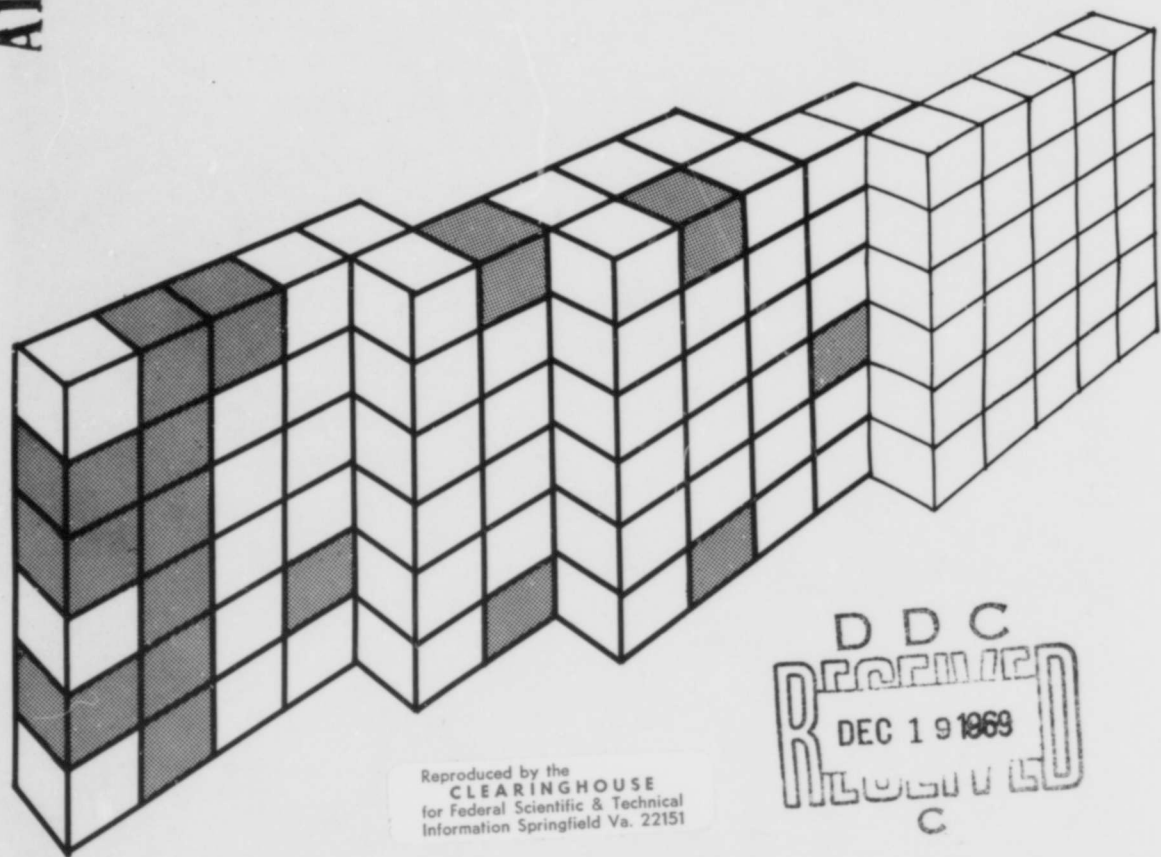


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A FACTOR ANALYSIS OF FIGURAL-MEMORY ABILITIES

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INTRODUCTION

This study was the third of its kind conducted by the Aptitudes Research Project (ARP) at the University of Southern California in the operation area of memory in the structure-of-intellect (SI) model. The first in the series (Brown, Guilford, and Hoepfner, 1968) was devoted to semantic-memory abilities and the second (Tenopyr, Guilford, and Hoepfner, 1966) to symbolic-memory abilities. Both studies were quite successful in demonstrating six SI abilities as factors in each area.

Background of the Study

So much of the pertinent history of the investigation of memory abilities was covered by Brown, et al., (1966) and by Tenopyr, et al., (1966) that very little need be repeated here. The source of hypotheses regarding the separate and distinct visual-figural-

memory abilities was the structure-of-intellect theory, which calls for six such abilities, in line with the six kinds of products of information.

