A FACTORIAL ANALYSIS OF SOME TESTS OF RIGIDITY

by

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TABLE OF CONTENTS

INTRODUCTION

Very generally by rigidity the writer understands a personality phenomenon which is determined by past experience, present experience, constitution--all or any of these (if they be deemed separable). It functions as a persisting effect, resisting forces that tend to produce changes in behavior.

Agreement on the nature of rigidity which may exist at this high level of generality tends to vanish as investigators attempt to describe rigidity more exactly. Definitions of rigidity are numerous and not always obviously related one to another. The writer does not propose to discuss here the multiplicity of existing rigidity definitions. In certain cases investigators appear to use similar words to refer to different things and different words to refer to the same thing. The consequent breakdown in communication may slow progress in understanding the common concept presumably involved.

No purely conceptual calculus exists for comparing different definitions of rigidity with one another, or for translating one into the other. Experimental arbitration of conceptual differences is possible, first, if we grant that what an investigator thinks rigidity is will determine the tests he constructs to measure it, and, second, if we know for each case concerned to what extent this is true. Investigators may differ widely in the degree to which their modes of measuring a phenomenon stem from their preexperimental notions concerning the nature of the phenomenon. High correlation between separate tests referred to as measures of rigidity does not imply equivalence of conceptualization until we know the degree to which conceptualization has determined the test for each case.

This study will relate scores on rigidity tests in order to reveal areas of functional unity and lines of cleavage in these tests. Common scientific curiosity about what does and what does not belong together is considered ample warrant for it. If this study can also function as an empirical check on conceptualization, or if it prepares the way for other studies to do this, so much the better.

The number of existing tests presumed to measure rigidity, perseveration, flexibility, or some correlative term is very great. The direct correlation of all these tests would involve an extremely lengthy study. The present study adopts a more practicable alternative which involves correlation of scores from a sample of rigidity tests. These tests are chosen to differ from each other in terms of properties which are believed to be important in differentiating the whole population of rigidity tests. The writer believes that the classification of rigidity tests into low level or motor and high level or "amotor" is meaningful and important. He therefore deliberately chose and constructed a sample of rigidity tests that differed along this alleged "level of complexity" dimension. If it is found, for example, that the motor and "amotor" tests in the sample are not functionally related (do not correlate highly) tentative statements can be made about the population of tests in the following manner: All existing disposition rigidity tests which can be assumed to be similar to the motor tests in the sample battery are not related to all existing tests which can be assumed to be similar to the "amotor" rigidity tests in the sample battery.

The eventual purpose, making statements about the population of rigidity tests, determines the choice of dimensions according to which our experimental sample of tests will vary. The dimensions believed to be crucially involved in the construction of the present battery and their relevance in terms of the general method just outlined will now be discussed.

Dimension I - Disposition Rigidity--Experimentally-Induced Set

The two properties apparently involved in defining this dimension may be related to some degree.

(1) Time spent in developing the disposition to be overcome.

Rigidity may be measured by the difficulty a subject has in substituting behavior, newly adequate to the situation, for previously established behavior, formerly adequate to the situation. The character and strength of the disposition which tends to keep on producing the inadequate behavior may be some function of the time spent in developing it. Hence there may be a difference between rigidity measured where (i) the disposition to be overcome is established within the testing situation, and where (ii) the disposition to be overcome is well entrenched, overlearned, or culturally induced.

(2) Recognition of the need for a change.

The factor which may be most crucial in mediating the presence or lack of required response in the rigidity situation is stated in terms of extreme cases.

(i) Once the subject sees that the situation now requires it, the requisite response follows more or less automatically.

(ii) We assume all subjects know what response the situation requires.

We then order them according to their ability to produce the adequate response in the face of previously established dispositions tending to produce other responses.

Luchins' (5) work with the "Einstellung effect" is best described in terms of the first alternatives in (1) and (2), and is cited as an example of the experimentally-induced set design as we have here defined it. By disposition rigidity the writer refers to the latter alternatives in (1) and (2), presumably exemplified in the present study by tests 3 to 8 and 13 to 16.

Walker, Staines, and Kenna (16) were the first to distinguish disposition rigidity experimentally. Cattell (1) claimed to have isolated a factor of disposition rigidity in a factorial analysis of seven tests presumed to measure disposition rigidity. All but one of these were motor tests.

Dimension II - Levels of Difficulty or Levels of Complexity

Cattell (1) and Fisher (3) in reviewing the history of rigidity studies have suggested that levels of complexity are an important way of stating the difference between many tests in the field. Some tests (e.g., writing "e" backwards) seem to require the exercise of somewhat "lower" functions than do other presumed tests of rigidity (e.g., the ability to classify material in many different ways).

Heretofore there has been no systematic attempt to define this dimension experimentally by deliberate construction of a battery of tests presumed to vary along it. This is at least partly because we do not know just what it is that is involved in differentiating one level of complexity from another.

The approach to a phenomenon on different levels is important methodologically in fields of study other than rigidity. Murphy (9, p. 171) describes Binet's approach to intelligence in these words:

> "It was his feeling that instead of approaching the big and the complex through the little and the simple, it was imperative to confront the big and the complex directly."

Nevertheless the subject's performance in simpler situations seems to be more easily and adequately described by testing situations which yield numerical scores. This is important either when the simpler situation is itself psychologically significant, or when the simpler situation is related to a psychologically significant or lifelike situation.

Grant that psychological significance goes with greater complexity, and the relations of tests on different levels of complexity involve important methodological questions. Does the complex of variables acting in more lifelike situations necessitate measurement of the organism's performance in each new and separate lifelike situation? Or will a simpler measure taken from a simpler testing situation allow us to predict either to a more complex situation or to many such situations at once?

In regard to rigidity, Luchins asks:

> "Is there a general factor of rigidity characteristic of all or much of a person's behavior? For example, is the same level of rigidity characteristic of one's motor activities as of his mental reactions? And are all of his mental (or motor) activities subject to the same level of rigidity?"

The foregoing section discussed the relevance and importance to this study of the dimensions which have been tentatively entitled

(I) disposition rigidity to experimentally induced set and (II) level of complexity. It has attempted to show that these dimensions may be employed in making statements about functional relations in the population of rigidity tests, statements which are based on functional relations found in a sample of rigidity tests.

Oliver and Ferguson's (12) study is a clear example of the method described above. They discussed and found favorable the evidence from factorial analysis indicating a factor of "amotor"* disposition rigidity. The study was designed to determine the relation of scores on these tests to scores on tests of reasoning ability, experimentally-induced set and perceptual rigidity as measured by the Gottschaldt figures test.

Fisher (4) presents the problem of levels of complexity much as Luchins does, and notes the lack of previous work on the problem. He states that a "complexity" and an "emotional involvement" parameter run through his battery which includes the following presumed measures of rigidity (4, p. 6):

1. Comparison of self with pictured persons
2. Trait judgments formed on the basis of pictures
3. Number of colored ribbons favorably reacted to
4. Rosenzweig picture frustration

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* The writer believes that we know more about what these tests do not involve than about what they do involve and that names such as "cognitive", "ideational", or "perceptual", imply the reverse. For the present, therefore, he proposes "amotor" as a more appropriate general designation for all tests which crucially require something other than the ability to move and coordinate skeletal muscle in an unusual way.

5. Number of groupings made in Vigotsky blocks
6. Range of interests
7. Number of interpretations of T. A. T. offered
8. Number of things the subject finds annoying, or thinks others find annoying
9. Number of things ink blots suggest to the subject
10. Degree to which level of aspiration fails to follow apparent success or failure in a hand steadiness test.

The relation of tests at different levels of complexity might have provided data relevant to the present study even though Fisher's tests are not obviously of the disposition rigidity type. We will suggest briefly why his data are not relevant to this study.

(a) Defects in Experimental Design (from the point of view of the present investigation).

(1) Significant trends in the data might be a function of "emotional involvement", not "level of complexity" if the tests actually do vary in two dimensions at once.

(2) Some of the tests require quite elaborate and abstruse rationales for understanding their relation to rigidity at all.

(3) There is no obvious continuum of complexity built into the test battery according to some a priori notion of the nature of complexity in rigidity.

(b) Experimental Data.

(1) Fisher spends the major portion of his study explaining his data from the point of view of the "emotional involvement" parameter while using the pattern of scores on groups of tests as itself a score.

(2)He grants that evidence for functional unity among his rigidity tests is inconclusive. Moreover, insofar as the exceptions taken to Fisher's experimental design are maintained, neither the lack or presence of functional unity would have bearing on the attempt to understand rigidity from the point of view of levels of complexity.

Cattell (1) factor analyzed seven tests "involving solely the 'creative effort' principle and confined largely, but not entirely, to motor performances." (p. 234) His rotated matrix (p. 236) is presented:

	Factor 1	Factor 2
1.	.76	-.06
2.	.35	-.30
3.	.37	.28
4.	-.01	.27
5.	.34	.13
6.	.42	-.33
7.	.79	.00

Tests 1, 6, and 7 were motor tests requiring reverse stroke writing. Tests 2 and 3 were motor tests closer to the alternation type. Tests 4 and 5 are speed of reversed reading tests. According to Cattell, "the first factor is clearly the general disposition rigidity factor, highest in reverse writing of letters and numbers, but present also in a 'perceptual' speed test--reading words written backwards." The writer accepts this study as good evidence for the existence of functional unity in motor tests.

Cattell and Tiner (2) factorized the correlation matrix yielded by 17 measures of 100 male college students. The centroid analysis yielded five factors which were rotated into simple structure.

MAIN LOADINGS ON FACTOR I

Description of Tests	Cattell's Interpretation of their meaning	Loadings
Finding hidden objects in pictures.	"Low ability to restructure habitual visual perception"	-.66
Performance under distraction compared with performance under normal conditions.	"Little attention to distracting situations."	-.57
Speed at which the subject reports flicker fusion.	"Low speed of flicker fusion"	+.44
Creative effort motor perseveration.	"High motor perseveration"	+.30
Number of things a subject judges could be present at a certain place in a drawing and number of things ink blots suggest.	"High fluency"	+.23

Cattell and Tiner call this factor "disposition rigidity." Another factor, factor III, is also "clearly in the area of behavior which experimenters have defined as rigidity" but "is distinct from the classical rigidity or 'p' factor" (p. 338). Involved in this factor are "low ability to reconstruct hidden words", "low ability to invent answers to riddles", "low speed of flicker fusion", "faithful repetition of Werner Tone Rhythm test", and "low ability to restructure habitual perception".

The writer agrees with Cattell and Tiner that this illustrates how some psychologists "in using the same term 'rigidity' . . . are assuming a single characteristic or process where, in fact, there are several" (p. 321).

STATEMENT OF THE PRESENT PROBLEM

The present study is a factorial analysis of two tests of reasoning ability, four measures of speed, four measures of "motor" disposition rigidity, and six tests presumed to measure "amotor" disposition rigidity.

(1) It aims to check again on the existence of a motor disposition rigidity factor.

(2) It extends and elaborates Oliver and Ferguson's (12) study as a check on the existence of a factor of "amotor" disposition rigidity. The writer tried to fill out this factor by adding to the three highest-loading Oliver and Ferguson (12) tests three which he devised to involve "amotor" disposition rigidity.

(3) This study begins the type of research Fisher (4, p. 1) called for by relating rigidity tests systematically designed to fall on different "levels of complexity". We may recognize two aspects of this question: One of them is similar to the questions raised in (1) and (2). Is a common factor of rigidity evidenced in all tests in spite of the fact that they differ in degree of complexity? Moreover, no matter what the pattern of intercorrelation is, we may be able to clarify conceptualization by an experimental (operational) definition of the dimension, levels of complexity. In this case, the definition might be given in terms of factor loading on one or more factors. This study includes tests of speed and reasoning ability for this purpose and also

(4) to relate tests of disposition rigidity to tests of mental ability and speed. It may be argued that the functional unity found

to pertain in some rigidity batteries is due more to a common component of reasoning ability and/or speed than to any factor of rigidity. Moreover, intelligence and rigidity are not always distinguished conceptually--witness Munn's (8, p. 410) definition of intelligence as "flexibility".

(5) This study yields data bearing on the relative merits of methods for scoring the motor disposition rigidity tests. It proposes and uses a new method.

