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A FACTORIAL STUDY OF THE REASONING AND CLOSURE FACTORS*

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A battery of 46 tests was given to 237 college men. A factor analysis using the Thurstone technique revealed eight clearly interpretable first-order factors, one dubious factor, and a residual factor. The factors were interpreted as induction, deduction, flexibility of closure, speed of closure, space, verbal comprehension, word fluency, and number. Four second-order factors were abstracted from the matrix of first-order correlations. The presence of induction, deduction, and flexibility of closure on the first second-order factor, interpreted as an analytic factor, confirmed previous indications of relationships between the reasoning and closure factors. A second bipolar factor is interpreted as a speed of association factor. The third factor is interpreted as facility in handling meaningful verbal materials—perhaps an ability to do abstract thinking. The fourth factor is possibly a second-order closure factor—perhaps an ability to do concrete thinking.

This study is an investigation of the relationships between the reasoning and closure factors. Since the reasoning factors have been considered cardinal elements in intelligence, their association with the closure factors, indicated in previous research (4, 10, 14), assumes considerable importance and interest. Up to the present time no thoroughgoing analysis of these relationships has been made.

In his pioneer study of the "primary mental abilities" (6) Thurstone described three reasoning factors: induction or the ability to discover an underlying rule or principle in a task, deduction or the ability to proceed logically and to apply principles, and restricted thinking or the ability to solve tasks that "involve some form of restriction in the solution." Of these three factors only one, induction, has proved itself a consistent factor in subsequent studies (7, 8, 13). A factor termed deduction was isolated in one study (8), but it probably can not be identified with the previous deduction factor. Re-

stricted thinking has not appeared since the first study. Tests purporting to measure these three factors were included in the present study. The induction factor was most heavily represented.

The closure factors were first reported in the *Factorial Study of Perception* (10). There Thurstone described three closure or gestalt factors: strength of configuration, flexibility of closure, and speed of closure. Bechtoldt in a subsequent study of the perceptual domain (1) found evidence of two closure factors, one a "facility in restructuring formal perceptual material possessing a weak intrinsic structure," and the other, a "facility in organizing simultaneous visual configurations under the distraction of continuing activity." Other investigators have reported factors similar to the above closure factors (3, 4, 14). As will be shown in the discussion of the factorial results of the present study, two of the closure factors, flexibility of closure and speed of closure, seem well established. Their role in the complex of mental organizations is just beginning to be delineated.

In the battery of the *Factorial Study of Perception* (10) Thurstone included composite tests of each of the recognized primary mental abilities. The composite test of induction had prominent loadings on the flexibility of closure factor, which Thurstone described as "the ability to manipulate several more or less irrelevant or conflicting gestalts or configurations." Since this was the only test of reasoning in the battery, no reasoning factor appeared in the study and the indication of a relationship between the reasoning and the closure factors was suggestive rather than conclusive. The present study employs probably the largest group of reasoning tests ever to be assembled in a single battery together with representative tests of the closure factors. All three of the reasoning factors and the five closure factors were represented by tests. In addition, to help stabilize the reasoning factors, which are invariably complex tests involving other factors than reasoning, tests of four of the stable primary mental abilities, space, number, verbal comprehension, and verbal fluency, were added to the battery.

The Tests

There are forty-six tests in the present battery.* All of them are group tests of the paper and pencil variety, speed tests rather than power tests. Preceding each test proper, with one or two exceptions, is a fore-test which familiarizes the subject with the task demanded.

*A microfilm copy of these tests may be secured from the department of microfilming at the University of Chicago.

The completion type of test item form was employed throughout the test battery wherever feasible and especially in important tests for key factors, because it was felt that better than the multiple-choice test item, the completion form approaches the actual situation in which the abilities in question are called into play.

Most of the tests were reproductions or modifications of tests utilized in previous studies, and full accounts of them can be obtained in the references quoted following each test. Moreover in the discussion of the factorial results many of the tests will be described in some detail.

Twenty-two of the forty-six tests are reasoning tests: Letter Series (8), Number Series (6), Letter Grouping (8), Number Patterns (8), Reasoning II (adapted from Cyril Burt for the Hyde Park study of induction, (8), Pattern Analogies (6), Reasoning III (adapted from Cyril Burt for the Hyde Park study of induction (8), Secret Writing (13), Arithmetic (6), Tabular Squares (a new test involving the filling in of tables of numbers), Tabular Completion (6), Marks (8), Numerical Judgment (6), False Premises (6), Figure Classification (6), Reasoning I (6), Verbal Analogies I (6), Verbal Analogies II (a new test that requires the selection of a complete ratio rather than the second half of a ratio), Figure Grouping (8).

There are fourteen tests of closure in the battery: Copying (6), Gottschaldt Figures (10), Designs (7), Block Counting (6), Paper Puzzles (prepared by T. G. Thurstone, and similar to the form board test used in 6), Mechanical Movements (6), Hidden Words (a new test in which the subject finds four letter words amidst a jumble of letters), Street Gestalt (10), Backward Writing (13), Mutilated Words (10), Incomplete Words (13), Four-Letter Words (1), Scrambled Words (a new test in which the subject identifies four-letter words, the letters of which have been rearranged to form a meaningless but pronounceable word), Hidden Letters (10), Picture Squares (prepared by T. G. Thurstone and used in 1), Hidden Pictures (10), Identical Forms (6).

The following tests were added to the battery to anchor the various reference factors: (a) tests of space: Figures (13), Cards (13), Solid Blocks; (b) tests of verbal comprehension: Definition (a variation of the Completion test of the American Council on Education Psychological Examination), Vocabulary (6), Completion (a sentence completion type of test constructed for the present battery); (c) tests of word fluency: First Letter (13), Suffixes (13); (d) tests of number: Multiplication (6), Addition (6).

Testing and First-Order Factoring

Some of the tests were administered in a preliminary tryout. Then two hundred and fifty students at the University of Notre Dame volunteered to participate in the study proper, and of this number two hundred and thirty-seven finished all forty-six tests. The scores of these latter were reduced to single digits, and the product moment correlation coefficients and the split-half reliability coefficients contained in Table 1 were computed with the assistance of International Business Machine equipment and a Marchant calculator. The range of the correlation coefficients is from —.11 to .76, and eighty-three per cent of all the coefficients are significant at the 1% level of confidence. It should be noted that none of the few negative coefficients is significant. In the factor analysis the correlation coefficients were carried out to four places, but they have been reduced to two digits and the decimal points omitted in Table 1 because of the size of the table.