Only two previous investigations lay good claim to having demonstrated by factor analysis any abilities satisfying one of the six SI-hypothesized abilities. The AAF research during World War II (Guilford and Lacey, 1947) reported a factor of "visual memory" that could be identified as SI ability MFS (memory for figural systems). The best representative tests involved remembering arrangements of things in a map of an area. Later, Christal (1958) reported an ability to remember arrangements of objects on a printed page, in one representative task. He also reported a color-memory ability, but it could not be decided from his results whether the ability amounted to a more general-figural-memory ability or whether it was a perceptual ability rather than an intellectual ability.

¹ The test-development phase of this study was supported by Grant GB-4536 from the National Science Foundation, Psychology Program of the Biological and Medical Science Division. The major part of the investigation was done under Contract Nonr-228(20) with the Office of Naval Research, Personnel and Training Branch. The ideas expressed here are our own, and do not necessarily reflect the views of those agencies. This material may be reproduced for any purpose of the United States Government. Among the authors, Guilford and Hoepfner were responsible investigators and Bradley was study leader.

² The term "figural" in the title refers only to information from visual input; no other kind of input was involved.

Selection of Abilities for Investigation

The decision to work on the figural-memory abilities automatically selected six abilities. Ten reference factors were also represented by tests for ten abilities outside the set of primary interest. Four parallel memory abilities, two symbolic and two semantic, were systematically brought into the study, to determine whether new tests stayed clear of relations to abilities in those two content categories. Three parallel figural-cognition abilities were represented, in order to see whether new memory tests were free from cognition variance. One divergent-production ability dealing with figural information, and two convergent-production abilities, one figural and one semantic, were also included to provide some minimal sampling in those areas.

Table 1

Memory and Figural Matrices from the Structure-of-Intellect Model, Showing Investigated Abilities

	Content				Operation					
	Figural	Symbolic	Semantic	Behavioral	Cognition	Memory	Divergent Production	Convergent Production		Evaluation
U	MFU	MSU	MMU			MFU	DFU			Units
C	MFC				CFC	MFC				Classes
R	MFR				CFR	MFR				Relations
S	MFS					MFS				Systems
T	MFT				CFT	MFT		NFT		Transformations
I	MFI	MSI	MMU			MFI				Implications

Table 1 is designed to provide an orientation with respect to the abilities involved in this study, in terms of their locations in the SI model. Shown first is the two-dimensional matrix devoted to memory abilities, of which 24 altogether are predicted by the SI model. The two previous analyses by the ARP demonstrated the 12 distinct abilities in the symbolic and semantic columns. There has been no investigation of the hypothetical six behavioral-memory abilities. Only the memory abilities investigated in this study are marked by trigrams in the memory matrix.

The second matrix in Table 1 represents all figural abilities, of which 30 are forecast by the SI model. Previously demonstrated are all the figural-cognition and figural-evaluation abilities, all except one of the divergent-production abilities, and all except two of the convergent-production abilities. With success in this particular analysis, only three of the thirty visual-figural abilities will remain to be demonstrated. The only reference factor not represented in Table 1 is that for NMS (convergent production of semantic systems), which is neither figural nor is it a memory ability.

HYPOTHESIZED FACTORS AND THEIR TESTS

Visual-Figural-Memory Factors

Several issues and other considerations had bearings upon the kinds of tests designed for the six hypothesized visual-memory factors. The two general test-development strategies that have served well in other areas of SI abilities were applied in this study. The most obvious guide is the nature of the ability itself. If it is MFC, the test has to involve memorizing and a test on the results of that memorizing to determine how much of the observed information has been fixed for the short time interval between E's study of the information and his test. Memory tests are distinctly different from tests for all other kinds of operation by virtue of this two-stage feature. For MFC the information to be memorized must be in visual-figural form, because of the "F" specification in the trigram for this ability. The mental construct to be memorized is a class idea, so the test must be so structured that remembering other kinds of products will be of little or no aid in doing well in the retention test. This aspect of tests has generally been the one most difficult to control.

