGA | 64 | 6.31 | | 3.95 | |
| Within Subj. | | | | | |
| P | 1 | 7.35 | 3.74 | 11.28 | 9.94 |
| TP | 1 | 14.22 | 7.24 | 7.67 | 6.76 |
| GP | 1 | .50 | .25 | .59 | .52 |
| TGP | 1 | 1.68 | .86 | .17 | .15 |
| AP | 1 | .06 | .03 | .42 | .37 |
| TAP | 1 | 2.35 | 1.19 | .59 | .52 |
| GAP | 1 | .13 | .06 | .59 | .52 |
| TGAP | 1 | .50 | .25 | 3.34 | 2.94 |
| PS:TGA | 64 | 1.96 | | 1.13 | |
| I | 1 | 276.13 | 76.01 | 2183.50 | 698.94 |
| TI | 1 | 26.89 | 7.40 | .09 | .03 |
| GI | 1 | .00 | .00 | 2.53 | .81 |
| TGI | 1 | .01 | .00 | .42 | .13 |
| AI | 1 | 50.00 | 13.76 | 35.42 | 11.34 |
| TAI | 1 | 11.68 | 3.22 | .17 | .05 |
| GAI | 1 | .01 | .00 | .59 | .19 |
| TGAI | 1 | .06 | .01 | .59 | .19 |
| IS:TGA | 64 | 3.64 | | 3.12 | |
| PI | 1 | 46.72 | 26.53 | 6.42 | 5.88 |
| TPI | 1 | 1.13 | .64 | 11.28 | 10.34 |
| GPI | 1 | .01 | .01 | .03 | .03 |
| TGPI | 1 | .06 | .03 | 1.53 | 1.40 |
| API | 1 | 3.13 | 1.77 | .59 | .54 |
| TAPI | 1 | 3.56 | 1.99 | .28 | .26 |
| GAPI | 1 | 20.06 | 11.39 | .00 | .00 |
| TGAPI | 1 | 3.13 | 1.77 | .28 | .26 |
| PIS:TGA | 64 | 1.76 | | 1.09 | |

Code: T = Treatment, G = Gender, A = Ability, S = Subjects, P = Time of Posttest, I = Item Type

F ratios of 4.00 or above are significant at p=.05

Table E6 Analysis of Variance Table for Evaluation of Coaching Effectiveness for the Four Item Types by the Number Series Coaching Group

| Effects | df | Mean Square | F |
|---|---|---|---|
| Betw. Subj. | | | |
| G | 1 | .03 | .01 |
| A | 1 | 2.25 | .97 |
| GA | 1 | .03 | .01 |
| S:GA | 32 | 2.33 | |
| Within Subj. | | | |
| M | 3 | 15.45 | 42.25* |
| GM | 3 | .27 | .73 |
| AM | 3 | .19 | .53 |
| GAM | 3 | .05 | .13 |
| MS:GAM | 96 | .37 | |

Code: G = Gender S = Subjects *Sig. at p=.05
A = Ability M = Measures

Table E7 Analysis of Variance Table for Evaluation of Coaching Effectiveness for the Four Item Types by Both Groups

| Effects | df | Mean Square | F |
|---|---|---|---|
| Bet. Subjects | | | |
| T | 1 | 3.09 | 1.75 |
| G | 1 | .48 | .27 |
| TG | 1 | .07 | .04 |
| S:TG | 84 | 1.77 | |
| Within Subjects | | | |
| M | 3 | 2.83 | 7.90* |
| TM | 3 | 29.46 | 82.44* |
| GM | 3 | .15 | .41 |
| TGM | 3 | .46 | 1.30 |
| MS:TG | 252 | .36 | |

Code: G = Gender S = Subjects *Sig. at p=.05
A = Ability M = Measures