The split-half method of ascertaining the reliability of speeded tests yields coefficients that are admittedly higher than those obtained when the scores from equivalent forms of the tests are correlated. In the absence of such equivalent forms for the forty-six tests of the present experimental battery, the split-half coefficients, which are generally quite high, are presented as indicative of the probable range of the corresponding true reliability coefficients. Since a factor analysis employs the inter-test correlations and not the reliability coefficients, the latter are not of primary importance in the present study. If tests are sufficiently reliable that meaningful factors can be obtained—as seems to be the case in hand—one can later determine the reliability of the tests by more acceptable procedures. These split-half reliability coefficients are, therefore, reported for what they are worth with the admission that some of them are probably too high.

The correlation matrix was factored twice by the complete centroid method of Thurstone (12), so as to stabilize the communalities. Ten factors were abstracted leaving negligible residuals. The unrotated factor matrix is reproduced in Table 2. This factor matrix was rotated to a first-order oblique simple structure according to the principles and methods of rotation set down by Thurstone (12). The final transformation matrix which carried the orthogonal F matrix into the oblique solution is found in Table 3. The resulting oblique factor matrix is reproduced in Table 5, and the cosines between the reference vectors or axes of this oblique factor matrix are given in Table 4.

The Interpretation of the Factors

In the case of each factor, all tests having loadings of more than .20 will be listed in the table preceding the interpretation of the factor. The interpretation of each factor is based primarily upon the tests with high loadings, i.e., loadings above .30. When a structure is highly oblique, however, as in the present study, one may not expect the factor loadings to be as high as in an orthogonal pattern. Hence greater liberty may be taken in interpreting factor loadings of lesser magnitude. Such interpretations of loadings between .20 and .30 will be offered as supplementary and subordinate evidence, when the interpretations seem reasonable, and particularly when the interpretations are in accord with results reported in other studies employing the same or very similar tests.

Factor A : Induction

1.	Letter Series	.47
2.	Number Series	.45
3.	Letter Grouping	.38
4.	Number Patterns	.36
5.	Reasoning II	.35
6.	Pattern Analogies	.33
7.	Reasoning III	.33
8.	Secret Writing	.31
9.	Arithmetic	.31
10.	Tabular Squares	.29
11.	Tabular Completion	.27
12.	Marks	.24
13.	Numerical Judgment	.23
18.	Verbal Analogies II	.22
26.	Hidden Words	.21

Introspection of the processes involved in these tests clearly indicates induction as their chief component. In Letter Series one must analyze the arrangement of the letters to determine the underlying principle of construction and then fill in the empty blanks with the appropriate letters. The same process is involved in Number Series. In Letter Grouping, the subject must find something common to three of the four groups, a principle of grouping. In Number Patterns, the digits in each cell of the square are selected according to some principle of arrangement, which the subject must discover before he can fill in the empty cell designated by an 'x.' Again induction. In each of the problems in Reasoning II and Reasoning III, the subject must find the principle or reason which give the key to the solution. In Pattern Analogies, the subject must determine the principle or rela-

one aims in the construction of tests is the so-called "pure" test, a test whose variance is almost entirely explained by one factor. Unfortunately it seems that pure tests of induction cannot be constructed, since by its nature a test of induction demands a medium of operation, which necessarily brings into play other factors.

One might have expected Figure Grouping to be represented on Induction. This variant of Figure Classification, however, has never been a satisfying test. Constructed for the Hyde Park Study (8), it gave only a moderate loading on induction. In the Thurstone's *Factorial Studies of Intelligence* (13), it had no loading on induction, and only a small loading on perception. In the recent study of mechanical aptitude (12), it showed no significant loadings on any factor. And yet its communality is about .65. Apparently this test is one of those mentioned above, whose factor loadings are depressed in an oblique solution.

Mention may be made here of the Army Air Force study of the reasoning factors (2). Three possible reasoning factors were reported in this study, a general reasoning factor, and two additional factors whose interpretation was merely conjectural. There is no apparent correspondence between these factors and the reasoning factors reaffirmed in the present study. Perhaps an oblique rather than an orthogonal simple structure solution of the Army Air Force data would yield more similar results. In any case the interpretation of the present reasoning factors is very plausible and agrees with previous studies employing the same or very similar tests.

Factor B: Deduction

14.	False Premises	.42
15.	Figure Classification	.42
16.	Reasoning I	.40
17.	Verbal Analogies I	.26
18.	Verbal Analogies II	.24
19.	Figure Grouping	.23

The conventional syllogisms in False Premises and Reasoning I clearly stamp them as tests of deduction. In the PMA study (6), these two tests were the highest on the deductive factor. Apparently, Figure Classification, so different in content from the syllogistic tests, involves the same factor. In this test, having grasped the principle of construction in a problem easily, the subject has then to apply the principle in a deductive manner as he designates the items in the trial group that belong to the first of the standard groups. Similarly in the Verbal Analogies tests, the principal reasoning component would

seem to be, not the induction of the principle involved in the ratio, but the deductive element concerned with selecting the element which bears out the principle already grasped. The loading of Figure Grouping on this factor is probably due to the very high correlation between this test and its parent test Figure Classification.

The interpretation of this reasoning factor is straightforward. A point might be raised, however, concerning the discrepancies between the deductive factor in the Hyde Park study (8) and this present factor. In that battery the order of loadings on deduction was: Arithmetic, Number Series, Mechanical Movements, Reasoning II, Reasoning III, Verbal Analogies, and Reasoning I. Many of these tests in the present battery have shifted over to the inductive factor. But in the previous study the subjects were younger and likewise a less selected group. The PMA study (6), which also used college students as subjects, gives a factorial pattern for the reasoning tests that is more consonant with the results of the present study. Perhaps the younger, less selected, subjects are forced to use more deduction in the solution of these tests, whereas for the more able and more experienced groups, no analytic procedures are necessary. They would tend to adopt a more synthetic and almost preceptual application of the principles induced. An interesting series of studies might be made of the changes in factorial composition of the same group of tests when given to different age groups.

The observations concerning low loadings and the factorial complexity of reasoning tests made in connection with the induction factor are also pertinent here. The media for the deductive factor are words and figures.

The small number of tests with high loadings on this factor indicate the desirability of another study with a larger number of tests designed to establish more convincingly this deductive factor. One might experiment with various types of syllogisms, including, of course, implicit syllogisms, and formal syllogisms with implied premises.