(6) It includes a short discussion of problems relating to rotation for simple structure and discusses the results of rotation by two different methods.

EXPERIMENTAL PROCEDURE

A. Description of Tests

Tests 1 and 2

Two tests from Thurstone's A. C. E. (1947) battery were included as tests of reasoning ability.

Test 1 - Number Series Test

Each item consisted of a series of numbers which proceeded according to some rule. For each series the subject was required to find the number in the five possibilities listed to the right which completed the series according to this rule.

Sample items are:

1.	8	11	14	17	20	23		10	13	23	25	26
2.	27	27	23	23	19	19		15	16	17	18	19
3.	16	17	19	20	22	23		18	20	22	24	25

The answers are 26, 15, and 25 respectively. The time limit was eight minutes.

Test 2 - A. C. E. Verbal Analogies

The subject is given three words. He must find the word listed on the right which is related to the third word as the second word is related to the first.

Sample items are:

SKY - BLUE	GRASS -	GREEN	SOD	PATH	BLUE
ICE - SOLID	WATER -	HARD	FIRE	IRON	LIQUID
EAR - MUSIC	NOSE -	FACE	PERFUME	BREATH	TONE

The answere are GREEN, LIQUID, and PERFUME. The time limit was five minutes.

Tests 3 to 8

These tests were presumed to measure "amotor" or high level rigidity.

Test 3 - Reversed Reading

The subject was presented with a number of sentences of simple meaning. The letters making up the words were in reverse order (right to left) but the words making up the lines followed each other normally from left to right. The subject was required to read each sentence and mark it true or false.

Some sample items are:

YREVE ERAUQS SAH RUOF SEDIS. _____

EHT NUS NETFO SRAEPPA SA A
NEERG LLAB. _____

The sentences are True and False respectively. The time limit was four minutes.

Test 4 - Reversed Clock Reading

The subject was asked to give the approximate time indicated on each of 60 clock faces. Most of these clock faces were reversed (by the simple method of reversing the order of the 3, 6, 9, and 12 reference points). This made "later-than" a point counterclockwise in relation to the reference point instead of clockwise as in a normal clock face. (a) is a sample normal, (b) a sample reversed clock face.

(a)

(b)

The approximate times are 7:20 and 4:40 respectively. The time limit was four minutes.

Test 5 - Scheier's Arithmetic Test

This test consisted of 85 simple arithmetic problems involving the addition, subtraction, and multiplication of simple digits. One rule relating to multiplication and one rule relating to fractions was changed.

(1) If the smaller number comes first multiply as usual, but if the larger number comes first subtract the second number from the first to obtain the correct answer. Thus, while 4 x 6 is 24, 7 x 3 equals 4.

(2) Change each fraction so that it equals its numerator multiplied by its denominator (in that order). Thus, $\frac{5}{4}$ equals 5 x 4, $\frac{2}{3}$ equals 2 x 3.

Some problems involved one or the other of these changes but most involved both of them concurrently. Sample items are:

(i) $\frac{6}{3} - 2 =$ (ii) $\frac{3}{4} + 2 =$

The answers are 1 and 14 respectively. The time limit was four minutes.

Test 6 - Arithmetic Test

This test was devised by John Arthur Oliver (11). It consists of 60 simple arithmetic problems involving the addition, subtraction, multiplication and division of simple digits. In no case were more than four digits involved in a single problem. The subject's instructions were that for the purpose of this test a plus sign meant subtract, a minus sign meant add, a multiplication sign meant divide, and a divide sign meant multiply, the different operations being performed in sequence.

Sample items are:

5 + 3 =

3 x 3 - 1 =

7 + 9 + 3 x 2 =

The correct answers are 2, 2, and 30. The time limit was four minutes.

Test 7 - Alphabet Test

This test was devised by John Arthur Oliver (11). The subject is asked to write the letter of the alphabet which comes 2, 3, or 4 before the one listed, depending on the number written after the letter. For example, M - 3 signifies that the subject must write the letter in the alphabet that is three letters before M. This letter is J. Sample items are:

P - 3, D - 2, J - 4.

The answers are M, B, and F respectively. The test consisted of 52 items. The time limit was four minutes.

Test 8 - Opposites

This test was devised by John Arthur Oliver (11). The subject was asked to associate seasons of the year with the months January, August, October, and April. He was instructed to give the season normally associated with the month when the month appeared in capital letters, the season opposite to the normal one when the month appeared in small letters.

Sample items are:

october _____

AUGUST _____

OCTOBER _____

The answers are Spring, Summer, and Autumn respectively. The time

limit was three and one-half minutes. Subjects were allowed to abbreviate answers.

There were four motor tests. Each had an "X" and a "Y" phase.

<u>"Motor Creative Effort" - Reverse stroke "e"</u>

Phase X--the subject writes small "e" as fast as he can for thirty seconds.

Phase Y--the subject writes small "e" backwards as fast as he can for two minutes; i.e., he begins the "e" where he usually ends it and ends it where he usually begins it.

<u>"Motor Creative Effort" - Reverse Stroke "123"</u>

Phase X--the subject writes "123123123" as fast as he can for thirty seconds.

Phase Y--the subject writes "123123123" as fast as he can for two minutes but each number is written with a reverse stroke; i.e., he starts it where he usually ends it and ends it where he usually begins it.

<u>"Motor Creative Effort" - Mirror Image "Z"</u>

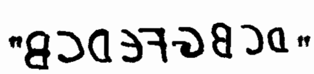
Phase X--the subject prints "Z" as fast as he can for thirty seconds.

Phase Y--the subject prints the mirror image form of "Z" (which is "Ƨ") as fast as he can for two minutes.

<u>"Motor Creative Effort" - Mirror Image "BCD"</u>

Phase X--the subject prints "BCDEFGBCDEFGBCDEFG" as fast as he can for thirty seconds.

Phase Y--the subject prints the mirror image forms of "BCDEFGBCDEFG" as fast as he can for two minutes. These mirror image forms are:

 .

B. Scoring

Higher scores on tests 1 to 8 were presumed to indicate better performance; i.e., more ability on the reasoning tests and less rigidity on tests 3 to 8. The traditional "4X - Y" score for the motor tests is presumed to be greater as there is more rigidity. This score, subsequently referred to as the "X - Y" score, is four times the number of items written forwards minus the number of items written backwards. An "X" and a "Y" score were also taken for each motor test. The "X" or "speed" score is the number of items written forwards, the "Y" score is the number of items written backwards or in an unusual way.

The scores for the motor tests are given with their numerical designations:

9. Writing "e" forwards.
10. Writing "BCD" forwards.
11. Writing "123" forwards.
12. Writing "Z" forwards.
13. Writing "e" backwards.
14. Writing "BCD" backwards.
15. Writing "123" backwards.
16. Writing "Z" backwards.
17. "4X - Y" for the "e" test.
18. "4X - Y" for the "BCD" test.
19. "4X - Y" for the "123" test.
20. "4X - Y" for the "Z" test.

Therefore, there are twenty scores represented in the correlation matrix.

C. The Sample and the Administration of Tests

The test battery was administered to sixty volunteers in six groups. All tests were administered in one session under uniform conditions for each group. Motivation appeared to be fairly high in all cases throughout the one and one-half hour session.

The group consisted of ten females and fifty males ranging in age from 16 to 52 years (or 16 to 32 years, when two cases of 42 and 52 years are disregarded). Fifty-one college students from McGill University and Sir George Williams College were in the group. These were fairly equally distributed between upperclassmen and underclassmen. Six subjects were high school students and the other three subjects were not students.

ANALYSIS OF RESULTS

The Correlation Matrix (See Table 1)

The writer proposes to give reasons for preferring the "Y" to the "X - Y" measure of motor rigidity, for purposes of this study at least. He considers no one of them conclusive but taken together they are impressive.

(a) Evidence for the Functional Similarity of "Y" and "X - Y" Scores.

(i) Correlations between the "Y" and "X - Y" scores were +.97 for the "e" test, +.94 for the "BCD" test, +.91 for the "123" test, and +.97 for the "Z" test.

(ii) The pattern of correlation coefficients of "Y" scores with all other scores (except other "Y" scores and "X - Y" scores) is very similar to the pattern of correlation coefficients for the same test using the "X - Y" scores.

(b) Evidence for the Preferability of the "Y" Score.

(i) The "Y" score seems more consistent for purposes of this study because the "amotor" rigidity tests (tests 3 to 8) are really "Y", not "X - Y" scores. Test 3, for instance, measures the speed with which the subject reads backwards not the difference between his forward and backward reading speed.

(ii) Intercorrelations among the "Y" scores are all positive and much higher than intercorrelations among the "X - Y" scores, one of which is negative. Mean intercorrelations are +.43 for the "Y" scores and +.18 for the "X - Y" scores.

It may be argued that speed makes intercorrelations of "Y" scores reveal a spuriously high functional unity. The inclusion of presumably

TABLE 1: INTERCORRELATIONS FOR THE TWENTY SCORES

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
1. Number Series	X	.56	.38	.42	.38	.40	.46	.23	.12	.15	.16	.09	.17	.33	.10	.19	.15	.33	.04	.20
2. Verbal Analogies		X	.25	.35	.18	.29	.42	.30	-.09	.12	.02	.01	.27	.33	.25	.18	.31	.34	.27	.21
3. Reversed Reading			X	.39	.20	.53	.55	.18	.15	.49	.32	.34	.26	.37	.37	.21	.24	.23	.26	.14
4. Reversed Clocks				X	.21	.19	.37	.20	.01	.21	.13	-.02	.05	.19	.18	.22	.05	.14	.14	.27
5. Scheier Arithmetic					X	.40	.27	.19	.11	.32	.08	-.01	.02	.27	.04	.11	-.02	.19	.01	.16
6. Oliver Arithmetic						X	.37	.32	.22	.38	.38	.24	.07	.35	.29	.12	.02	.25	.15	.07
7. Oliver Alphabet							X	.12	.00	.29	.11	.28	.21	.18	.26	.27	.23	.09	.24	.23
8. Oliver Opposite								X	.08	.36	.19	.20	.35	.45	.42	.27	.36	.38	.38	.26
9. "e" forwards									X	.38	.48	.53	.42	.33	.29	.38	.20	.23	.10	.28
10. "BCD" forwards										X	.24	.51	.38	.57	.45	.36	.31	.26	.39	.27
11. "123" forwards											X	.50	.36	.32	.42	.28	.27	.28	.01	.18
12. "Z" forwards												X	.42	.43	.41	.66	.31	.29	.22	.47
13. "e" backwards													X	.53	.41	.52	.97	.47	.29	.48
14. "BCD" backwards														X	.30	.40	.49	.94	.18	.34
15. "123" backwards															X	.44	.37	.17	.91	.39
16. "Z" backwards																X	.46	.32	.36	.97
17. "4X-Y" for "e"																	X	.02	-.20	.24
18. "4X-Y" for "BCD"																		X	.39	.35
19. "4X-Y" for "123"																			X	.25
20. "4X-Y" for "Z"																				X

"pure" speed scores in the battery (tests 9 to 12) will at least to some extent answer this objection by partialing out speed factorially.

(iii) The following data indicate that correlations of "Y" scores with other scores were higher than correlations derived from "X - Y" scores not only for speed tests, but for "amotor" rigidity tests as well. In 35 out of 40 possible comparisons, correlations derived from "Y" scores were higher. The average correlation of "Y" scores for all motor rigidity tests with speed tests was +.41; the corresponding figure for "X - Y" scores was +.26. The average correlation of "Y" scores for each motor rigidity test with all "amotor" rigidity tests was +.23; the corresponding figure for "X - Y" scores was +.19. Both scoring methods gave approximately the same size coefficients with the tests of reasoning ability.

(iv) The meaning of a score based on one performance ("Y") is clearer than the import of a score which is some combination of two separable performances ("X - Y" or "X/Y").

The six foregoing considerations lead the writer to propose that the "Y" score be used instead of some combination score ("X - Y" or "X/Y") in scoring motor disposition rigidity tests, with the proviso that the effects of speed are controlled as suggested. The "X - Y" scores (17 to 20) were not included in the factor analysis.

The Factor Analysis

The four factors extracted by centroid analysis (Table 2) were rotated by two methods.