Another source of test ideas has been the successful tests for abilities in parallel places in the SI model. For example, tests for MFC might be modeled after tests of CFC, or MSC, changing only one parameter in the trigram. This approach works fairly well in the majority of cases, but has not been fully successful in all.

One general self-imposed requirement in developing tests in the memory category has been to provide recall and recognition tests of retention. Where this has been done in the symbolic and semantic areas, tests of the two kinds have almost invariably gone together on the same factor. Where a test fails, it has been for some reason other than its being in a recall or a recognition form. In the figural area of content, the requirement for recall tests poses the

problem that recall tests require E to produce figures in line drawings, and the motivation and skill for drawing differ so much that this activity must be restricted to the simplest figures. It may be seen in what follows that there is one recall test for each of the six MFX abilities, except in the one case where there are two. It was not possible to determine whether or not recall and recognition tests would separate into two groups on different factors, but it could be determined whether the recall form of test would go with the recognition tests. Results from the other two content areas have been reassuring, but the question could not be ignored in a new content area.

For convenience, all the tests used in this analysis are briefly described and an illustrative item is given for each one in the Appendix, with the tests listed in alphabetical order. Only sufficient description to characterize each test will be given in what follows here. In general, there are three familiar test formats; a completion type for recall tests, a matching format, especially in tests for MFI, and multiple-choice and true-false types in the recognition tests.

MFU - Memory for Figural Units

Figural Letter Recognition - E studies a page full of scattered letters, all different and each letter in a different style of print. In each item of the retention test, each letter given on the study page is presented in four styles, one of which is identical with that of the studied letter. Only figural properties are therefore relevant.

Figure Recall - On the study page, E studies ten relatively simple geometric shapes, and he attempts to reproduce them on the test page. Artistic shortcomings are overlooked in scoring; E only needs to show that he remembers the nature of the figure.

Figure Recognition - E studies some detailed geometric figures on the study page. On the test page the figures are mixed with an equal number of new ones, and to each given figure E merely responds that he has or has not seen the figure on the study page.

Object Recognition - The study page contains 15 familiar objects, e.g., a necktie, a screwdriver, or sunglasses, each in a certain style. On the test page E has a four-choice item on every object, the alternatives representing four different styles of the same object.

Remembering Faces - A popular example of remembering visual-figural units is memory for faces. Ten faces of different people, easily discriminated, are shown, five of each sex. The ten are mixed with as many more on the test page, with E to say whether or not he had seen each face on the study page. Thus, for MFU there were two two-choice retention tests and two four-choice tests, and one recall test.

MFC - Memory for Figural Classes

In tests for MFC, the information to be memorized is in the form of figural-class ideas applying to figural objects. In every test, E is to generate his class

ideas from sets of three objects that have one or more common properties. The cognition task is kept at low difficulty, lest some CFC variance enter into the test score. E should not fail an item in the retention test because he was unable to see what class idea was represented on the test page. All Es should be aware of the class ideas, leaving things to individual differences in retention only to provide variations in scores.

Figural Class Recall presents sets of three figures on the study page, each set having one common element: e. g., a dot, a right angle, or a broken line. On the test page, regardless of the forms of the studied figures, E is given a large set of circles (in one part) or squares, all outlined in widely spaced dotted lines. E is to put into each such figure a common element he remembers from the study page.

In Memory for Figural Classes, having studied sets of three figures to observe the class ideas represented, E is given twice as many single figures, half of which are classifiable in the studied sets and half not, in a true-false recognition test.

In Object Class Memory, the presented sets contain three line drawings of familiar objects, grouped, not because of any common realistic property but because of similarity of shape, e. g., oval objects or objects with projections in the same direction. A yes-no recognition test is then given for single objects that may or may not satisfy requirements for class membership.

Recognition of Figural Classes is like each of the two just mentioned in some respects. The main differences are in the kinds of figures and kinds of common attributes.