Factor C: Flexibility of Closure

20.	Copying	.45
21.	Gottschaldt Figures	.41
22.	Designs	.38
23.	Block Counting	.29
24.	Paper Puzzles	.27
12.	Marks	.23
25.	Mechanical Movements	.22
26.	Hidden Words	.22
31.	Four-Letter Words	.20

Tests with high loadings on this factor seem to involve the holding in mind of a configuration or gestalt, and the operating with it against distractors. Thus in Copying the subject must keep in mind the figure he is trying to reproduce, and not allow the regular pattern of dots to distract him as he connects the appropriate dots. In Gottschaldt Figures the subject must hold in mind the standard figure as he decides whether or not it is embedded in the more complex trial figures. That subject does best who has a clear image of the standard, and need not refer to it often while examining the trial figures. Similarly in Designs, the subject retains in mind the image of the capital Sigma, while he examines the trial figures. In Block Counting, the subject keeps in mind the entire formation of the pile of blocks as well as their sizes and shapes, as he counts those which touch the block in question. In Paper Puzzles the subject must keep in mind the size and shape of the large figure into which the smaller pieces must fit. In Marks, the factor is less evident, but perhaps the subject is aided by keeping in mind the spatial location of the Marks in the preceding parts of an item, as he tries to verify the proposed solution in later lines. In Mechanical Movements, again, the subject may be helped if he can recall and visualize the spatial relations and the form of the pulleys, gears, etc., as he answers the verbal questions. In Hidden Words, if one keeps the pattern of four-letters-in-a-straight-line in mind, one finds it easier to operate amid the confusion of letters. Similarly in Four-Letter Words, it helps in the spotting of the four-letter words, if one has formed some sort of image of a group of four-letter words, and holds this against the distractions of the line of letters.

This interpretation of factor C is strengthened by Thurstone's interpretation of a similar factor in his recent study of mechanical aptitude (12). The following tests have loadings on this factor called by him the Second Closure Factor, C_2, "flexibility of closure:"

Designs	.38
Copying	.36
Paper Puzzles	.32
Gottschaldt Figures	.30
Block Counting	.20
Mechanical Movements	.11

These tests correspond quite nicely to the list of tests in the present battery on factor C. The few tests in this battery not found on the list above were not included in Thurstone's battery. Similar factors have been reported by Rimoldi (4) and Yela (14). Here then we

would seem to have a stable ability, whose importance in mental life has yet to be determined.

It is interesting to note the relationship between Thurstone's restricted thinking factor in the PMA study (6) and this flexibility of closure factor. Copying, Block Counting, Form Board (similar to Paper Puzzles), and Mechanical Movements were four of the six tests with highest loadings on the restricted thinking factor. The other tests with loadings on the closure factor were not included in the former study. Perhaps these two factors are really the same.

Factor D: Speed of Closure

27.	Street Gestalt	.49
28.	Backward Writing	.46
29.	Mutilated Words	.41
30.	Incomplete Words	.37
35.	Hidden Pictures	.34
31.	Four-Letter Words	.34
32.	Scrambled Words	.26
36.	Identical Forms	.26
34.	Picture Squares	.23
33.	Hidden Letters	.22

This factor should probably be identified with what Thurstone has called recently (12), the first Closure Factor, C_1, "speed of closure," and what he termed speed of perception in the *Factorial Study of Perception* (11). It is likewise similar to Bechtoldt's factor G, which he described as "facility in restructuring formal perceptual material possessing a weak intrinsic structure" (1). Meili (3) describes a factor similar to the present factor, which he calls "globalization," a facility for combining distinct elements to form a whole. Street Gestalt had a prominent loading on "globalization." The factor clearly involves something more than mere speed of perception, such as you might find in a cancellation of letters test. In all of the tests with loadings on this factor, there is an unstructured field, in which some reorganization must occur. This process of reorganization may well be termed closure.

In Street Gestalt, the subject must reconstruct the original picture. In Backward Writing, he must reverse the already reversed words. In Mutilated Words he must reconstruct the original words whose parts have been erased. In Incomplete Words, the missing letters must be supplied. In Hidden Pictures the often poorly structured elements of the hidden faces, etc., must be fused into wholes. In Four-Letter Words, the spaced letters of the words must be fused. In Scrambled Words the whole word must be reassembled. In Hidden

Letters, the dots must be united to form the letter or digit demanded. It is more difficult to verify this interpretation in Identical Forms and Picture Squares. However, in both tests there is the perception of rather complex detail and the identification of this with something already seen. The process of identification may be similar to the structuring of formal visual material.

In both of Thurstone's studies referred to above, Street Gestalt and Mutilated Words have high loadings on this factor of speed of closure. In Bechtoldt's study, Four-Letter Words, Mutilated Words, and Hidden Pictures, were prominent on factor G. Their presence also on the speed of closure factor of the present study leads to the tentative identification of factor G with speed of closure.

Factor E: Space

37.	Figures	.46
38.	Cards	.43
39.	Solid Blocks	.40
19.	Figure Grouping	.35
28.	Backward Writing	.32
6.	Pattern Analogies	.31
36.	Identical Forms	.27
15.	Figure Classification	.26
17.	Verbal Analogies I	.22
34.	Picture Squares	.22
25.	Mechanical Movements	.21

The three highest tests on this factor unmistakably stamp it as a space factor, since they are standard tests of space. In his recent study on mechanical aptitude (12), Thurstone isolated three space factors. The first of them has the same three tests in identical order at the head of the factor loadings.

Backward Writing can be solved by revolving mentally the reversed word in space. Identical Forms, Figure Classification, and Mechanical Movements had similar loadings on the space factor in the PMA study (6). Figure Grouping is a variant of Figure Classification, and like Pattern Analogies, seems to involve the comparison and moving around in space of geometrical forms.

Factor F: Verbal Comprehension

40.	Definition	.71
41.	Vocabulary	.62
42.	Completion	.52
17.	Verbal Analogies I	.39
18.	Verbal Analogies II	.30
5.	Reasoning II	.28
7.	Reasoning III	.28

| 16. | Reasoning I | .25 |
| 11. | Tabular Completion | .20 |

Again we have a stable Primary Mental Ability, whose nature can be determined from the tests with highest loadings. Definition and Vocabulary are standard tests for the verbal comprehension factor. Completion, a form of sentence completion test, failed to show any significant loadings on the closure factors, but proved to be a good test of verbal comprehension. This is not surprising, since the greater one's comprehension of the words in the sentences with all their connotations, the more rapid the completion of the sentences by the subject. Verbal Analogies tests have always involved a great deal of verbal comprehension, for the obvious reason that one cannot complete the analogy unless the words in the first ratio are clearly understood and their logical verbal relationship comprehended. Reasoning I, II, and III, are completely verbal in content. Tabular Completion also had a small loading on this factor in the PMA study (6). Apparently the verbal headings on the columns and rows of the tables of this test introduce a verbal component; Tabular Squares has no verbal headings, and no loading on the present factor.

There is also an interesting difference in the loadings of Reasoning I and False Premises on this factor. The syllogisms in Reasoning I are conventional in content as well as in form, but False Premises employs utterly ridiculous premises and meaningless conclusions. In the latter test, consequently, no premium is placed upon understanding the premises and conclusions. The subject is forced to concentrate almost exclusively upon the deductive reasoning involved in the test. In the oblique solution, therefore, Reasoning I has a moderate loading on Verbal Comprehension, False Premises a loading of only .032.