TABLE 2

CENTROID FACTOR LOADINGS

Tests	I	II	III	IV
1.	.541	-.497	-.140	-.164
2.	.460	-.432	-.361	-.048
3.	.639	-.193	.288	.216
4.	.404	-.373	-.085	.194
5.	.365	-.309	.022	-.189
6.	.584	-.280	.390	-.204
7.	.545	-.376	.076	.333
8.	.494	-.001	-.185	-.143
9.	.450	.495	.122	-.192
10.	.664	.143	.125	.087
11.	.516	.281	.302	-.184
12.	.603	.532	.093	.171
13.	.573	.364	-.289	-.046
14.	.680	.110	-.144	-.210
15.	.584	.178	.081	.099
16.	.605	.353	-.291	.270

(1) Centroid axes were rotated two by two through specific tests. Approximately twenty possible rotations were tried until it was reasonably certain that close to the best possible simple structure attainable by this method had been reached.

(2) The writer then attempted to obtain a simple structure solution by rotating all the centroid axes at once through a forty-five degree angle.*

Although the first method produced a closer approximation to simple structure, it is proposed to base the interpretation of centroid factors on the second rotation (Table 3) for the following reasons:

(i) The interpretation of both factor matrices is very similar but the matrix produced by the second method presents a clearer picture in the writer's opinion.

(ii) The first method involves the rather abitrary assumption that the communality of the tests through which axes are rotated is concentrated in one or less than all of the factors.

(iii) The writer finally wished to test empirically a hypothesis to the effect that there is always a determinate relation between the position of axes at the end of the best possible centroid solution and the position of axes when the best possible simple structure has been achieved. Certain theoretical considerations lead him to believe that this relation is represented by a forty-five degree rotation of axes.

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* The writer is grateful to Dr. C. F. Wrigley for suggesting the transformation matrix required here (in Dr. Cyril Burt's unpublished lecture notes) and for instruction in the use of this matrix.

TABLE 3

ROTATED FACTOR MATRIX

All axes at once rotated through 45 degrees.

Tests	I	II	III	IV
1. Number Series	-.130	.506	.174	.530
2. Verbal Analogies	-.190	.602	.218	.290
3. Reversed Reading	.475	.379	-.029	.451
4. Reversed Clocks	.071	.527	-.039	.249
5. Scheier Arithmetic	-.055	.231	.111	.441
6. Oliver Arithmetic	.245	.135	.059	.729
7. Oliver's Alphabet	.288	.588	-.120	.332
8. Oliver's Opposites	.084	.268	.410	.226
9. Writing "e"	.437	-.179	.507	.135
10. Writing "BCD"	.508	.242	.298	.280
11. Writing "123"	.457	-.125	.339	.361
12. Writing "Z"	.698	.074	.436	-.004
13. Reverse stroke "e"	.301	.225	.635	-.017
14. Mirror image "BCD"	.218	.252	.572	.318
15. Reverse stroke "123"	.470	.222	.292	.193
16. Mirror image "Z"	.467	.407	.489	-.155

Two interpretations of the rotated matrix produced by the second method (Table 3) will now be given.

Interpretation 1

Factor I - Speed or Motor Speed

12.	Writing "Z"	.698
10.	Writing "BCDEFGBCDEFG"	.508
3.	Reversed reading	.475
15.	Reverse stroke "123"	.470
16.	Writing mirror image "Z"	.467
11.	Writing "123123"	.457
9.	Writing "e"	.437
13.	Writing reverse stroke "e"	.301
7.	Oliver's alphabet test	.288
6.	Oliver's reverse arithmetic	.245

The general pattern was to be expected on the basis of pre-experimental notions concerning the nature of the tests. The "speed" tests (tests 9 to 12) loaded this factor highest, the measures of motor disposition rigidity (tests 13 to 16) next highest, and some measures of "amotor" disposition rigidity (tests 3, 7, and 6) next highest. Other "amotor" disposition rigidity tests (tests 4, 5, and 8) had vanishing loadings in this factor and the tests of reasoning ability (tests 1 and 2) had slight negative loadings. Eye movement probably provides the component in the reversed reading test (test 3) which accounts for its high loading in this motor speed factor.

Factor II - Reasoning Ability

2.	Verbal analogies	.602
7.	Oliver's alphabet test	.588
4.	Reversed clocks	.527
1.	Number series	.506
16.	Writing mirror image "Z"	.407
3.	Reversed reading	.379
8.	Oliver's opposite seasons	.268
14.	Writing mirror image "BCDEFG"	.252

The two reasoning ability tests (tests 1 and 2) and "amotor" rigidity tests 7, 4, 3, and 8 have high loadings on this factor as might be expected. The fairly high loadings for writing "BCD" forwards and for all the motor rigidity tests (tests 13 to 16) are interpretable on the basis of the not impossible hypothesis that simple motor functions related to mental ability do exist. Notcutt (10, p. 207) found a significantly high correlation between tests of motor perseveration and intelligence. Vernon (15, p. 84) cites evidence indicating a "common element" in "mental speed tests and in tapping, dotting, writing, and tracing a simple maze . . .". Evidence such as this has apparently prevented any final decision in favor of a multiple factor (14) over a two factor (13) theory of factorial analysis.

Factor III - Motor or Low-level Rigidity

13.	Writing reverse stroke "e"	.635
14.	Writing mirror image "BCD"	.572

9.	Writing "e"	.507
16.	Writing mirror image "Z"	.489
12.	Writing "Z"	.436
8.	Oliver's opposite seasons	.410
11.	Writing "123"	.339
10.	Writing "BCD"	.298
15.	Writing reverse stroke "123"	.292

Each of the reverse speed or motor rigidity scores except 15 loads this factor higher than its forward speed counterpart. Oliver's opposite seasons test is clearly a test where the difficulty due to conflicting tendencies is not great. The shift required was easy and of an automatic nature. The loadings are consistent with the interpretation of this factor as involving ability to perform in an unusual way where the shift required is low level, motor, and not primarily symbolic.

Factor IV - "Amotor" Disposition Rigidity

6.	Oliver's arithmetic	.729
1.	Number series	.530
3.	Reversed reading	.451
5.	Scheier's arithmetic	.441
11.	Writing "123"	.361
7.	Oliver's alphabet	.332
14.	Writing mirror image "BCD"	.318
2.	Verbal analogies	.290
10.	Writing "BCD"	.280

4.	Reversed clocks	.249
8.	Oliver's opposite seasons	.226
15.	Writing reverse stroke "123"	.193

All the tests designed to measure "amotor" disposition rigidity load this factor highly, with the possible exception of Oliver's opposite seasons test. Moreover, the following table shows a similar pattern of rotated loadings for the rigidity tests common to this study and Oliver and Ferguson's (12).

	Oliver and Ferguson's Factor B	This Study's Factor IV
Oliver's Arithmetic	.525	.729
Oliver's Alphabet	.425	.332
Oliver's Opposites	.360	.226
Number Series	-.005	.530

The fact that Oliver and Ferguson's simple structure was oblique may explain the radical difference in loadings for the number series test.

It is possible that reasoning tests 1 and 2 involve rigidity in addition to reasoning ability. Both already have high loadings on a factor identifiable as reasoning ability. The number series test particularly quite plausibly involves the dropping of one hypothesis concerning the correct principle in order to adopt another.

The first interpretation distinguishes the following broad functional unities: speed (factor I), reasoning ability (factor II), motor or low level disposition rigidity (factor III), and "amotor"

or high level disposition rigidity (factor IV). The writer recognizes the possibility that the supposed lack of correlation between these abilities or functional unities may be a function of the factorial method used. If an oblique instead of an orthogonal solution had been successful, for example, factor III and factor IV might have been found to be negatively correlated. The orthogonal solution was quite meaningful and clear, however, and warrants the tentative conclusion that speed, reasoning ability, motor, and "amotor" disposition rigidity are in fact independent entities.

The presumed independence of motor and "amotor" disposition rigidities has important implications for our understanding of rigidity. Rigidity is a phenomenon of such a type that if a person is rigid in respect to motor, automatic, or low level matters, he may be either rigid or flexible in regard to high level, symbolic, or "amotor" behavior. From a knowledge of one case we can presume to know nothing about the other.

The implication for psychometrics is clear. When we wish to know something about a person's "amotor" rigidity we must test him in high level situations, not try to predict his performance in such situations from knowledge of his performance in simpler situations. Insofar as this is shown to be the case, the development of more adequate techniques for measuring performance in high level or lifelike situations becomes more important for the psychologist than the continued use and interrelation of measures of performance in simpler situations.

Interpretation 2

Considerations which lead the writer to propose a second interpretation of the rotated factor matrix will now be discussed.

If we grant that tests of reasoning ability (tests 1 and 2) can have high loadings in "amotor" disposition rigidity, factor IV, why is it not plausible to interpret factor II as a rigidity factor of another type? Such an interpretation would further be consistent with the high loadings of motor rigidity tests 13 to 16 on this factor. The assumption that intelligence and allegedly simple motor functions are related would no longer be required.

The interpretation of factor IV as simply "amotor" rigidity does not make obvious why writing "123", writing "BCD", and writing mirror image "BCD" should load that factor highly. More specific propositions about the nature of this factor seem to be required.

In the motor disposition rigidity factor (factor III) each "Y" loading except the one for reverse stroke "123" is higher than its "X" counterpart. This was to be expected. The surprising fact is that the "Y" loadings are not much higher than the "X" loadings. One would not expect simple operations performed in a normal way to have high loadings on a factor identifiable as rigidity. Reconsideration of the nature of the tasks involved in this case, however, makes acceptance of tests 9 to 12 as rigidity tests more plausible.

Writing "e" in the normal manner, for instance, may be to some extent a measure of rigidity in overcoming dispositions involved in writing "ℓ" forwards. Likewise, writing "Z" forwards is to some extent writing "S" backwards. It may be important to note, too,

that writing "Z" backwards is to some extent writing "S" forwards. If such allegedly "simple" tasks involve rigidity it may be that any task that might be devised involves some unaccustomed components and hence rigidity. The maxim would be that everything done forwards involves something done backwards. Moreover, this will be true regardless of what the experimenter happens to name the test (e.g., "pure" speed). It may be true whether or not the subject happens to recognize that the task he performs involves some unaccustomed components.

Cattell and Tiner's (2) isolation of two factors identifiable as rigidity supports the suggestion that this phenomenon may indeed occur at many independent levels of functioning.

If the interpretation is accepted that "speed" tests (9 to 12) involve appreciable rigidity components, there remain but two tests in the battery not interpretable on a priori grounds as rigidity tests. The first interpretation suggested how one of these tests, number series, could be thought to involve rigidity. The second interpretation's description of all the factors as rigidity factors may not be unwarranted, then, in terms of the content of the tests in the battery. Although more radical than the first interpretation, the second interpretation is to some extent an extension of it influenced by the several considerations just discussed.

Factor I - Ability to perform against weak low level interfering dispositions (measured by speed).

Let us suppose that all tasks involve some unaccustomed components and the supposed "speed" tests (tests 9 to 12) generally involve the

overcoming of weaker interfering dispositions than do the other tests. Factor I is on this basis more properly interpreted as lowest level rigidity.

Factor II - Ability to perform (or organize) against "amotor" or high level interfering dispositions of a visual or spatial nature.

Both Oliver's and Scheier's arithmetic tests, involving numerical, symbolic, and presumably non-spatial operations, are sharply lower in loading as compared with factor IV. Test 12 may involve spatial imagery in visualizing what "lies behind" a letter in an oft-seen alphabet. It is finally quite plausible to suppose that motor rigidity tests (13 to 16) involve some spatial type reorientation in writing letters in unusual ways. Spatial reorientation seems most clearly involved in mirror image writing and the two mirror image tests (14 and 16) do in fact load factor II more highly than do the other "Y" scores.

"Spatial rigidity" factor II may involve "reasoning" tests just as does rigidity factor IV. The fact that tests which on preexperimental grounds were believed to measure motor as well as "amotor" rigidity load factor II appreciably suggests that it is in fact some sort of a rigidity factor and not a reasoning factor as the first interpretation proposed. The discussion of factor IV will emphasize that while factor II is primarily visual and spatial in nature, factor IV is primarily symbolic. Such a difference is not clearly consistent with the identification of one factor as reasoning ability, the other as rigidity. An alternative is to call these factors spatial and visual reasoning ability. Such an interpretation would be forced to explain high motor loadings

on both these factors, however. It is finally more reasonable to suppose that ten tests designed to measure rigidity (tests 3 to 8 and 13 to 16) would determine two rigidity factors than to suppose that two tests designed to measure reasoning ability would determine two reasoning ability factors.