MFR - Memory for Figural Relations

The one recall test for MFR (Figural Relations Recall) presents 12 pairs of triangles of equal size and shape, differing in terms of internal lines in such a way that it may be said that the second is related to the first in some cognized fashion. In the retention test, E is given the first member of each pair and he is to sketch the second member. It was recognized that E can look upon the difference between the two members of a pair as a change from one to the other, hence as a transformation. We shall see that the results lend some foundation to that possibility.

Analogies tests have been faithful representatives of relations abilities, in different content and operation areas, varying according to the SI location of the ability. For MFR, Memory for Figural Analogies presents for study ten pairs of related figures. The retention test presents the same relation transposed to two new figures, with two mislead answers in a multiple-choice format.

Trend tests have also been found to serve as measures of relational abilities, so two trend tests were developed for MFR. Matrix Trend Recall presents a 4 X 4 matrix, in each cell of which a certain kind of figure belongs. The same relation applies in all the rows and another relation applies in the columns. Having understood the two relations and seeing a starting figure in one cell, E should be able to say

what kind of figure goes in each blank cell. With ten blanks left in the test matrix and with 20 figures as potential cell occupants, in a numbered list, E is to match figure and cell in accordance with his remembered relations. The title of this test includes the term "recall," but the matching task more properly puts the test in the recognition category.

A matrix is a two-dimensional trend test. Remembering Figural Trends is a one-dimensional trend test. The study page gives ten 5-step trends, and E is to recognize those trends in new figures, seen among ten new trends. The trends on the test page are all exhibited in circular figures, so that shapes would not give away the answers.

MFS - Memory for Figural Systems

The figural systems most used in tests of SI abilities have emphasized arrangements of lines and objects in space. In Monogram Recall, each study page shows five different arrangements of three capital letters to form reasonable monograms. On the test page E is given the same three letters, which he is to arrange in the five ways shown on the study page. His task is to reconstruct the arrangements.

In Orientation Memory, E is to memorize the arrangement of ten quite different houses or commercial buildings shown located in a street map. In the test task the same map is shown without the houses but with land plots separated by dotted lines. The ten houses (buildings), numbered, are presented below the map, with E to locate each house (building) by number in the map, in a matching test.

Remembering Object Orientation presents 15 familiar objects in five rows and three columns on the study page. E is to memorize their relative locations so that in the test for retention he can say in which direction any given object is from another object. E has eight directional arrows to use in answering each item. We shall see that the arrows may have taken on the role of symbols, at least to some extent.

System-Shape Recognition is quite different from the other three for MFS. In a large rectangle on the study page, nine odd-shaped, mostly elongated, curvaceous, outlined objects are given in a certain arrangement. On the test page, each item is a small rectangle that contains three shapes from the study page. On a true-false test, E indicates whether or not the three shapes are arranged exactly as they were on the study page.

MFT - Memory for Figural Transformations

Like relations, particularly, transformations are transposable, and in testing retention of observed transformations, E must show that he can reconstruct the same transformation in a new setting of objects or he must correctly recognize the studied transformation in new dress. In Figural Subtraction Recall, the transformation in every case is a subtraction of part of a given figure, as the title implies. On the study page E is shown how a part is removed from a somewhat complex figure, leaving a certain kind of part.

On the test page, E deals with an analogous subtraction with new figures. Given the old first figure and the new first figure, E is to sketch what the remainder should be if the same kind of subtraction were made. The mention of analogies smacks of relations, and we shall see that MFR does become involved in this test.

Front-View Recognition asks E to effect an imagined rotation of a given geometric figure so that he would be looking directly at the front side of the three-dimensional figure. The test page asks for recognition of the correct front views from among an equal number of false fronts.

Memory for Hidden Figures is a direct parallel to the Hidden Figures test that is so commonly representative of ability NFT. E is to cognize certain transformations in the form of revision of parts of a complex figure into a simple figural object, and his memory for that transformation is tested later. On the study page, he is shown how the simple figure is made from parts of the complex figure. On the test page the complex figure is presented all in dotted lines, with E to sketch the transform with his pencil. In a real sense this is a recall test.