Factor G: Word Fluency

43.	First Letter	.59
30.	Incomplete words	.48
44.	Suffixes	.48
32.	Scrambled Words	.43
3.	Letter Grouping	.25
1.	Letter Series	.24
28.	Backward Writing	.23
31.	Four-Letter Words	.22
29.	Mutilated Words	.21

In all of these tests one detects the operation of the ability to think of words rapidly, which characterizes the word fluency factor. First Letter and Suffixes are conventional tests of this ability. Sub-

jects with the ability to think of words rapidly obviously do better on Incomplete Words, in which they are obliged to supply the missing letters in words; on Scrambled Words, in which they must reassemble four-letter words; on Backward Writing, in which they must reverse words; on Four-Letter Words, in which they must spot words in a line of evenly spaced letters; on Mutilated Words, in which they must fill in the erasures of the maimed words. It is somewhat surprising to find Letter Grouping and Letters Series with even such small loadings on word fluency, but this is not without precedent, since they had even higher loadings on this factor in the Hyde Park study (8).

Factor H: Number

45.	Multiplication	.65
46.	Addition	.54
32.	Scrambled Words	.33
28.	Backward Writing	.28
13.	Numerical Judgment	.27
31.	Four-Letter Words	.27
10.	Tabular Squares	.24
30.	Incomplete Words	.24
4.	Arithmetic	.23

The ability to perform simple numerical operations clearly defines this factor. Multiplication and Addition are stock tests for this factor. Nor is it unusual to find reasoning tests such as Numerical Judgment, Tabular Squares, and Arithmetic with a number component.

It is, however, interesting to note the presence of Scrambled Words, Backward Writing, Four-Letter Words, and Incomplete Words, with even moderate loadings on the number factor. This is in line with the hypothesis of Landahl and Coombs (quoted by Thurstone, 10, pp. 199-200) that the number factor really measures "facility with highly practiced associations." Certainly all of these verbal, non-numerical tests operate with very well known, and hence well-practiced, words. The loadings are not large enough to substantiate the hypothesis but they are suggestive.

Factor J

34.	Picture Squares	.36
35.	Hidden Pictures	.34
36.	Identical Forms	.26
7.	Reasoning III	.23
12.	Marks	.22

8.	Secret Writing	.22
26.	Hidden Words	.21

It is difficult to determine whether this factor is residual or allied to Bechtoldt's factor Y (1). Picture Squares and Identical Forms were included in the present battery precisely because they showed loadings on Bechtoldt's factor Y. But all the loadings on this present factor are small, and Hidden Pictures, the second highest test on this factor, had a loading of zero on Bechtoldt's Y. If this factor were to be identified with Bechtoldt's, however, the change in the factorial composition of Hidden Pictures might be due to alterations in time limits and instructions. The time limits were lengthened for this battery. And instead of allowing the subjects to work as long as they wished on an individual picture, they were instructed to find a limited number of relatively easy pictures in each problem first, and then after finishing all of the problems to come back and look for the more difficult hidden pictures. This change in instructions probably increased the scores somewhat. Tentatively, then, the factor might be considered as akin to Bechtoldt's which he described as facility in organizing simultaneous visual configurations under the distraction of continued activity. Thus, in Picture Squares, one must scan the various pictures of the square, trying to pick out two that are identical despite the distraction of the other similar pictures. In Identical Forms, one tries to pick out the form that is identical with the standard, while being distracted by the nearly identical other forms. In Hidden Pictures, one is looking for a person or a face, despite the distraction of the picture as a whole.

It must be admitted, however, that it is difficult to verify this interpretation of the factor in the other tests with loadings over .20. Hence, the factor should be considered as a residual factor, until this tentative interpretation is substantiated by further investigations in this domain.

Factor K: Residual

36.	Identical Forms	.38
3.	Letter Grouping	.34
15.	Figure Classification	.27
19.	Figure Grouping	.26
1.	Letter Series	.25
33.	Hidden Letters	.23

No interpretation has been made of this factor. There is nothing which the above tests seem to have in common. Hence it has been considered a residual factor.

The Second-Order Domain

Table 6 reproduces the correlations between the primary factors. The intercorrelations between the eight clearly interpretable primaries are positive for the most part except for the speed of closure factor, which has a large negative correlation with the number factor, and small negative correlations with several other factors. The high correlation between space and the second closure factor, flexibility of closure, is not surprising when we consider that all of the tests with high loadings on the closure factor have shown fairly high loadings on the space factor in other studies, and that in Thurstone's *Factorial Study of Perception* (10), the composite space test and Gottschaldt Figures, one of the primary tests of flexibility of closure, both had significant loadings on the same factors, A and E.

In factoring Table 6 the last two factors were neglected—the last factor because it seems to be residual, and the other factor because its interpretation is not definite and the loadings on it are low. The complete centroid method for factoring was employed again, and a number of trials were made until the communalities were very stable —varying but a few thousandths on the last two runs—and the residuals uniformly small. The resulting orthogonal factor matrix F_2 is reproduced in Table 7.

The matrix F_2 was then rotated to an oblique simple structure. The resulting oblique factor matrix V_2 and its transformation matrix are reproduced in Tables 8 and 9 respectively. Table 10 gives the cosines between the reference vectors.

Since there are four factors in the second order and only eight primary factors, it is obviously not possible to determine these four factors with great confidence. The interpretation, then, of the second order can only be tentative. Such interpretations, however, are often interesting and meaningful. Final judgment must be reserved until the results of this second order are confirmed by succeeding studies.

Factor a

Space	.74
Deduction	.68
Induction	.67
Flexibility of Closure	.64

The loadings on this factor remind one of the findings in the *Factorial Study of Perception* (10). There Thurstone found that the composite reasoning test had a high loading on his factor E, flexibility of closure. There was also a correlation of .39 between the composite reasoning test and Factor A, "strength of configuration," which included, among the tests with loadings on it, the space composite and

Gottschaldt Figures. Since space also had a loading on factor E of
.22, it is not surprising that space should be represented on this pres-
ent second-order factor. It has been suggested (4) that Thurstone's
A and E are closely related and may sometimes be fused into a single
factor. At any rate Thurstone's results seem in line with those pre-
sented here.

Recently Yela, in refactoring some of Alexander's data (14), re-
ported a correlation of .59 between a reasoning factor and a percep-
tual factor that he identified with the flexibility of closure factor. He
also found space, the closure factor, and the reasoning factor on a
second-order factor.

Thurstone, again, in his most recent study on mechanical apti-
tude, got a correlation of .63 between induction and flexibility of clo-
sure, .38 between induction and space, and .53 between space and flexi-
bility of closure. All of these results are in harmony with those of
the present study.