Factor III - Ability to perform against fairly strong low level interfering dispositions (measured by speed).

The motor or low level rigidity factor in the first interpretation becomes an intermediate level rigidity in the second interpretation. Tests which involve low level or motor interfering dispositions of moderate strength (tests 13 to 16) load this factor most highly.

Factor IV - Ability to perform against "amotor" or high level interfering dispositions of a symbolic type (measured by speed).

Oliver's arithmetic, number series, and Scheier's arithmetic have high loadings on this factor. All involve symbolic numerical operations. It is not difficult to maintain that the reversed reading test involves symbolic as well as other components. The high loading of test 11, writing "123", may be related to the fact that, in common with tests 1, 5, and 6, it involves numbers. There seems to be a more significant fact for interpretation, however. Writing "123" and "BCD" in both normal and unusual ways seems to be separate from the rest of the motor speed and rigidity tests in terms of loading on this factor. The other motor tests (tests 9, 12, 13, and 16) require the repetition of the same operation. But writing "2" is different from writing "1" and writing "G" is different from writing "F", etc. This difference seems more

important in determining the loadings for factor IV than the fact that tests 9 to 12 involve reversed operations.

It may be that some sort of satiation effect is more important in the tests where there is repetition of the same operation, "e" or "Z". Another tentative hypothesis fits into the interpretation of factor IV much more directly, however. The repetitive performance of a single operation may require little more than continuing motor or skeletal orientations. It may be that some rudimentary sort of memory, hence covert and symbolic reaction begins to be required where performance involves different operations separated in time.

The second interpretation finds at least four independent types of rigidity, weak motor (factor I), stronger motor (factor III), "amotor" spatio-visual (factor II), and "amotor" symbolic (factor IV). It suggests tentatively that types of rigidity may be distinguished from one another both because of the strength of the dispositions to be overcome, the distinction between factors I and III, and because of the type of disposition to be overcome, the distinction between factors II and IV, and possibly the distinction between factors I or III and factors II or IV. The relation of speed and reasoning ability to each other and to rigidity is not wholly clear in this interpretation. Even if it is true that the presumed speed and reasoning ability tests might have determined factors of their own in a differently constituted battery, it also appears true that both types of test may involve in addition large rigidity components.

To say that there are independent rigidities involved in performing at different levels of complexity is not necessarily to deny the

importance of defining this dimension operationally. We may still want to place a given rigidity test according to the level of functioning required of the subject. The following speculation is largely an exercise to show how factorial analysis may be used to define an important dimension such as levels of complexity. It presents a hypothesis which is subject to empirical verification, however.

Speed tests 9 to 12 load factor I highest, then factor III, and load lowest in factors IV and II. The reasoning tests load lowest in factor I, higher in factor III, and highest in factors II and IV. The dimension along which we have isolated weak low level motor rigidity, stronger low level motor rigidity, and "amotor" symbolic rigidity and spatio-visual rigidity is consistently characterized by decreasing speed loadings and increasing reasoning ability loadings. Suppose then we construct a battery composed of many speed, reasoning ability, and rigidity tests. We may be able to assign the rigidity tests definite level of complexity ratings--high level when they have low speed confirmed by high reasoning ability loadings, or low level when they have higher speed loadings confirmed by lower loadings in the reasoning ability factor. Experimental confirmation of the hypothesis might come when the rigidity tests are found to group in higher and lower level factors according to the operational definition of level of complexity given by the ratio or difference of their loadings in the speed and reasoning ability factors. Such mutual confirmation is not necessarily useless duplication. The ten rigidity tests which might group in four level of complexity factor steps could be placed on a continuum by means of the ratio of their loadings on

speed and reasoning ability factors. Moreover, general confirmation of the hypothesis would allow us to determine one rigidity test's level of complexity without including many other rigidity tests in the same battery. It is not even necessary to do a new factor analysis on the larger correlation matrix formed by the addition of each rigidity test to the original matrix composed of speed and reasoning ability tests. (7)

CONCLUSIONS, INTERPRETATIONS, AND SUGGESTIONS

This section includes conclusions common to both interpretations of our rotated factor matrix.

(1) The present study proposes a method of rotating axes into the simple structure position. This method implies that the relation between the position of centroid axes when the best centroid solution has been obtained and the position of rotated axes when the best possible approximation to simple structure has been obtained is a constant for any factorial analysis. The hypothesis that this relation is represented by rotation of all axes through a forty-five degree angle was partially confirmed, since an approximation to simple structure was in fact obtained by this method. This approximation did not appear quite as good as the approximation to simple structure obtained through two by two rotations, and the success of the method may be due to special conditions pertaining only to this study. Moreover, final confirmation of the hypothesis would seem to require that it be given exact mathematical statement.

(2) This study concludes in favor of a "Y" as opposed to an "X - Y" score for purposes of scoring motor disposition rigidity tests.

(3) The "Y" method of scoring confirms the existence of a factor of motor disposition rigidity.

(4) The existence of an "amotor" disposition rigidity factor or factors is confirmed.

(5) A method for operationally defining the dimension, levels of complexity, is tentatively proposed.

(6) Whether or not reasoning ability and speed are related to rigidity, it appears that components of certain speed and reasoning ability tests may be involved in rigidity factors.

(7) Rigidity at one level of performance may not be functionally related to rigidity at another level of performance. The first interpretation delineates two independent rigidities, motor and "amotor". The second interpretation describes four independent rigidities and tentatively suggests that both the type and the strength of the disposition to be overcome can determine functional independence. This interpretation includes an a priori analysis of tasks (such as writing "e") which makes reasonable the assumption that most or all behavior may involve some rigidity components. The suggested manyness and ubiquity of rigidity is completely consistent with the interpretation of the nature of rigidity which follows.

Rigidity may refer not so much to an ability measured as to one mode of measuring any ability. One may measure scholastic aptitude, for instance, using an analogy type test or again using a completion type test. The supposition is that the same phenomenon is being measured in two different ways. A test which requires the subject to perform operations significant in scholastic aptitude in an unusual way may be as much another way of testing scholastic aptitude as it is the exemplification of some pervasive personality characteristic called rigidity, for one type of material. It is possible that high level of scholastic ability can be expressed equally well in completion, analogic, or reverse type operations, and consequently may be measured as well by tests requiring one type of operation as by tests requiring the other.

It may be that the child who does his lessons well forwards could also do them well backwards. It is interesting to note in this connection that throughout the present study similarity of content of motor operation determined similarity of factor loadings to a large extent. For instance, writing "123" forwards was often closer in loading to writing "123" backwards than to other forward type operations.

An experiment that will bear on the line of reasoning outlined in the preceding paragraphs immediately suggests itself. The test battery will include tests of several abilities which might be expected to be reasonably independent. Each of these abilities will be measured in several different ways. These may include analogy and completion type tests, etc. and finally a rigidity type test which requires the performance of operations important in the ability in unusual ways. Finally, the battery will include other rigidity tests.

Will test content (type of ability measured) or mode of measurement determine functional unities or factors? If and where rigidity is more properly a mode of measurement, it will enter into the determination of functional unities in much the same way as do the other modes of measurement. The rigidity type test of reasoning ability might load the reasoning factor with the other types of reasoning test, for instance. If and where rigidity is an ability expressible in many different types of operations, the rigidity techniques of measuring abilities like reasoning ability and manual dexterity will form a functional unity with the other rigidity tests. The writer proposes to conduct this study.

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APPENDIX

The twelve tests used in this study are reprinted on the following pages.

SPEED OF WRITING TEST
(LETTERS)

NAME _____

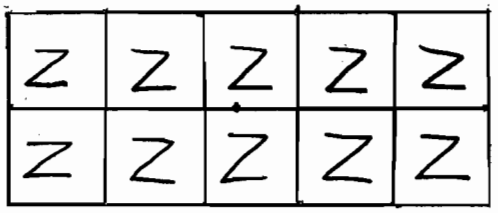
AGE _____ SEX _____ DATE _____

INSTRUCTIONS

1. This is a writing speed test. Your task is to print the letter "Z" as fast as you can.

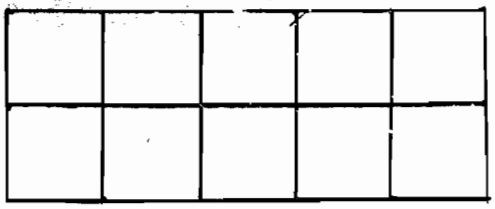
2. Your paper will be marked off into blocks. You must put each letter in a separate block. Only legible letters will be counted on your score.

3. This is what your paper should look like:



Notice that the letters are printed, not written, and that these are capital letters, not small letters.

4. Now try a few lines for practice:



5. If you have any questions about the test ask them now. When the signal is given (not yet) turn to the next page and print "Z" as fast as you can. Work as rapidly as you can. YOU HAVE ONLY THIRTY SECONDS IN WHICH TO WORK.

DO NOT TURN THIS PAGE UNTIL YOU ARE TOLD TO DO SO

SPEED OF WRITING TEST
(MIRROR IMAGE LETTERS)

NAME _____

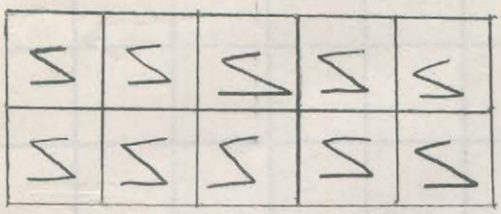
AGE _____ SEX _____ DATE _____

INSTRUCTIONS

1. This is a writing speed test. Your task is to print the letter "Z" as fast as you can. In this test, however, print the letter in its mirror image form.

2. Your paper will be marked off into blocks. You must put each letter in a separate block. Only legible letters will count on your score.

3. This is what your paper should look like. Look at this example carefully until you are certain you know what is meant by the mirror image form of "Z".



4. Now try a few lines for practice:

5. If you have any questions about the test ask them now. When the signal is given (not yet) turn to the next page and print "Z" in its mirror image form as fast as you can. Work as rapidly as you can. YOU HAVE ONLY TWO MINUTES IN WHICH TO WORK.

DO NOT TURN THIS PAGE UNTIL YOU ARE TOLD TO DO SO

SPEED OF WRITING TEST
(NUMBERS)

NAME _____

AGE _____ SEX _____ DATE _____

INSTRUCTIONS

1. This is a writing speed test. Your task is to write "123123123" etc. as fast as you can.

2. Your paper will be marked off into blocks. You must put all numbers within the blocks, each within a separate block. Only legible numbers will count on your score.

3. This is what your paper should look like:

1	2	3	1	2
3	1	2	3	1

4. Now try a few lines for practice:

5. When the signal is given (not yet) turn to the next page and write the numbers as fast as you can. If you have any questions about the test ask them now. Work as rapidly as you can. YOU HAVE ONLY THIRTY SECONDS IN WHICH TO WORK.

DO NOT TURN THIS PAGE UNTIL YOU ARE TOLD TO DO SO.

SPEED OF WRITING TEST
(NUMBERS WITH REVERSE STROKES)

NAME _____

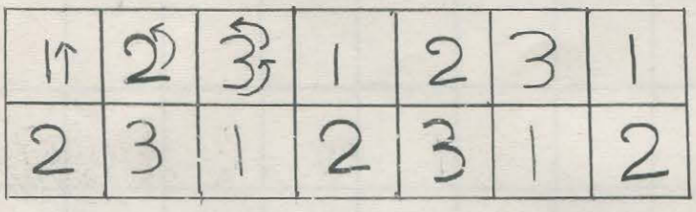
AGE _____ SEX _____ DATE _____

INSTRUCTIONS

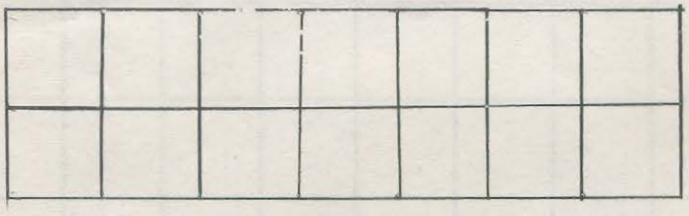
1. This is a speed of writing test. Your task is to write "123123123" etc. as fast as you can. In this test, however, you must reverse the direction of your movement in writing each figure. Thus you start each figure at the point where you usually end it and finish it at your usual starting point.