The two remaining tests are similar in principle but different in one or two respects. One deals with orientation of real objects in space, and the other with orientations of irregular, rectangular blocks. Both present changes in orientation and both call for recognition of the same changes in new objects of the same kinds. The first test is Remembering Spatial Changes and the second is Visualization Memory. The second is an adaptation of a good test of CFT (visualization) known as Block Rotation, which was also in the test battery. The correlation between these two tests was sufficiently low that neither went significantly on the other factor, an example of how an apparently minor modification in a test can change its factor representation drastically.

MFI - Memory for Figural Implications

Tests for MFI call for tasks of the paired-associates type. E is to learn that Y is connected with X so that if X comes later so does Y. But to control for ability MFU, memory for particular Y members of pairs, it is best not to require recalling Y, but merely to require connecting it properly with X. A matching test of some kind is the most natural format for the purpose. One recall test was included, however, namely, Paired Figure Recall. E studies 10 pairs of simple figures, followed by a recall test. One could predict some MFU variance for this test, but the test should not be as strong on MFU as on the MFI component.

One matching test, Face-Shield Matching, presents something like a family shield paired with a face, 10 pairs being given on the study page. Remembering Flag-Letter Pairs presents 10 flag-letter pairs, followed by a matching test. Remembering Hand-Object Pairs gives ten pairs, each hand in a different position, with fingers and thumb in different states of contraction, paired with a familiar object sketched in a certain style. The retention test is in multiple-

choice form. Given the particular hand, E sees two objects each in two styles, one object in one of its styles being correct. Thus a double discrimination must be made by E in memory; first as to which kind of object and then as to which style.

Reference Factors and Their Tests

Tests for the reference factors will be even more briefly characterized. They are also more fully described in the Appendix. Two were entirely new--Remembering Symbol Codes (MSI) and Memory for Meanings (MMU)--and one was a revision of an earlier form--Temporal Ordering for NMS. The tests and their factors follow:

Figural Class Inclusion (CFC) - Which of five alternative figures belongs in the class with two given figures?

Figure Classification (CFC) - Which single figure belongs in the same class with which set of three figures, in short matching problems?

Figure Analogies (CFR) - Which of five figures correctly completes each figural analogy?

Figure Matrix (CFR) - Which of five figures belongs in a marked, vacant cell of a 3 X 3 matrix, with one trend in rows and another in columns?

Block Rotation (CFT) - Which of five irregular, rectangular blocks represents a new, rotated position for a given block?

Paper Folding (CFT) - Which of five marked pieces of paper correctly represents how a folded and cut paper would look after being unfolded?

Memory for Listed Nonsense Words (MSU) - Recognize 15 studied nonsense syllables mixed with 15 new ones.

Recall of Nonsense Words (MSU) - Write recalled nonsense syllables after studying a list of 15.

Number-Letter Association (MSI) - Having studied pairs of two-digit numbers and single letters, given each number, write the connected letter.

Numerical Operations (MSI) - An abridged form of the Guilford-Zimmerman Aptitude Survey, Part III.

Remembering Symbol Codes (MSI) - After studying pairs containing nonsense syllables and symbols in the form of punctuation marks and operation signs, E takes a matching test.

Memory for Meanings (MMU) - After studying 15 common words, including nouns, adjectives, and verbs, E is to recognize close synonyms among 15 new words.

Picture Memory (MMU) - After studying 15 pictures of familiar objects, E writes their names in a recall test.

Recalled Words (MMU) - After studying 20 familiar words scattered on a page, E takes a recall test.

Books and Authors (MMI) - E studies 15 pairs, each containing a family name followed by the title of a book that suggests the author's occupation. Given