One explanation of this factor may be the fact that it is possible
to solve the space and closure tests in either one of two ways, analyti-
cally or synthetically. In the analytic solution, one analyzes the prob-
lem and arrives at a solution by a process of logical reasoning. For
example, one traces out the standard figures in the trial figures of
Gottschaldt Figures, one compares the length of lines and the size of
the angles in Copying, one reasons to the true position of the cut cor-
ner when the forms are turned in Cards. In the synthetic procedure,
one actually sees the standard figure in the trial figures in Gottschaldt
Figures, one traces out a pattern on the dots with the image of the
pattern clearly in mind in Copying, and in Cards, Figures, and Solid
Blocks, one imagines the rotation of the card, figure, or block. Appar-
ently the synthetic process is more effective in solving the space and
closure tasks, and the first-order factors reflect this process. But
since the synthetic and analytic procedures are not entirely opposed,
the analytic procedure might be reflected in this second-order factor
and in the correlations between the primaries.

Another explanation emphasizes the fact that there are certain
configurational or gestalt elements in both induction and deduction.
In searching for a principle in a particular item, one must keep in
mind the elements of the problem, and the relationships between these
elements may be visualized in a spatial and configurational manner.
In deduction one may solve the syllogisms with the assistance of a
spatial framework or configuration, in which the middle term is the
bond or link between the other two terms. Or in the analogies test,
one may represent the proportions in a spatial arrangement. Or in

the application of a test like Figure Classification, a person might keep some general examples of the rule governing an item in mind while he marks the test symbols.

Whatever be the true explanation for the relationship between the reasoning factors and the flexibility of closure factor, the fact itself seems undeniable. The present study has confirmed its existence more strongly by demonstrating its presence even when the reasoning and closure factors have been adequately determined in the same battery, which has not been the case in the studies hitherto.

Factor β

Number	.58
Word Fluency	.57
Verbal Comprehension	.49
Speed of Closure	—.46

This is a bipolar factor. Analysis of the primaries at the extremes leads to the tentative interpretation of this factor as a sort of speed of association factor. At one extreme are well-practiced, drilled, common associations such as numbers, words beginning with certain letters or involving frequently used words, and even the practiced association of particular connotations or meanings with particular words such as one finds in the tests of verbal comprehension. At the other pole is the speed of closure factor, in which one is required to fill in or complete unstructured configurations. Such a task is unusual and not commonly experienced, even though the figures and words themselves are not uncommon. Individuals who are adept in working with the mechanical sort of tasks at the positive pole, would, under this interpretation, find difficulty in the more imaginative unfamiliar tasks required in the closure tests.

It is interesting to note that Street Gestalt, which has the highest loading on the speed of closure factor, had a negative loading of .25 on the number factor in Bechtoldt's study (1); that the correlation between the composite number test and the composite speed of closure test in the *Factorial Study of Perception* (10) was —.15; that the perceptual primary in Taylor's study (5) had a negative correlation of .24 with number. It would be interesting to investigate this phenomenon in a further study.

Factor γ

Deduction	.77
Verbal Comprehension	.57
Induction	.39

Tentatively this second-order factor may be interpreted as fa-

cility in handling meaningful verbal materials. An alternative interpretation might look upon it as an analytic ability, something akin to Spearman's noegenesis, the ability to grasp and discover relations. Finally it could be considered as the ability to do abstract thinking. All of the primaries with loadings on this second-order factor are concerned with meaningful situations, and also with verbal material to some degree at least. In deductive tests like the syllogism tests and the verbal analogies, one is concerned with meaningful verbal materials. The verbal analogies tests and the reasoning tests had loadings on verbal comprehension also. In addition, Definition involves the understanding of the meaning of definition of a word. Vocabulary requires the selection of a synonym for a word in a meaningful phrase. Completion demands an understanding of a sentence and the reality corresponding to the sentence, before the subject can supply the correct words to complete the sentence. Finally, in all tests of induction one is concerned with a rule or principle underlying a meaningful arrangement of verbal, numerical, or pictorial materials, and the rule is often phrased by the subject verbally to himself in the course of solving an item. Furthermore, you have meaningful verbal materials in Arithmetic, Reasoning II, Reasoning III, and Verbal Analogies III.

It is significant, too, that the space and closure primaries, which are primarily synthetic in character are not found on this factor. Nor does the number factor, which is concerned with highly practiced, mechanical associations, have a loading on this factor. Word fluency is absent too, but this factor calls for a spontaneous and somewhat mechanical recall of words. One recalls the words not because of their connotations but rather because of the positions of individual letters or groups of letters in the words.

Factor 8

Flexibility of Closure	.56
Speed of Closure	.40
Space	.33
Word Fluency	.26

One might call this factor a configurational or perhaps a closure factor. Thurstone's factor A, strength of a configuration, had among the tests with loadings on it, the composite space test, Gottschaldt Figures which has a high loading on the flexibility of closure factor, and Street Gestalt and Mutilated Words, which are prominent on the speed of closure factor. In addition the composite word fluency test had a correlation of .20 with this factor. Perhaps this present factor is to be identified with factor A, which has not shown up elsewhere in this battery.

TABLE 1
Product-Moment Correlation Coefficients
(With Decimal Points Omitted)