2. Your paper will be marked off into blocks. You must put each number in a separate block. Only legible numbers will count on your score.

3. Your paper should look just as it did in the first test. The direction your pencil moves in making each number is the reverse of normal, however. The arrows drawn in for the first three numbers in the example show the direction your pencil should move as it makes the numbers.



4. Now try a few lines for practice:



5. If you have any questions about the test ask them now. When the signal is given (not yet) turn to the next page and write the numbers as fast as you can. Work as rapidly as you can. You have only two minutes in which to work.

DO NOT TURN THIS PAGE UNTIL YOU ARE TOLD TO DO SO

SPEED OF WRITING TEST
(LETTERS)

NAME _____

AGE _____ SEX _____ DATE _____

INSTRUCTIONS

1. This is a writing speed test. Your task is to print "BCDEFGBCDEFG" etc. as fast as you can.

2. Your paper will be marked off into blocks. You must put each letter in a separate block. Only legible letters will count on your score.

3. This is what your paper should look like:

B	C	D	E	F
G	B	C	D	E

4. Now try a few lines for practice:

5. If you have any questions about the test ask them now. When the signal is given (not yet) turn to the next page and print the required letters as fast as you can. Work as rapidly as you can. YOU HAVE ONLY THIRTY SECONDS IN WHICH TO WORK.

DO NOT TURN THIS PAGE UNTIL YOU ARE TOLD TO DO SO

SPEED OF WRITING TEST
(MIRROR IMAGE LETTERS)

NAME _____

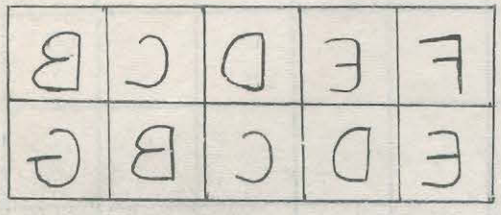
AGE _____ SEX _____ DATE _____

INSTRUCTIONS

1. This is a writing speed test. Your task is to print "BCDEFGBCDEFG" etc. as fast as you can. In this test, however, print the letters in their mirror image form.

2. Your paper will be marked off into blocks. You must put each letter in a separate block. Only legible letters will count on your score.

3. This is what your paper should look like. Look at this example carefully until you are certain you know what is meant by the mirror image form of each of these letters.



4. Now try a few lines for practice:

5. If you have any questions about the test ask them now. When the signal is given (not yet) turn to the next page and print the letters "BCDEFGBCDEFG" etc. in their mirror image form as fast as you can. Work as rapidly as you can. YOU HAVE ONLY TWO MINUTES IN WHICH TO WORK.

DO NOT TURN THIS PAGE UNTIL YOU ARE TOLD TO DO SO.

SPEED OF WRITING TEST
(LETTERS)

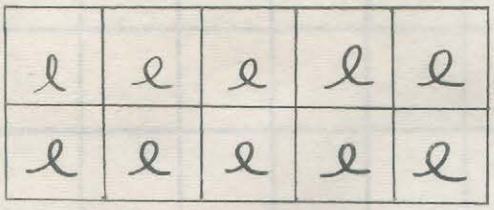
NAME _____

AGE _____ SEX _____ DATE _____

INSTRUCTIONS

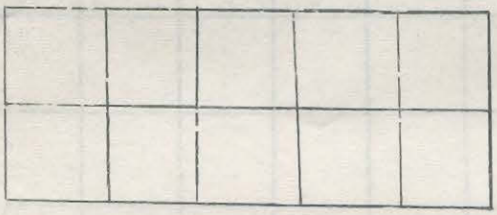
1. This is a writing speed test. Your task is to write "eeeeeeeee" etc. as fast as you can. Your paper will be marked off into blocks. You must put each letter in a separate block. Only legible letters will count on your score.

2. This is what your paper should look like:



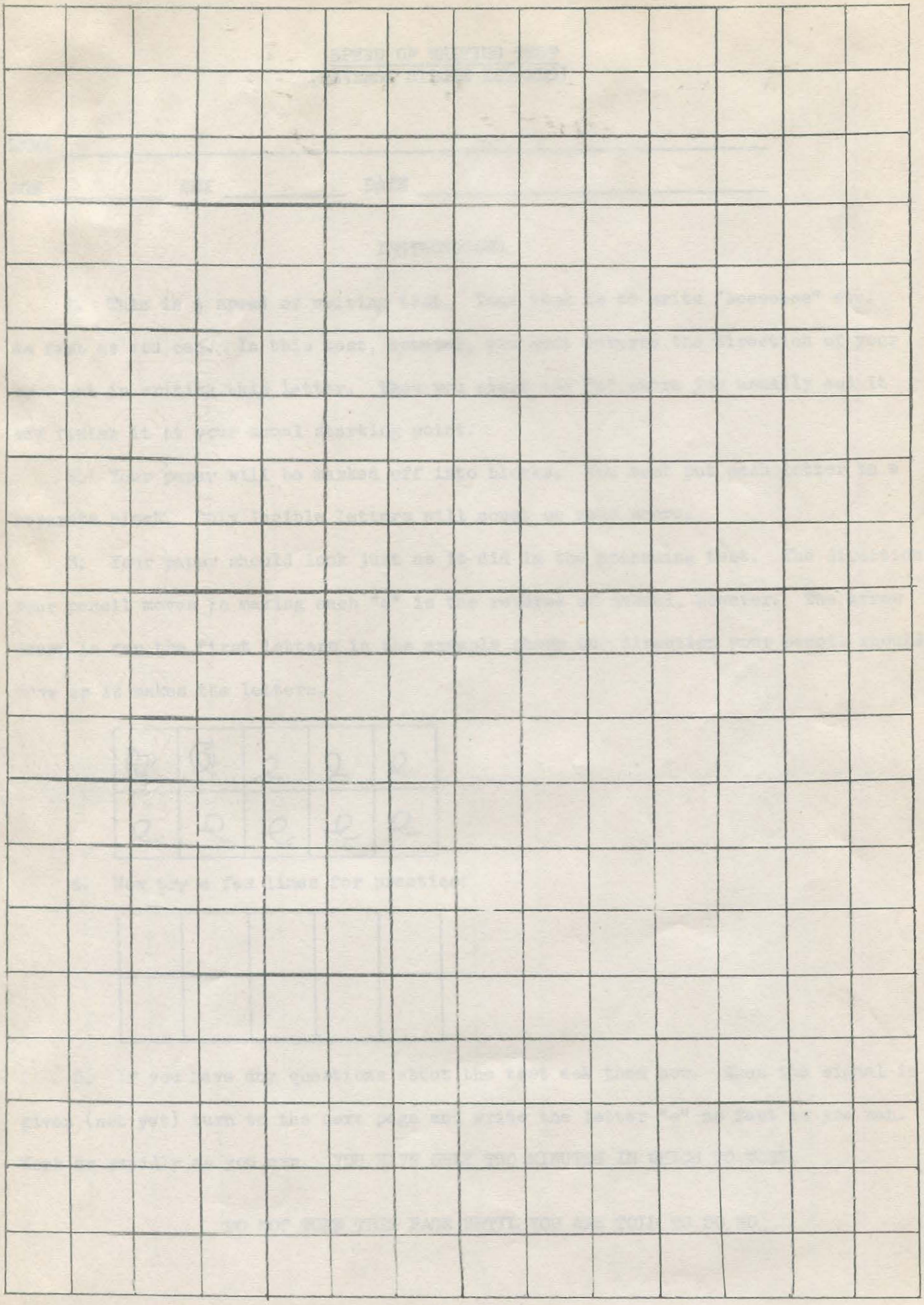
Notice especially that there is no connection from one "e" to another.

3. Now try a few lines for practice:



4. If you have any questions about the test ask them now. When the signal is given (not yet) turn to the next page and write the letter "e" as fast as you can. Work as rapidly as you can. YOU HAVE ONLY THIRTY SECONDS IN WHICH TO WORK.

DO NOT TURN THIS PAGE UNTIL YOU ARE TOLD TO DO SO



SPEED OF WRITING TEST
(REVERSE STROKE LETTERS)

NAME _____

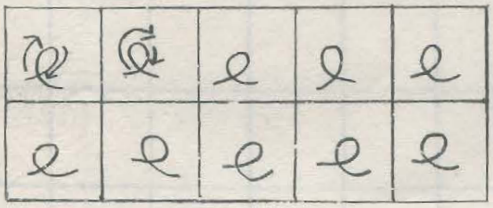
AGE _____ SEX _____ DATE _____

INSTRUCTIONS

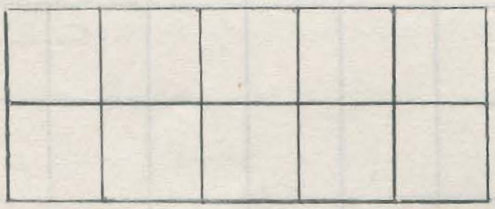
1. This is a speed of writing test. Your task is to write "eeeeeeee" etc. as fast as you can. In this test, however, you must reverse the direction of your movement in writing this letter. Thus you start the "e" where you usually end it and finish it at your usual starting point.

2. Your paper will be marked off into blocks. You must put each letter in a separate block. Only legible letters will count on your score.

3. Your paper should look just as it did in the preceding test. The direction your pencil moves in making each "e" is the reverse of normal, however. The arrow drawn in for the first letters in the example shows the direction your pencil should move as it makes the letters.



4. Now try a few lines for practice:



5. If you have any questions about the test ask them now. When the signal is given (not yet) turn to the next page and write the letter "e" as fast as you can. Work as rapidly as you can. YOU HAVE ONLY TWO MINUTES IN WHICH TO WORK.

DO NOT TURN THIS PAGE UNTIL YOU ARE TOLD TO DO SO

ARITHMETICAL PROBLEMS

NAME _____

AGE _____ SEX _____ DATE _____

INSTRUCTIONS

1. This test consists of a number of arithmetical problems involving addition, subtraction and multiplication. Certain rules of arithmetic have, however, been changed. These include a rule relating to multiplication and a rule relating to the use of fractions.

2. Consider first the rule relating to multiplication. In ordinary arithmetic four multiplied by three is equal to three multiplied by four. It doesn't matter which number comes first, the product is the same in both cases: $3 \times 4 = 4 \times 3$.

In this test, this rule is changed. Three multiplied by four equals twelve as before, but four multiplied by three equals one. If the smaller number comes first we multiply as usual but if the larger number comes first, we subtract the second number from the first number to obtain the correct answer.

3. Look at these examples:

(a) $4 \times 6 = 24$
$7 \times 3 = 4$
$2 \times 1 = 1$
$3 \times 6 = 18$

(b) Now try these:

$3 \times 2 =$
$2 \times 6 =$
$8 \times 4 =$
$6 \times 3 =$

Your answers should have been 1, 12, 4, and 3 respectively.

4. Consider now the rule relating to fractions. In ordinary arithmetic $\frac{6}{2}$ means that six is divided by two and this is of course equal to three; that is $\frac{6}{2} = 6 \div 2 = 3$. In this test six over two will mean six multiplied by two (<u>not</u> two multiplied by six). All fractions are changed so that they are equal to the numerator (top figure) multiplied by the denominator (the bottom figure): that is, $\frac{6}{2} = 6 \times 2$.

Look at these examples:

(a) $\frac{5}{4} = 5 \times 4$

(b) $\frac{2}{3} = 2 \times 3$ (<u>not</u> 3×2)

GO RIGHT AHEAD TO THE NEXT PAGE

ARITHMETICAL PROBLEMS (CONTINUED)

5. In this test both the rule relating to multiplication and the rule relating to fractions are changed. Notice what happens when we use both of these new rules at once in our arithmetic.