Table 2

Means, Standard Deviations, Reliabilities, and Distributions of Scores

Test Name and Code	Mean	Standard Deviation	Reliability ^a	Form of Distribution ^b
1. Block Rotation CFT06A	3.69	4.31	.79	0
2. Books and Authors MMI01A	16.28	5.60	.81	+
3. Face-Shield Matching MFI01A	12.40	4.58	.83	0
4. Figural Class Inclusion CFC04A	10.82	3.53	.49	0
5. Figural Class Recall MFC01A	18.92	4.44	.71	0
6. Figural Letter Recognition MFU01A	16.37	6.51	.82	0
7. Figural Relations Recall MFR03A	19.19	3.55	.77	-
8. Figural Subtraction Recall MFT01A	20.65	5.15	.81	-
9. Figure Analogies CFR01A	16.66	5.95	.79	-
10. Figure Classification CFC01A	10.80	3.28	.56	0
11. Figure Matrix CFR02B	11.45	4.06	.60 ^d	0
12. Figure Recall MFU02A	12.51	3.63	.72	0
13. Figure Recognition MFU03A	44.04	9.85	.80	-
14. Front View Recognition MFT02A	29.82	7.01	.80	-
15. Hidden Figures NFT04B	7.28	2.68	.61	0
16. Internally Consistent Figures NFT05A	16.75	4.39	.57	-
17. Make A Figure Test DFU02B	34.55	10.06	.81	0
18. Matrix Trend Recall MFR01A	15.86	4.31	.88	-- ^e
19. Memory for Figural Analogies MFR02A	26.89	4.68	.87	-- ^e
20. Memory for Figural Classes MFC02A	33.34	11.55	.82	-
21. Memory for Hidden Figures MFT03A	20.26	5.45	.83	0
22. Memory for Listed Nonsense Words MSU12A	42.05	10.71	.83	-
23. Memory for Meanings MMU08A	35.97	18.01	.91	0
24. Monogram Recall MFS01A	11.36	2.78	.52	0
25. Number-Letter Association MSI08A	12.83	5.17	.80	0
26. Numerical Operations MSI01B	24.52	9.13	.89 ^d	+
27. Object Class Memory MFC03A	24.41	6.01	.65	-
28. Object Recognition MFU04A	26.81	3.83	.79	-- ^e
29. Orientation Memory MFS03A	12.01	3.56	.72	0
30. Paired Associates Recall MMI03A	26.99	7.03	.90	-
31. Paired Figure Recall MFI04A	12.39	4.45	.82	0
32. Paper Folding CFT07B	7.44	4.36	.73	+
33. Penetration of Camouflage NFT02B	18.72	6.60	.83 ^c	0
34. Picture Arrangement NMS02D	12.43	2.38	.52	0
35. Picture Memory MMU04A	25.77	3.57	.53 ^d	0
36. Recall of Nonsense Words MSU13A	19.84	4.74	.75 ^d	0
37. Recalled Words MMU05A	26.64	4.92	.69 ^d	0
38. Recognition of Figural Classes MFC04A	28.99	6.50	.67	-
39. Related Alternatives MMI04A	19.09	7.46	.89	-
40. Remembering Faces MFU05A	30.80	7.17	.78	-
41. Remembering Figural Trends MFR04A	28.51	6.49	.71	-
42. Remembering Flag-Letter Pairs MFI02A	10.39	4.26	.78	0
43. Remembering Hand-Object Pairs MFI02A	20.25	5.71	.67 ^d	0
44. Remembering Object Orientation MFS02A	15.39	8.30	.90	0
45. Remembering Spatial Changes MFT04A	23.25	4.66	.70 ^d	-
46. Remembering Symbol Codes MSI09A	13.50	5.17	.88	-
47. Sketches DFU01C	15.60	4.12	.79	0
48. System-Shape Recognition MFS04A	13.08	7.09	.54 ^d	0
49. Temporal Ordering NMS04A	27.04	9.59	.51 ^d	0
50. Verbal IQ	114.25	9.80		
51. Visualization Memory MFT05A	8.97	4.06	.65	0
52. Sex	.40	.49		

^a Reported reliability estimates are Kuder-Richardson coefficients unless noted.

^b Distribution forms are coded: --, strong negative skew; -, slight negative skew; 0, symmetrical; and +, slight positive skew.

^c Items not dichotomously scored and no speededness; reliability estimate is item-alpha coefficient.

^d Tests showed evidence of speededness; reliability is part-alpha coefficient.

^e Raw test scores grouped into 3 or 4 categories with symmetrical shape for correlation analysis.