	Rel.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1.	86		65	63	55	47	53	57	47	54	47	44	43	44	38	45
2.	77	65		54	51	53	55	55	43	60	43	45	36	43	33	46
3.	92	63	54		57	45	53	55	40	51	41	39	41	36	36	41
4.	87	55	51	57		39	51	50	43	50	48	46	38	38	34	40
5.	62	47	53	45	39		49	56	40	59	39	45	33	28	36	44
6.	75	53	55	53	51	49		55	43	54	38	41	34	35	33	50
7.	79	57	55	55	50	56	55		53	60	40	47	40	37	45	42
8.	97	47	43	40	43	40	43	53		53	35	38	41	40	25	44
9.	78	54	60	51	50	59	54	60	53	·	48	45	32	52	42	48
10.	96	47	43	41	48	39	38	40	35	48		38	31	35	25	37
11.	92	44	45	39	46	45	41	47	38	45	38		33	33	27	24
12.	82	43	36	41	38	33	34	40	41	32	31	33		26	21	36
13.	65	44	43	36	38	28	35	37	40	52	35	33	26		22	34
14.	45	38	33	36	34	36	33	45	25	42	25	27	21	22		44
15.	98	45	46	41	40	44	50	42	44	48	37	24	36	34	44	
16.	69	35	43	28	32	51	34	58	36	50	23	36	23	23	51	49
17.	92	49	42	46	39	49	45	55	37	54	26	34	25	31	42	46
18.	86	49	51	48	40	56	47	57	45	57	28	36	38	37	43	52
19.	88	48	44	49	46	40	54	46	45	49	34	29	35	37	38	70
20.	92	40	39	44	46	28	41	41	37	34	32	28	46	29	30	47
21.	81	38	37	41	41	33	49	44	43	39	29	32	37	41	35	53
22.	94	27	24	29	36	23	39	33	36	27	25	35	26	18	24	31
23.	97	48	43	51	50	34	45	45	41	45	39	36	46	38	35	49
24.	82	48	47	42	45	39	50	36	41	42	32	34	40	35	26	45
25.	88	38	43	36	47	44	54	45	40	51	20	39	37	44	44	54
26.	89	41	44	43	46	39	46	45	45	41	35	36	32	34	25	46
27.	70	09	03	06	03	−01	14	09	08	−03	−06	−05	09	07	07	18
28.	97	45	43	48	36	31	51	38	36	34	35	35	25	30	19	40
29.	82	29	17	18	18	17	21	22	21	20	10	17	17	09	20	19
30.	91	37	38	41	33	27	31	34	36	33	35	25	20	19	15	23
31.	88	27	23	33	31	11	14	24	29	21	26	17	20	13	14	21
32.	93	40	36	47	46	29	30	38	32	39	45	29	25	24	23	24
33.	79	23	11	23	29	11	29	16	19	18	12	19	20	16	16	31
34.	83	25	23	29	31	21	39	33	31	26	16	16	27	18	12	20
35.	69	06	03	06	10	−08	13	13	08	−08	−04	01	09	00	04	07
36.	98	41	22	47	35	18	40	35	30	22	25	27	34	25	20	37
37.	96	39	32	34	36	23	46	33	36	35	26	29	36	28	23	44
38.	96	47	40	42	44	33	51	36	39	36	38	36	39	34	31	50
39.	74	33	36	33	36	38	48	35	33	40	25	36	31	31	24	43
40.	90	24	31	32	22	49	31	48	27	44	19	29	05	15	30	30
41.	96	24	33	31	20	42	23	48	26	42	25	29	18	07	26	28
42.	81	44	38	45	40	52	36	61	44	56	31	47	25	34	39	41
43.		16	18	32	13	20	18	19	12	15	20	06	10	01	09	12
44.		15	12	20	07	14	10	08	03	17	14	11	08	01	13	−01
45.	89	33	34	37	40	21	23	33	30	43	44	37	22	39	14	20
46.	90	32	34	31	29	18	17	25	19	35	34	38	21	26	10	12

TABLE 1 (Continued)

16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
35	49	49	48	40	38	27	48	48	38	41	09	45	29	37
43	42	51	44	39	37	24	43	47	43	44	03	43	17	38
28	46	48	49	44	41	29	51	42	36	43	06	48	18	41
32	39	40	46	46	41	36	50	45	47	46	03	36	18	33
51	49	56	40	28	33	23	34	39	44	39	-01	31	17	27
34	45	47	54	41	49	39	45	50	54	46	14	51	21	31
58	55	57	46	41	44	33	45	36	45	45	09	38	22	34
36	37	45	45	37	48	36	41	41	40	45	08	36	21	36
50	54	57	49	34	39	27	45	42	51	41	-03	34	20	33
23	26	28	34	32	29	25	39	32	20	35	-06	35	10	35
36	34	36	29	28	32	35	36	34	39	36	-05	35	17	25
23	25	38	35	46	37	26	46	40	37	32	09	25	17	20
23	31	37	37	29	41	18	38	35	44	34	07	30	09	19
51	42	43	38	30	35	24	35	26	44	25	07	19	20	15
49	46	52	70	47	53	31	49	45	54	46	18	40	19	23
	48	56	42	31	32	22	26	26	44	33	-02	20	22	25
48		67	49	34	35	22	34	38	41	25	13	38	23	23
56	67		50	40	38	25	39	40	49	45	08	29	17	28
42	49	50		47	46	38	53	52	54	48	19	45	24	23
31	34	40	47		65	48	54	60	52	51	20	37	24	34
32	35	38	46	65		56	61	59	58	46	25	45	22	30
22	22	25	38	48	56		51	41	40	42	25	42	24	26
26	34	39	53	54	61	51		61	54	55	21	39	18	29
26	38	40	52	60	59	41	61		58	41	20	37	21	21
44	41	49	54	52	58	40	54	58		42	21	34	18	28
33	25	45	48	51	46	42	55	41	42		13	38	24	37
-02	13	08	19	20	25	25	21	20	21	13		27	33	14
20	33	29	45	37	45	42	39	37	34	38	27		30	48
22	23	17	24	24	22	24	18	21	18	24	33	30		41
25	23	28	23	34	30	26	29	21	28	37	14	48	41	
06	16	19	23	28	32	32	31	15	12	27	19	45	22	55
20	34	36	26	33	34	35	35	19	27	40	10	50	25	64
04	14	17	31	25	22	20	29	28	35	24	24	29	11	13
15	22	26	36	30	23	26	41	30	31	35	20	30	26	21
-02	05	00	05	19	22	19	15	09	09	24	30	21	22	15
08	35	25	43	51	44	41	48	39	29	34	27	51	25	26
18	30	29	53	38	39	44	57	48	43	34	11	36	13	14
18	35	37	53	51	54	41	65	61	54	46	17	49	22	28
21	28	32	48	42	49	39	59	48	54	42	09	35	11	21
48	58	55	29	25	25	22	18	23	31	18	01	25	14	25
46	51	50	25	23	12	19	12	12	22	18	-05	19	10	31
53	64	56	44	33	31	25	32	29	34	30	06	35	20	33
11	24	24	17	23	13	17	12	11	10	17	06	28	11	51
10	20	20	05	14	05	01	05	11	01	11	01	21	18	29
12	24	21	23	30	26	23	30	18	13	27	-11	36	-03	29
08	20	17	10	15	18	12	20	07	02	17	-11	32	02	35

TABLE 1 (Continued)