(a) Look at these examples:

(i) $\frac{4}{3} = 1$ ($\frac{4}{3} = 4 \times 3$ and $4 \times 3 = 1$) (ii) $\frac{2}{3} = 6$ ($\frac{2}{3} = 2 \times 3$ and $2 \times 3 = 6$)

(b) Now try these:

(i) $\frac{7}{4} =$

(ii) $\frac{2}{4} =$

Your answers should have been 3 and 8 respectively.

6. The ordinary rules relating to addition and subtraction are not changed. You will have problems where you must use both the ordinary rules relating to addition and subtraction and the new rules relating to multiplication and fractions:

(a) Look at these problems:

(i) $2 + \frac{5}{3} = 4$ $\left[\frac{5}{3} = 5 \times 3 = 2 \text{ and } 2 + 2 = 4\right]$

(ii) $\frac{7}{3} - \frac{1}{3} = 1$ $\left[\frac{7}{3} = 7 \times 3 = 4, \quad \frac{1}{3} = 1 \times 3 = 3 \text{ and } 4 - 3 = 1\right]$

(b) Now try these problems:

(i) $\frac{4}{2} - 1 =$

(ii) $\frac{3}{4} + 2 =$

Your answers should have been 1 and 14 respectively. You need not show how you arrived at your answer as has been done in 6(a). All you need to do is write down the correct answer.

7. When the signal is given (not yet) turn to the next page and do as many problems as you can. The time allotment for this test is five minutes. You probably will not have time to finish but stop immediately when the stop signal is given. If you have any questions about the test, ask them now.

Work as rapidly and as accurately as you can.

DO NOT TURN THIS PAGE UNTIL YOU ARE TOLD TO DO SO

ARITHMETICAL PROBLEMS

$2 \times 3 =$

$4 \times 2 =$

$5 \times 1 =$

$2 \times 1 =$

$3 \times 6 =$

$\frac{5}{6} =$

$\frac{4}{2} =$

$2 \times 5 =$

$7 \times 1 =$

$6 \times 5 =$

$\frac{3}{5} =$

$\frac{4}{2} + 1 =$

$\frac{4}{1} =$

$\frac{6}{3} - 2 =$

$2 \times 4 =$

$\frac{3}{4} + 2 =$

$\frac{4}{3} + 2 =$

$\frac{3}{6} - 8 =$

$\frac{1}{3} =$

$\frac{5}{3} + 1 =$

$5 \times 4 =$

$6 \times 1 =$

$6 \times 4 =$

$4 + \frac{3}{2} =$

$4 \times 5 =$

$6 \times 1 =$

$\frac{9}{7} + \frac{1}{3} =$

$\frac{8}{1} =$

$\frac{5}{4} =$

$6 \times 8 =$

$5 \times 1 =$

$\frac{1}{5} =$

$\frac{2}{4} =$

$\frac{3}{1} =$

$\frac{6}{7} - 2 =$

$\frac{15}{10} =$

$10 \times 4 =$

$\frac{6}{1} =$

$\frac{1}{2} =$

$\frac{2}{1} =$

$2 \times 6 =$

$10 \times 8 =$

$\frac{4}{5} =$

$\frac{10}{6} =$

GO RIGHT AHEAD TO THE NEXT PAGE

ARITHMETICAL PROBLEMS

$\frac{3}{4} - \frac{1}{4} =$

$10 \times 20 =$

$\frac{8}{4} =$

$\frac{1}{4} + 4 =$

$3 \times 2 =$

$\frac{3}{6} + \frac{6}{3} =$

$5 \times 1 =$

$\frac{3}{1} =$

$\frac{2}{4} - 4 =$

$10 \times 2 =$

$\frac{5}{3} =$

$\frac{4}{5} + \frac{8}{4} =$

$\frac{10}{5} =$

$6 \times 5 =$

$4 \times 5 =$

$\frac{7}{10} =$

$10 \times 9 =$

$\frac{6}{3} + \frac{10}{2} =$

$\frac{4}{6} - 4 =$

$10 \times 3 =$

$\frac{7}{1} =$

$2 \times 8 =$

$3 \times 10 =$

$\frac{1}{5} + \frac{3}{1} =$

$\frac{1}{3} + \frac{6}{3} =$

$8 \times 10 =$

$\frac{8}{7} + \frac{3}{4} =$

$\frac{3}{6} - \frac{4}{2} =$

$\frac{10}{3} + 5 =$

$10 + \frac{2}{4} =$

$\frac{4}{3} + \frac{3}{4} =$

$\frac{1}{2} + \frac{10}{5} =$

$\frac{6}{4} - \frac{1}{2} =$

$\frac{6}{10} + 10 =$

$\frac{3}{8} - \frac{5}{1} =$

$\frac{5}{10} + \frac{10}{5} =$

$\frac{2}{1} + \frac{1}{2} =$

$\frac{4}{2} + \frac{3}{6} =$

$\frac{5}{6} + \frac{1}{3} =$

$8 \times 5 =$

$\frac{3}{5} - 5 =$

REVERSED READING TEST

NAME _____

AGE _____ SEX _____ DATE _____

INSTRUCTIONS

1. In this test the letters making up the words are in reverse order (right to left) but the words making up the sentences and lines follow each other normally from left to right. You will be asked to read the sentences and mark them true (T) or false (F).

2. Look at this example:

YREVE ERAUQS SAH
RUOF SEDIS. T

The sentence says, "Every square has four sides.", which is true. Consequently a "T" has been marked in the space provided.

3. Now try these examples:

(a) ON RETTAM EREHW UOY OG ELPOEP ERA ELPOEP. T

(b) LAERTNOM SAH YNAM SESUB. _____

(c) NODNOL DNA WEN KROY ERA EHT SEMAN FO SEITIC. _____

(d) EHT NUS NETFO SRAEPPA SA A NEERG LLAB. _____

The answers to these sentences are not difficult once you understand them. Sentence (a) is true and "T" has been written in the space provided. The correct answers for (b), (c), and (d) are true, true, and false respectively, consequently "T", "T", and "F" should have been marked in the spaces provided.

4. When the signal is given (not yet) turn to the next page and do as many as you can. The time allotment for this test is five minutes. You probably will not have time to finish but stop immediately when the stop signal is given. If you have any questions about the test, ask them now.

Work as rapidly and as accurately as you can.

DO NOT TURN THIS PAGE UNTIL YOU ARE TOLD TO DO SO

REVERSED READING

EMOS ELIBOMOTUA STNEDICCA
ERA DESUAC YB SSELERAC GNIVIRD. ____

EW LLET EMIT YB GNIKOOL TA
RUO SKCOLC. ____

SKLOF HTIW EULB RIAH ERA A
NOMMOC THGIS. ____

YREVE YAD TA EVIF EMOS REMRAF
SEVIRD S1H SWOC NWOD EKOORBREHS
TEERTS. ____

FI UOY TOOHS NA WORRA OTNI EHT
RIA. TI LLIW YLLAUTNEVE LLAF
OT HTRAE. ____

FI UOY KOOL NI A RORRIM OUY
EES FLESRUOY. ____

SIHT YTIC SI DLOC NI EHT RETNIW. ____

NEVES TUO FO THGIE SEIBAB NAC
KLAW TA HTRIB. ____

NEHW UOY EES EHT CIFFART THGIL
NRUT NEERG UOY POTS RUOY RAC. ____

YDOBYREVE NI EHT DLROW SEVOL
NILATS. ____

TSOM ELPOEP NAC ETIRW LLEW HTIW
RIEHT SEOT. ____

UOY NAC DLIUB SEMOH TUO FO KCIRB. ____

SREPAPSWEN EVIG SU EHT SWEN MORF
TSAL RAEY. ____

SLICNEP ERA YLLAUSU DESU OT NEPO
SNAC. ____

EW ESU A LOOP OT MIWS NI. ____

REGNIF SLIAN DLUOHS EB TUC
ECIWT A YAD. ____

EHT SEVAEL EVAEL EHT SEERT NI
EHT LLAF. ____

EMOS ELPOEP NI CEBEUQ OD TON
KAEPS HCNERF ____

UOY ERA WON GNIKAT A TSET. ____

EHT NOOM DNA EHT NUS ERA EHT
EMAS GNIHT. ____

NERDLIHC ERA SA A ELUR RELLAMS
NAHT STLUDA. ____

EHT ENOHPELET SI TNATROPMI
ESUACEB TI SI DOOG OT TAE. ____

NEVES DNA EERHT DDA PU OT NET. ____

SESROH KAEPS REHTAR DOOG
SHILGNE. ____

NEERG DNA DER DNA OSLA
WOLLEY ERA SROLOC. ____

EREH NI LAERTNOM EHT
ERUTAREPMET REVEN SEOG
WOLEB OREZ. ____

SROLIAS EVAEL RIEHT SPIHS
YLNO NI SMROTS. ____

EREHT ERA YNAM HSIF NI
EHT TRESED. ____

NEM REVO NEVES TEEF LLAT ERA
REHTAR ERAR. ____

SGOD SYAWLA EVIL OT EB A
DERDNUH. ____

EHT ELBIB SI A SUOIGILER KOOB. ____

NOISIVELET SA NA TNEMNIATRETNE
MUIDEM SI ETIUQ TNEICNA. ____

RUOY NIARB SI DETACOL NI RUOY
DAEH. ____

STAC ERA YLLAUSU RELLAMS NAHT
ECIM. ____

RUOF SULP THGIE SEVIG UOY
EVLEWT. ____

EW KLAW YB GNITTUP ENO TOOF
NO POT FO EHT REHTO. ____

EMOS ELPOEP NAC NUR RETSAF
NAHT SREHTO. ____

"DLO SKLOF TA EMOH" SI EHT
EMAN FO A ESAESID. ____

SOMIKSE EVIL NO EHT ROTAUQE. ____

YEKCOH SI A RALUPOP TROPS NI
MAIS ____

TSOM EERHT RAEY DLO NERDLIHC
ERA TA TSAEL XIS TEEF LLAT. ____

STLUDA NAC YLLAUSU EKAT ERAC
FO SEVLESMEHT RETTEB NAHT SEIBAB. ____

ELPOEP SEMITEMOS TEG TRUH
GNITHGIF SRAW. ____

TSOM ELPOEP EVAH OWT SDNAH HTIW
NET SREGNIF NO HCAE DNAH. ____

NI EHT TEBAHPLA "A" SYAWLA
SWOLLOF "B". ____

TSOM NEM TRATS GNIVAHS EROFEB
YEHT ERA OWT SRAEY DLO. ____

OPPOSITES TEST

NAME _____

DATE _____

AGE _____ SEX _____

INSTRUCTIONS

1. This is a test in which you are asked to associate a season of the year with a month of the year. The four months used in the test and the seasons to which they of course refer are as follows :
January (Winter), August (Summer), October (Autumn), April (Spring).

2. BUT - in this test you will sometimes be asked to reverse the seasons in such a way that Summer = Winter, Winter = Summer, Spring = Autumn, and Autumn = Spring. This reversal takes place when the month is printed in small letters. When it is printed in capitals then the ordinary unchanged association should be made. For instance the season that goes with "april" is not Spring but Autumn because the month is written in small letters. If it had been written "APRIL" then Spring would have been the right answer. Here are some other examples:

OCTOBER	Autumn
august	Winter
JANUARY	Winter

3. Try the following - you may abbreviate the months using the first two letters, thus Au, Sp, Su, Wi for Autumn, Spring, Summer, Winter.

october	_____
AUGUST	_____
OCTOBER	_____

The answers are, in their abbreviated form, Sp, Su, Au respectively.

4. When the signal is given (not yet) turn the page and do as many as you can. Work as rapidly and as accurately as possible and stop immediately when the stop signal is given.