Table 3
Correlation Matrix of 52 Variables (N = 202)

Test Name	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
1. Block Rotation		08	04	19	35	14	38	38	46	14	29	38	21	41	30	14	12	28	24	22	46
2. Books and Authors	08		50	19	30	28	32	34	31	21	21	24	22	17	12	02	31	14	22	31	25
3. Face-Shield Matching	04	50		31	34	47	35	37	31	17	28	24	42	17	09	07	18	18	34	22	43
4. Figural Class Inclusion	19	19	31		27	26	26	38	33	37	23	28	31	26	24	16	09	10	17	23	33
5. Figural Class Recall	35	30	34	27		39	57	53	40	26	31	63	42	32	28	24	28	41	42	26	53
6. Figural Letter Recognition	14	28	47	26	39		40	39	30	19	20	43	52	36	19	15	18	18	43	23	48
7. Figural Relations Recall	38	32	35	26	57	40		62	58	30	46	59	56	51	37	28	30	44	64	40	72
8. Figural Subtraction Recall	38	34	37	38	53	39	62		47	30	43	51	49	41	28	12	11	43	51	36	63
9. Figure Analogies	46	31	31	33	40	30	58	47		31	51	38	39	44	36	27	21	36	50	38	53
10. Figure Classification	14	21	17	37	26	19	30	30	31		26	26	18	16	12	11	12	15	23	24	24
11. Figure Matrix	29	21	28	23	31	20	46	43	51	26		30	26	24	32	13	21	35	43	33	40
12. Figure Recall	38	24	24	28	63	43	59	51	38	26	30		46	48	36	22	14	38	41	34	55
13. Figure Recognition	21	22	42	31	42	52	56	49	39	18	26	46		42	23	13	07	20	49	32	49
14. Front View Recognition	41	17	17	26	32	36	51	41	44	16	24	48	42		25	24	15	22	33	41	53
15. Hidden Figures	30	12	09	24	28	19	37	28	36	12	32	36	23	25		12	15	32	27	18	38
16. Internally Consistent Figures	14	02	07	16	24	15	28	12	27	11	13	22	13	24	12		15	11	23	04	19
17. Make A Figure Test	12	31	18	09	28	18	30	11	21	12	21	14	07	15	15	15		16	22	16	22
18. Matrix Trend Recall	28	14	18	10	41	18	44	43	36	15	35	38	20	22	32	11	16		45	27	32
19. Memory for Figural Analogies	24	22	34	17	42	43	64	51	50	23	43	41	49	27	23	22	45		29	61	
20. Memory for Figural Classes	22	31	22	23	26	23	40	36	38	24	33	34	32	41	18	04	16	27	29		39
21. Memory for Hidden Figures	46	25	43	33	53	48	72	63	53	24	40	55	49	53	38	19	22	32	61	39	
22. Memory for Listed Nonsense Words	01	20	32	28	18	36	11	23	18	13	17	22	38	22	05	21	04	10	20	17	17
23. Memory for Meanings	14	38	41	29	20	36	38	38	37	28	23	24	42	28	14	14	11	24	36	20	29
24. Monogram Recall	24	26	41	27	45	35	47	47	28	19	34	43	34	36	19	10	15	39	34	39	54
25. Number-Letter Association	17	45	43	26	33	41	33	35	32	22	19	34	36	28	18	10	12	17	28	26	31
26. Numerical Operations	10	26	17	09	16	11	23	14	28	14	22	15	09	11	25	05	24	15	14	16	12
27. Object Class Memory	27	13	18	20	35	24	38	34	39	20	37	31	33	25	16	19	01	20	36	24	35
28. Object Recognition	19	19	31	24	32	40	44	35	26	16	20	31	44	36	24	17	07	22	38	27	51
29. Orientation Memory	26	29	42	15	47	41	54	37	39	15	30	45	39	35	25	11	34	31	42	19	49
30. Paired Associates Recall	09	56	43	29	31	34	27	33	28	24	24	31	33	27	18	03	24	12	28	27	26
31. Paired Figure Recall	28	45	36	22	53	31	46	42	40	13	32	52	36	34	27	14	26	40	45	29	49
32. Paper Folding	41	21	26	28	29	27	41	36	51	25	40	46	29	40	40	23	18	22	31	21	49
33. Penetration of Camouflage	12	20	19	11	17	16	25	15	22	14	15	04	12	12	21	15	15	12	14	10	23
34. Picture Arrangement	35	23	18	17	22	13	35	41	36	13	30	15	14	20	20	14	07	25	35	25	36