31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46
27	40	23	25	06	41	39	47	33	24	24	44	16	15	38	32
23	38	11	23	03	22	32	40	36	31	33	38	18	12	34	34
33	47	23	29	06	47	34	42	33	32	31	45	32	20	37	31
31	46	29	31	10	35	36	44	36	22	20	40	18	07	40	39
11	29	11	21	-08	18	23	33	38	49	42	52	20	14	21	18
14	30	29	39	13	40	46	51	48	31	23	36	18	10	28	17
24	38	16	33	13	35	33	36	35	48	48	61	19	08	33	25
29	32	19	31	08	30	36	39	38	27	26	44	12	08	30	19
21	39	18	26	-08	22	35	36	40	44	42	56	15	17	43	35
26	45	12	16	-04	25	26	88	25	19	25	31	20	14	44	34
17	29	19	16	01	27	29	36	86	29	29	47	06	11	87	38
20	25	20	27	09	34	36	39	31	05	13	25	10	08	22	21
13	24	16	18	00	25	23	34	31	15	07	34	01	01	39	26
14	28	16	12	04	20	23	31	24	30	26	39	09	13	14	10
21	24	31	20	07	37	44	50	43	30	28	41	12	-01	20	12
06	20	04	15	-02	08	18	18	21	48	46	53	11	10	12	08
16	34	14	22	05	35	30	35	28	58	51	64	24	20	24	20
19	36	17	26	00	25	29	37	32	55	50	56	24	20	21	17
28	26	31	36	05	43	58	53	48	29	25	44	17	05	23	10
28	33	25	30	19	51	38	51	42	25	28	38	23	14	30	15
32	84	22	23	22	44	39	54	49	25	12	31	13	05	26	13
32	35	20	26	19	41	44	41	39	22	19	25	17	01	23	12
31	35	29	41	15	48	57	65	59	18	12	32	12	05	30	20
15	19	28	30	09	39	48	61	48	23	12	29	11	11	18	07
12	27	35	31	09	29	43	54	54	31	22	34	10	01	13	02
27	40	24	35	24	34	34	46	42	18	18	30	17	11	27	17
19	10	24	20	30	27	11	17	09	01	-05	06	06	01	-11	-11
45	50	29	30	21	51	36	49	35	25	19	35	28	21	86	32
22	25	11	26	22	25	13	22	11	14	10	20	11	18	-03	02
55	64	13	21	15	26	14	28	21	25	31	88	51	29	29	35
	52	15	20	19	36	15	21	15	21	32	30	37	21	82	31
52		06	26	10	24	23	35	24	27	34	36	50	26	45	44
15	06		18	10	33	25	26	31	04	-03	20	00	00	00	-06
20	26	18		24	48	32	39	37	14	08	24	12	05	20	11
19	10	10	24		24	15	23	08	-07	-07	01	07	05	-07	-02
36	24	33	43	24		46	54	37	19	11	30	14	14	25	14
15	23	25	32	15	46		70	58	11	06	18	07	09	25	18
21	35	26	39	23	54	70		61	18	07	25	10	12	32	19
15	24	31	37	03	39	58	61		10	01	24	09	07	27	13
21	27	04	14	-07	19	11	13	10		76	62	34	18	18	17
32	34	-03	08	-07	11	06	07	01	76		60	39	15	28	30
30	36	20	24	01	30	18	25	24	62	60		22	22	34	28
37	50	00	12	07	14	07	10	09	34	39	22		48	20	28
21	26	00	05	05	14	09	12	07	18	15	22	48		14	22
32	45	00	20	-07	25	25	32	27	18	23	34	20	14		69
31	44	-06	11	-02	14	18	19	13	17	30	28	28	22	69	

TABLE 2
Centroid Factor Matrix F

	I	II	III	IV	V	VI	VII	VIII	IX	X	h^2
1.	.710	−.111	.058	−.198	.085	.255	.107	−.040	−.193	−.011	.6815
2.	.676	−.184	.135	−.225	.110	.086	.123	−.075	−.023	−.139	.6197
3.	.702	−.120	−.030	−.104	−.036	.156	.031	.099	−.259	−.036	.6255
4.	.672	−.028	.010	−.225	.132	.038	−.018	.063	−.087	−.031	.5864
5.	.613	−.237	.292	−.027	−.028	−.011	.150	.056	.061	−.132	.5656
6.	.699	.112	.138	−.087	−.088	.118	.118	−.028	.051	−.187	.6016
7.	.730	−.200	.183	.024	.094	.098	.035	.106	.137	.058	.6600
8.	.623	−.014	.105	−.083	.139	.152	−.063	.075	.121	.057	.4760
9.	.714	−.282	.257	−.149	.023	.012	−.028	−.105	.062	.015	.6939
10.	.540	−.185	−.062	−.303	.056	−.018	−.113	−.004	−.133	−.041	.4570
11.	.562	−.148	.103	−.193	.037	−.079	−.063	.077	.156	−.076	.4331
12.	.518	.104	.040	−.160	.084	.019	.023	.186	−.124	.134	.3823
13.	.499	−.034	.138	−.228	.109	.107	−.169	−.165	.009	.072	.4056
14.	.495	−.087	.228	.182	.107	−.093	.087	−.162	−.135	.138	.4287
15.	.665	.160	.272	.126	−.050	.048	−.105	−.266	−.203	.070	.6904
16.	.528	−.245	.381	.269	.155	−.062	.103	−.072	.067	.149	.6267
17.	.645	−.225	.235	.248	−.206	.085	.045	−.034	.022	.090	.6447
18.	.679	−.203	.282	.150	−.056	.047	.149	.061	.017	.102	.6461
19.	.700	.209	.198	.052	−.169	.125	−.045	−.119	−.095	.039	.6465
20.	.664	.268	−.056	.073	.123	−.177	−.033	.147	−.196	.114	.6416
21.	.670	.303	.021	.067	.218	−.203	−.135	−.024	−.025	.015	.6589
22.	.547	.273	−.098	.052	.123	−.241	−.174	.075	.126	−.092	.5205
23.	.708	.312	.020	−.179	.057	−.125	−.005	.074	−.059	.084	.6599
24.	.641	.305	.158	−.085	.028	−.122	.011	.048	−.145	−.048	.5775
25.	.668	.245	.354	.056	.114	−.164	.037	−.072	.047	−.130	.6936
26.	.635	.135	−.041	−.074	.140	.011	.015	.119	.059	.037	.4675
27.	.206	.387	−.165	.334	.099	.192	−.007	−.075	.066	−.033	.3887
28.	.644	.102	−.310	.034	−.108	.126	−.077	−.188	.044	−.210	.6372
29.	.352	.096	−.189	.228	.215	.168	.164	−.088	.127	.006	.3459
30.	.547	−.190	−.475	.088	.178	.034	.130	−.090	.037	−.162	.6528
31.	.448	−.076	−.459	.139	.077	.032	−.201	.041	−.063	−.072	.4946
32.	.594	−.242	−.449	−.029	.078	−.059	.060	−.098	.044	−.117	.6522
33.	.321	.291	.065	.042	−.018	.196	−.120	.045	−.064	−.175	.2835
34.	.445	.229	−.103	−.051	−.089	.162	.102	.188	.234	.082	.3886
35.	.163	.306	−.267	.148	.124	.148	.114	.064	.153	.139	.3090
36.	.573	.333	−.219	.057	−.219	.158	−.139	.150	−.087	.096	.6220
37.	.562	.374	.064	−.201	−.259	−.124	.068	−.050	.027	.062	.5943
38.	.682	.393	−.018	−.211	−.159	−.146	.120	−.098	.018	.067	.7897
39.	.574	.331	.136	−.220	−.169	−.171	.071	−.026	.074	−.019	.5754
40.	.498	−.402	.177	.428	−.225	−.149	−.091	.147	.144	−.105	.7534
41.	.455	−.524	.061	.366	−.135	−.185	−.102	.171	.085	−.058	.7058
42.	.649	−.365	.156	.244	−.092	.061	−.181	.133	.084	.090	.7161
43.	.348	−.268	−.436	.282	−.186	−.190	.245	.056	−.151	−.140	.6130
44.	.233	−.209	−.303	.112	−.162	−.100	.298	.006	−.115	.064	.3446
45.	.475	−.292	−.265	−.406	−.135	−.150	−.353	−.126	.069	.210	.7760
46.	.380	−.394	−.318	−.324	−.115	−.108	−.183	−.122	.059	.093	.5911