DO NOT TURN THIS PAGE UNTIL YOU ARE TOLD

CIPOSITES TEST

APRIL	_____	october	_____	OCTOBER	_____
august	_____	AUGUST	_____	JANUARY	_____
AUGUST	_____	JANUARY	_____	august	_____
OCTOBER	_____	APRIL	_____	APRIL	_____
april	_____	january	_____	OCTOBER	_____
AUGUST	_____	OCTOBER	_____	AUGUST	_____
JANUARY	_____	JANUARY	_____	october	_____
OCTOBER	_____	august	_____	APRIL	_____
august	_____	APRIL	_____	january	_____
AUGUST	_____	AUGUST	_____	april	_____
OCTOBER	_____	april	_____	october	_____
january	_____	OCTOBER	_____	AUGUST	_____
august	_____	JANUARY	_____	january	_____
april	_____	APRIL	_____	AUGUST	_____
october	_____	august	_____	OCTOBER	_____
JANUARY	_____	october	_____	april	_____
APRIL	_____	OCTOBER	_____	AUGUST	_____
october	_____	APRIL	_____	january	_____
AUGUST	_____	january	_____	JANUARY	_____
OCTOBER	_____	AUGUST	_____	APRIL	_____
august	_____	October	_____	august	_____
APRIL	_____	april	_____	AUGUST	_____
JANUARY	_____	october	_____	october	_____
AUGUST	_____	AUGUST	_____	JANUARY	_____
april	_____	JANUARY	_____	APRIL	_____
APRIL	_____	october	_____	january	_____
OCTOBER	_____	APRIL	_____	april	_____
JANUARY	_____	january	_____	august	_____
october	_____	AUGUST	_____	october	_____
january	_____	april	_____	JANUARY	_____

ARITHMETIC TEST

NAME _____

DATE _____

AGE _____ SEX _____

DO NOT TURN THIS PAGE UNTIL YOU ARE TOLD

INSTRUCTIONS

1. This test consists of a number of easy mathematical problems involving addition, subtraction, multiplication, and division. BUT the signs have been changed in the following way :

+ means subtract

- means add

x means divide

÷ means multiply

2. Here is an example :

8 ÷ 4 = 32 because we read the division sign as a multiplication sign so it is 8 multiplied by 4 = 32.

3. Try these :

6 x 3 ÷ 2 =

5 ÷ 2 + 1 =

The answers to the above problems are 4 and 9 respectively.

4. When the signal is given (not yet) turn to the next page and do as many problems as you can. Work as quickly and as accurately as you can.

DO NOT TURN THIS PAGE UNTIL YOU ARE TOLD

ARITHMETIC TEST

5 + 3 =

4 x 2 =

9 ÷ 3 =

8 − 4 =

3 x 3 =

5 + 5 =

6 x 3 =

6 − 5 =

4 ÷ 2 =

7 + 3 =

6 + 3 − 2 =

5 + 4 − 7 =

3 − 9 + 6 =

8 x 2 − 1 =

6 ÷ 3 x 9 =

4 − 2 x 2 =

9 + 6 − 4 =

8 x 2 + 3 =

1 − 7 x 4 =

5 ÷ 3 − 2 =

9 x 3 + 2 =

5 + 3 − 2 =

3 x 3 + 1 =

6 ÷ 2 + 3 =

8 x 2 + 1 =

4 − 4 ÷ 8 =

7 ÷ 9 + 3 x 2 =

1 + 3 − 5 ÷ 4 =

2 ÷ 6 x 4 − 7 =

6 − 8 x 7 ÷ 4 =

4 x 2 − 3 + 1 =

5 x 5 − 4 ÷ 5 =

8 + 4 − 1 ÷ 3 =

9 + 2 ÷ 3 − 1 =

3 ÷ 9 − 4 + 7 =

5 ÷ 4 − 5 + 6 =

7 + 1 x 2 x 3 =

8 ÷ 2 − 4 x 5 =

8 − 3 + 5 x 3 =

3 + 2 ÷ 9 − 7 =

5 ÷ 5 − 2 + 8 =

4 x 2 − 2 ÷ 4 =

3 ÷ 3 − 1 + 2 =

4 + 4 ÷ 4 − 1 =

7 + 1 ÷ 3 x 2 =

5 − 3 x 4 + 1 =

9 x 3 + 2 ÷ 9 =

6 ÷ 3 − 2 x 2 =

8 x 2 ÷ 5 − 4 =

3 x 3 − 5 ÷ 2 =

4 ÷ 2 + 1 − 5 =

7 + 3 − 5 x 3 =

5 x 5 − 8 ÷ 4 =

2 − 2 ÷ 4 x 8 =

6 + 2 x 4 ÷ 9 =

8 ÷ 3 − 1 x 5 =

1 + 3 − 4 ÷ 7 =

9 x 3 + 2 ÷ 9 =

6 − 4 ÷ 2 + 5 =

6 ÷ 4 − 4 x 7 =

ALPHABET TEST

NAME _____

DATE _____

AGE _____ SEX _____

INSTRUCTIONS

1. This is a test to see how well you know the alphabet. In every case you are asked to write the letter which comes 2, 3, or 4 before the one listed. In other words L - 3 means that you must write down the third letter before L in the alphabet. This letter of course is I.

2. Consider the following examples :

P - 3 M

D - 2 B

J - 4 F

The letter M is the third letter before P in the alphabet, the letter B the second letter before D, and F the fourth letter before J.

3. Now try the following :

H - 3 _____

Y - 4 _____

T - 2 _____

The answers are E, U, and R respectively.

4. When the signal is given (not yet) turn to the next page and do as many as you can. You probably will not have time to finish but stop immediately when the stop signal is given.

Work as rapidly and as accurately as you can.

DO NOT TURN THIS PAGE UNTIL YOU ARE TOLD

ALPHABET TEST

D - 2	_____	N - 2	_____
K - 3	_____	H - 3	_____
G - 2	_____	V - 2	_____
M - 4	_____	Q - 4	_____
Q - 3	_____	E - 3	_____
O - 2	_____	W - 4	_____
C - 2	_____	L - 3	_____
F - 2	_____	P - 2	_____
I - 3	_____	Z - 4	_____
E - 2	_____	S - 2	_____
U - 4	_____	K - 3	_____
X - 2	_____	O - 2	_____
R - 2	_____	U - 3	_____
N - 2	_____	G - 2	_____
H - 3	_____	J - 3	_____
P - 2	_____	D - 3	_____
W - 4	_____	M - 4	_____
S - 3	_____	R - 3	_____
Z - 2	_____	Y - 3	_____
L - 3	_____	T - 2	_____
V - 2	_____	Z - 2	_____
Y - 4	_____	F - 3	_____
J - 3	_____	X - 4	_____
T - 4	_____	R - 2	_____
Q - 3	_____	W - 3	_____
O - 3	_____	H - 2	_____

From: A.C.E.
PSYCHOLOGICAL EXAMINATION
L.L. & T.G. Thurstone

NUMBER SERIES

NAME _____ INITIALS _____

DATE _____

DO NOT TURN OVER THE PAGE

UNTIL YOU ARE TOLD

1. The numbers in each series below proceed according to some rule. For each series you are to find the next number. For example, in this series, (the numbers on the left) each number

   2 4 6 8 10 12 10 11 12 13 (14)

   is 2 larger than the preceding number. The next number in the series would be 14. The number 14 in the row of numbers to the right has, therefore, been circled to show that it is the next number in the series

2. Find the rule for this series (on the left) and draw a circle around that number (in the group on the right) which comes next in the series:

   10 8 11 9 12 10 9 10 11 12 13

   This series goes by alternate steps of subtracting 2 and adding 3; therefore, you should circle the number 13, on the right.

3. Try the following for practice; circle the answer on the right:

   8 11 14 17 20 23 10 13 23 25 26

   27 27 23 23 19 19 15 16 17 18 19

   16 17 19 20 22 23 18 20 22 24 25

4. When the signal is given (not yet) turn over the page and work more problems of the same kind. Work as quickly as you can.

5. Wait for the signal.

1.	3	5	7	9	11	13	15	11	13	15	17	19
2.	17	20	23	26	29	32	35	37	38	39	40	41
3.	2	4	8	16	32	64	128	129	160	192	256	512
4.	8	11	9	12	10	13	11	7	9	12	14	15
5.	2	2	3	3	5	5	8	5	8	9	10	11
6.	10	11	10	9	10	11	10	8	9	10	12	13
7.	17	19	16	18	15	17	14	11	12	13	15	16
8.	22	20	23	21	24	22	25	21	23	25	27	28
9.	5	9	10	14	15	19	20	21	24	25	26	30
10.	3	6	8	16	18	36	38	40	48	68	76	80
11.	3	2	4	3	6	5	10	4	9	10	12	20
12.	8	24	12	36	18	54	27	3	9	12	54	81
13.	8	9	12	13	16	17	20	19	20	21	22	23
14.	70	68	34	32	16	14	7	0	1	3	4	5
15.	0	1	3	6	10	15	21	23	25	28	29	30
16.	14	15	13	16	12	17	11	5	13	18	22	23
17.	18	20	17	21	16	22	15	8	17	21	23	30
18.	4	7	6	6	9	8	8	5	7	8	10	11
19.	0	1	10	2	20	3	30	1	2	3	4	40
20.	14	16	19	13	15	18	12	6	10	14	15	18
21.	20	25	30	36	42	49	56	59	60	62	63	64
22.	50	43	37	31	26	21	17	12	13	14	15	16
23.	20	16	8	24	20	10	30	15	23	26	28	90
24.	0	1	3	4	5	7	8	6	7	8	9	10
25.	4	6	3	7	9	6	10	5	7	12	14	15
26.	54	45	37	30	24	19	15	12	13	14	16	17
27.	32	16	19	20	10	13	14	7	14	15	17	28
28.	45	54	18	27	9	18	6	2	8	9	12	15
29.	11	14	18	22	27	32	38	40	43	44	45	46
30.	89	78	87	76	67	56	65	45	54	56	74	76

From: A.C.E.
PSYCHOLOGICAL EXAMINATION
L.L. & T.G. Thurstone

VERBAL ANALOGIES

NAME _____ INITIALS _____

DATE _____

DO NOT TURN OVER THE PAGE

UNTIL YOU ARE TOLD

1. Read the following words:

FOOT-SHOE HAND- THUMB HEAD GLOVE FINGER

The first two words, FOOT-SHOE are related in some way. The next word is HAND. It can be combined with one of the remaining words in the row to make a similar pair HAND-GLOVE; so, we would underline the word GLOVE. Consider the following:

FATHER-SON MOTHER- AUNT SISTER CHILD DAUGHTER

Here, the word to be combined with MOTHER is DAUGHTER, to give the same relationship that exists between FATHER-SON. We should, therefore, underline the word DAUGHTER.

Thus, in each row of words, the first two form a pair. The third word can be combined with another word to form a similar pair; such a word will be found among those that remain.

2. Try the following for practice: underline the related words:

SKY-BLUE GRASS- GREEN SOD PATH BLUE

ICE-SOLID WATER- HARD FIRE IRON LIQUID

EAR-MUSIC NOSE- FACE PERFUME BREATH TONE

CATTLE-HAY MAN- EAT BREAD WATER LIFE

3. When the signal is given (not yet) turn over the page and work more problems of the same kind. Work as quickly as you can.

4. Wait for the signal.

1.	cow-animal	carrot-	radishes	tree	turnip	plant
2.	hunter-gun	fisherman-	game	fish	wet	pole
3.	painter-picture	sculptor-	artist	statue	decorator	photograph
4.	tree-forest	person-	child	couple	women	crowd
5.	bird-airplane	fish-	water	swims	submarine	fins
6.	darkness-sunlight	stillness-	moonlight	summer	boy	noise
7.	dinner-nutrition	golf-	club	course	exercise	tournament
8.	wagon-wheel	sled-	snow	ski	runner	toboggan
9.	mason-stone	smith-	wood	oil	metal	land
10.	game-referee	trial-	lawyer	defendant	judge	court
11.	medicine-dose	meat-	portion	meal	platter	protein
12.	duty-neglect	law-	penalty	restraint	violation	statute
13.	iron-rust	bread-	mold	butter	stale	wheat
14.	team-harmony	rivals-	group	solo	prize	opposition
15.	salesman-commission	novelist	publishers	interest	royalty	allowance
16.	munitions-armory	food-	table	feast	pantry	stove
17.	watch-second	calendar-	year	month	day	hour
18.	glass-transparent	wood-	opaque	dry	heavy	lumber
19.	camera-film	recorder-	music	symphony	photograph	disc
20.	suspect-convict	charge-	allege	dismiss	prove	offend
21.	digit-number	letter-	word	stationery	spelling	news
22.	band-march	orchestra-	music	party	dance	hotel
23.	wild-cultivated	woods-	forest	orchids	mushroom	greenhouse
24.	engine-cab	plane-	stabilizer	cockpit	propeller	engine
25.	automobile-gasoline	bullet-	soldier	powder	rifle	bomb

(OVER)

26.	ferry-bridge	elevator-	skyscraper	stairs	electricity	freight
27.	honors-diploma	bonus-	tip	salary	contract	salesman
28.	history-authority	fiction-	news	romance	novel	imagination
29.	roof-pitch	hill-	height	mountain	altitude	grade
30.	bird-wings	fish-	fins	gills	scales	swims
31.	platinum-lead	satin-	silk	dress	shiny	gingham
32.	disease-sanitation	accident-	doctor	caution	hospital	cleanliness
33.	discount-prompt	penalty-	tax	overdue	punish	pay
34.	kennel-Collie	coop-	chicken	Leghorn	rooster	hen
35.	medley-music	hash-	food	mixture	dinner	chopper
36.	landscape-photograph	concert-	recital	record	applause	critic
37.	ice-tongs	board-	saw	hammer	vise	lumber
38.	blister-burn	bruise-	cut	bleed	blow	sore
39.	ocean-gulf	continent-	cape	hill	bay	land
40.	Wednesday-week	July-	year	day	August	month

CLOCK READING

NAME _____

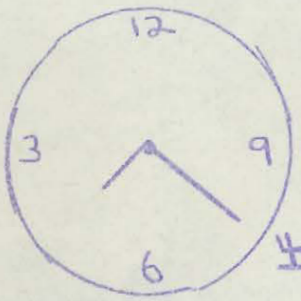
AGE _____ SEX _____ DATE _____

INSTRUCTIONS

1. In this test you will be presented with a number of clock faces. In some the numbers will run clockwise (the normal way) and in others the numbers will run counterclockwise. In both cases your task is to write down the approximate time that the clock hands indicate. You need not be exact.

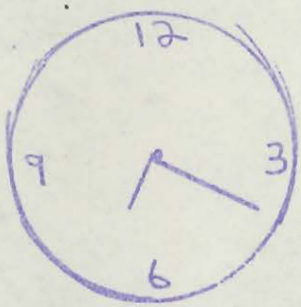
2. Look at these examples:

(a)



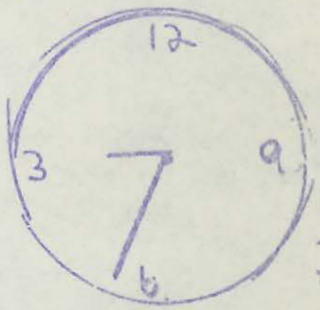
4:40

(b)



7:20

(c)

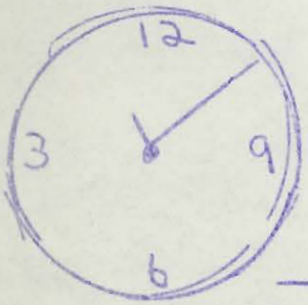


3:25

The hands indicate the following times for examples (a), (b), and (c): 4:40, 7:20, and 3:25; consequently these numbers have been written in the spaces provided. A time such as 4:35 or 5:40 would be acceptable for example (a) since you need not put down the exact time to be marked correct. Remember, do not waste time trying to puzzle out the time to the minute. An approximate answer will give you full credit and save you time.

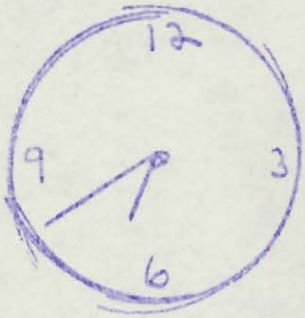
3. Now try these examples:

(a)



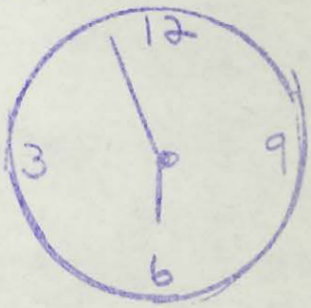
_____

(b)



_____

(c)



_____

For examples (a), (b), and (c) you should have written down times something like these: 2:50, 7:40 and 6:05.

GO RIGHT AHEAD TO THE NEXT PAGE

CLOCK READING

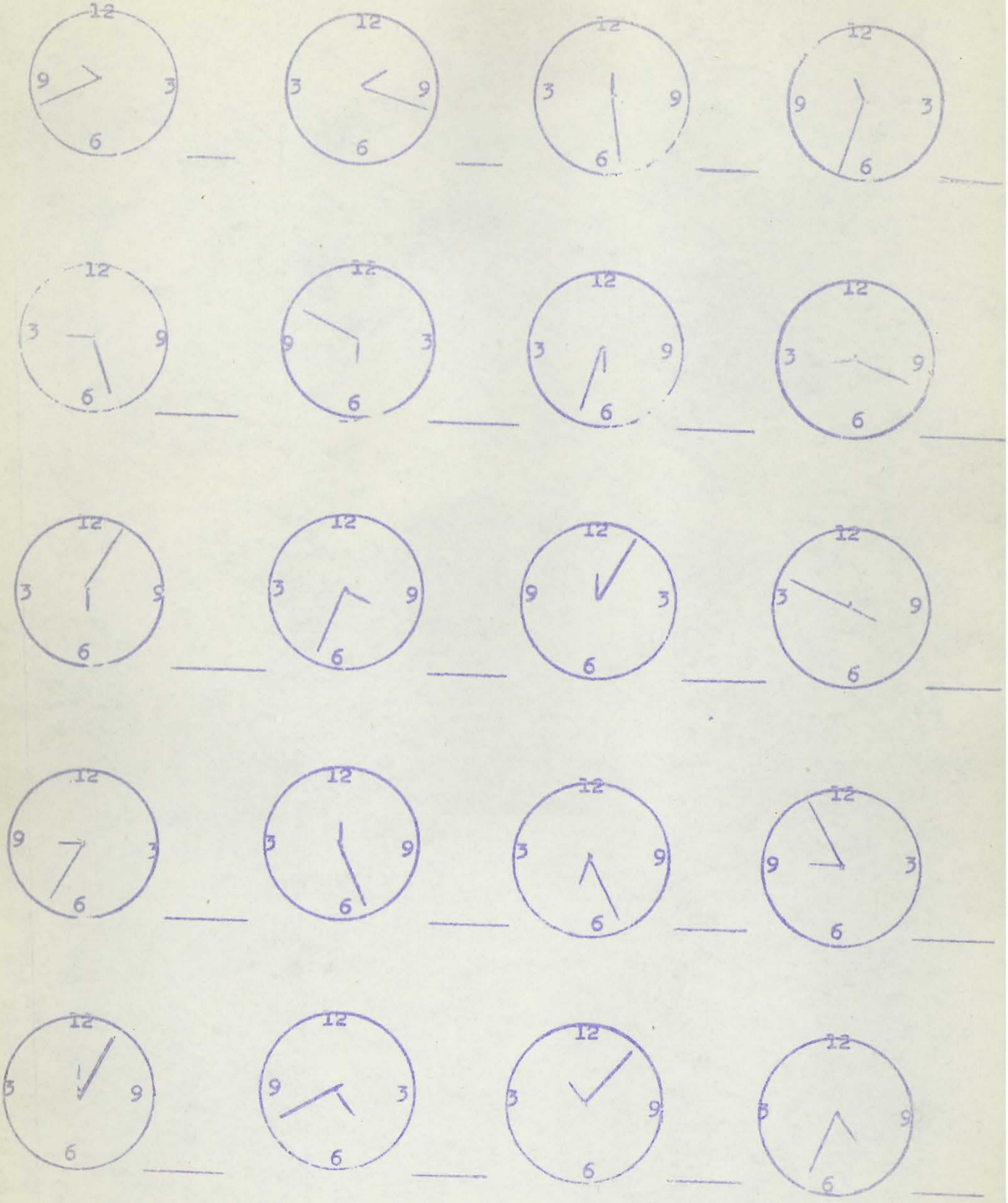
INSTRUCTIONS(CONTINUED)

4. When the signal is given(not yet) turn to the next page and do as many as you can. The time allotment for this test is five minutes. You probably will not have time to finish but stop immediately when the stop signal is given. If you have any questions about the test, ask them now.

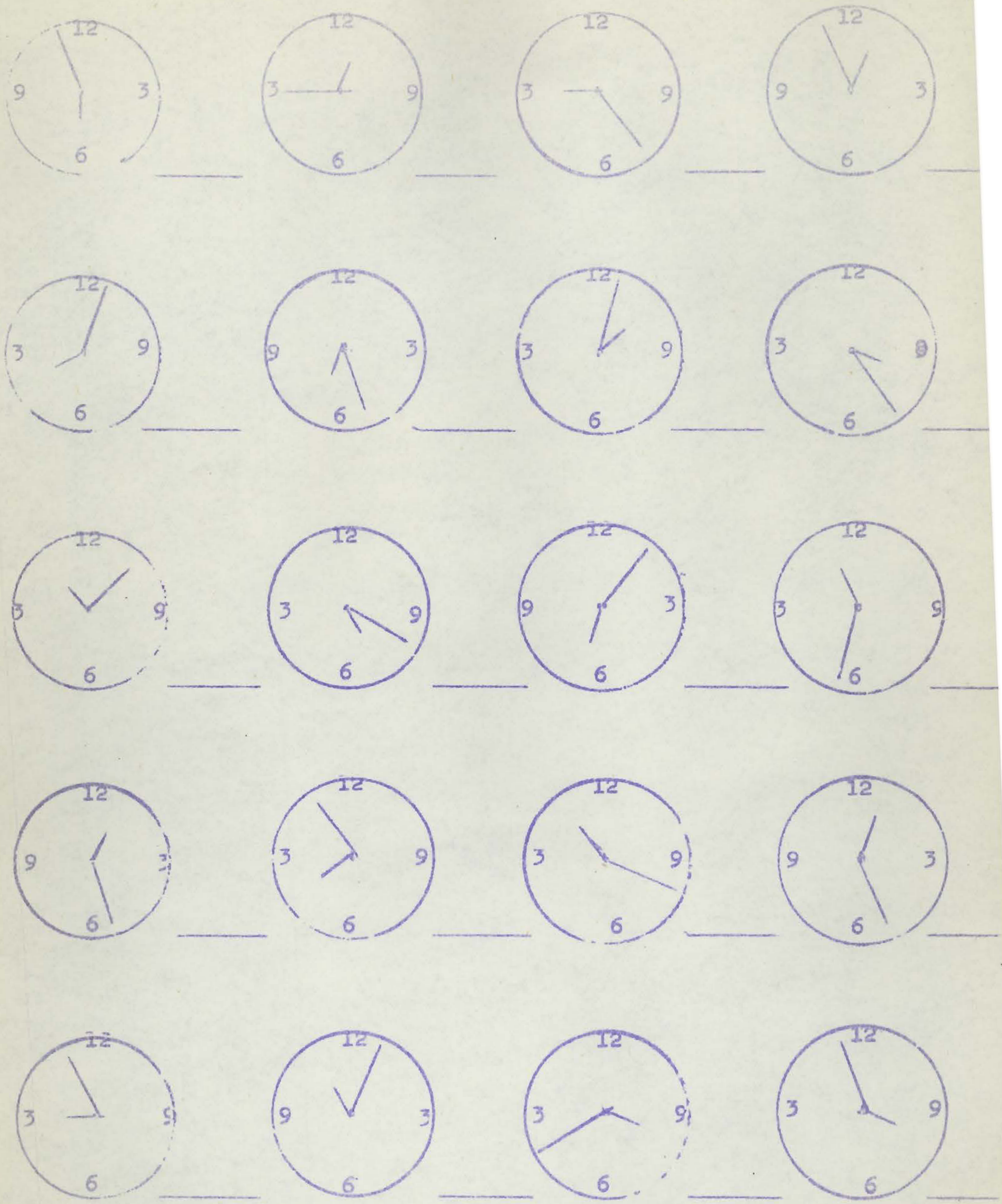
Work as rapidly and as accurately as you can.

DO NOT TURN THIS PAGE UNTIL YOU ARE TOLD TO DO SO

CLOCK READING



CLOCK READING



CLOCK READING