TABLE 3
Transformation Matrix

	A	B	C	D	E	F	G	H	J	K
I	.2313	.1525	.1609	.1739	.1847	.1737	.1608	.1502	.1198	.1231
II	−.1865	−.0373	.1385	.2295	.3582	−.3138	−.2177	−.2588	.0891	.0863
III	.2399	.2008	−.0328	−.4105	.0594	.2299	−.4822	−.3352	−.1286	−.0355
IV	−.4357	.2938	.0909	.3786	.0201	.4263	.0926	−.2317	.0286	.0937
V	.2670	.2267	.5205	.1232	−.7795	−.4282	.0051	.0550	.0474	−.2503
VI	.5353	.0324	−.5387	.4910	−.0389	−.0710	−.0546	−.0598	.3576	.4622
VII	.1733	.0711	−.2448	−.1910	.1135	−.2620	.6577	−.5416	.1786	−.3650
VIII	.3456	−.5395	.5063	−.3526	−.3507	.4077	−.2152	−.5740	.5149	.1780
IX	−.0632	−.2783	−.2610	.3933	.2232	.4185	−.4209	.2850	.3102	−.7176
X	−.3911	.6501	.0015	−.1830	−.1859	−.1955	−.1634	.1837	.6620	.1246

TABLE 4
Reference Vector Cosines C

	A	B	C	D	E	F	G	H	J	K
A	.9999									
B	−.3705	.9999								
C	−.0870	−.0769	.9999							
D	−.0785	.0388	−.3274	1.0000						
E	−.2925	−.1278	−.5725	.2083	1.0000					
F	−.0387	−.3719	−.0079	.0443	.2330	.9998				
G	.0240	.1862	−.1088	−.0006	.0109	−.3777	1.0001			
H	−.2959	.2190	−.1930	.3788	.0427	−.0966	−.1584	1.0000		
J	.1034	.0998	.0073	.0695	−.2208	.0945	−.1892	−.1713	1.0000	
K	.1441	.1540	.0250	−.0176	−.0684	−.0466	.0101	−.1334	.0666	1.0000

TABLE 6
Correlations between Primary Factors, R_{pl}

	I	D	C_2	C_1	S	V	W	N	K	Resid.
I	1.000	.498	.427	−.025	.503	.138	.058	.283	.033	−.197
D	.498	1.000	.262	.051	.278	.321	−.045	−.068	−.138	−.250
C_2	.427	.262	1.000	.133	.672	−.013	.149	.257	.186	−.068
C_1	−.025	.051	.133	1.000	−.091	−.059	−.111	−.382	−.189	−.050
S	.503	.278	.672	−.091	1.000	−.133	.066	.258	.289	−.058
V	.138	.321	−.013	−.059	−.133	1.000	.344	.118	−.101	−.026
W	.058	−.045	.149	−.111	.066	.344	1.000	.311	.241	.088
N	.283	−.068	.257	−.382	.258	.118	.311	1.000	.310	.114
K	.033	−.138	.186	−.189	.289	−.101	.241	.310	1.000	.010
Resid.	−.197	−.250	−.068	−.050	−.058	−.026	.088	.114	.010	1.000

TABLE 7
Centroid Factor Matrix F_2

	I	II	III	IV	h_2
I	.630	.287	.047	−.166	.5090
D	.502	.388	.530	−.255	.7485
C_2	.597	.413	−.207	.345	.6889
C_1	−.227	.396	.275	.337	.3975
S	.642	.443	−.369	.078	.7506
V	.359	−.352	.548	.062	.5569
W	.377	−.436	.056	.363	.4671
N	.531	−.346	−.328	−.089	.5172

TABLE 8
Oblique Factor Matrix V_2

	α	β	γ	δ
I	.678	.112	.393	.053
D	.669	−.043	.771	−.020
C_2	.640	−.011	.001	.563
C_1	.033	−.455	.033	.401
S	.743	−.011	−.019	.388
V	.015	.492	.571	.008
W	−.085	.572	.065	.263
N	.173	.583	−.023	−.099

TABLE 9
Transformation Matrix Λ_2

	α	β	γ	δ
I	.7245	.5566	.4460	.1806
II	.6621	−.8308	.0577	.3259
III			.8248	
IV	−.1917		−.3425	.9280

TABLE 10
Reference Vector Cosines C_2

	α	β	γ	δ
α	1.0000			
β	−.1468	1.0000		
γ	.4270	.2008	.9998	
δ	.1687	−.1702	−.2185	1.0000

REFERENCES

1. Bechtoldt, H. P. Factorial study of perceptual speed. Unpublished Ph.D. dissertation: Department of Psychology, University of Chicago, 1947.

2. Guilford, J. P. (Ed.) Printed classification tests. Report No. 5, AAF Aviation Psychology Program Research Reports. Washington: U. S. Government Printing Office, 1947.

3. Meili, R. L'analyse of l'intelligence. *Arch. Psychol.*, Geneve, 1946, 31, 1-69.

4. Rimoldi, H. J. A. Study of some factors related to intelligence. *Psychometrika*, 1948, 13, 27-47.

5. Taylor, C. S. A factorial study of fluency in writing. Unpublished Ph.D. dissertation: Department of Psychology, University of Chicago, 1946.

6. Thurstone, L. L. Primary mental abilities. Psychometric Monograph No. 1, 1938.

7. Thurstone, L. L. The perceptual factor. *Psychometrika*, 1938, 3, 1-17.

8. Thurstone, L. L. An experimental study of simple structure. *Psychometrika*, 1940, 5, 153-168.

9. Thurstone, L. L. Current issues of factor analysis. *Psychol. Bull.*, 1940, 37, 189-236.

10. Thurstone, L. L. A factorial study of perception. Chicago: Univ. Chicago Press, 1944.

11. Thurstone, L. L. Multiple-factor analysis. Chicago: Univ. Chicago Press, 1947.

12. Thurstone, L. L. Mechanical aptitude III: analysis of group tests. Chicago: Psychometric Laboratory, Univ. of Chicago, No. 35, 1949.

13. Thurstone, L. L., and Thurstone, T. G. Factorial studies of intelligence. Psychometric Monograph No. 2, 1941.

14. Yela, Mariano. Application of the concept of simple structure to Alexander's data. *Psychometrika*, 1949, 14, 121-135.