35. Picture Memory	11	38	29	18	32	26	35	23	19	12	03	33	26	24	19	-02	22	13	16	26	36
36. Recall of Nonsense Words	16	40	39	19	39	36	29	35	32	20	21	39	39	20	20	-06	08	31	29	28	26
37. Recalled Words	04	48	40	27	39	33	30	30	25	21	16	27	31	19	18	-01	12	24	25	26	31
38. Recognition of Figural Classes	24	20	34	27	41	41	54	48	46	20	28	45	52	44	32	11	08	23	45	42	51
39. Related Alternatives	10	58	48	26	26	36	34	37	37	22	19	19	37	29	13	07	23	13	32	32	30
40. Remembering Faces	06	18	39	14	18	42	33	29	24	07	14	24	45	25	10	07	07	16	23	18	30
41. Remembering Figural Trends	27	09	16	30	26	20	37	34	35	25	26	34	30	43	31	18	15	34	37	38	37
42. Remembering Flag-Letter Pairs	15	45	48	32	31	39	45	47	38	26	27	31	41	34	20	10	17	30	35	25	46
43. Remembering Hand-Object Pairs	20	41	47	20	30	41	45	40	27	12	15	32	54	35	20	09	10	03	31	24	46
44. Remembering Object Orientation	16	22	33	12	24	44	37	35	29	23	22	29	45	36	12	-06	05	17	43	26	43
45. Remembering Spatial Changes	33	32	30	21	43	41	61	51	44	20	22	46	49	53	36	20	14	36	53	33	53
46. Remembering Symbol Codes	14	52	46	29	27	44	35	29	31	22	19	28	43	30	18	13	30	06	25	23	35
47. Sketches	-08	26	15	00	17	12	11	01	04	00	07	03	-01	00	06	-03	48	06	09	07	03
48. System-Shape Recognition	21	10	28	26	23	23	36	33	29	25	29	33	35	31	12	09	-04	09	27	24	38
49. Temporal Ordering	23	31	29	25	31	28	44	32	41	28	31	25	26	32	18	10	25	19	40	27	36
50. Verbal IQ	08	16	18	17	19	18	26	25	19	14	21	22	14	16	25	03	13	07	33	08	20
51. Visualisation Memory	29	22	26	17	37	33	46	37	43	26	37	39	25	43	22	17	22	31	37	27	40
52. Sex	39	-18	-27	-12	-02	-15	06	02	05	-05	06	13	-11	14	04	13	01	-03	-11	-07	-02

Note. — Decimal points omitted.

each family name on the test page, E writes the name of the occupation.

Paired Associates Recall (MMI) - Like a typical paired-associates task, pairs of familiar words are studied. In a recall test, given the first member of each pair, E writes the second.

Related Alternatives (MMI) - E studies 15 pairs, each containing a family name followed by an occupation. In a later multiple-choice test, the name is given, followed by four objects commonly concerned in the occupations.

Make A Figure Test (DFU) - Given three unorganized line segments, E is to produce a variety of figures each including only those lines.

Sketches (DFU) - Given two arranged lines, E builds

on them to make familiar objects.

Hidden Figures (NFT) - Which of five simple Gottschaldt figures is embedded in each complex figure?

Internally Consistent Figures (NFT) - Is each complex drawing of a three-dimensional figure correctly organized?

Penetration of Camouflage (NFT) - Find several human faces hidden in a complex scene.

Picture Arrangement (NMS) - Given the panels of a four-part cartoon strip, arrange them in proper temporal sequence.

Temporal Ordering (NMS) - Given nine operations for carrying out a project, answer questions on which steps come earlier or later in the best sequence.

Table 3
(Continued)

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

PROCEDURES AND STATISTICAL RESULTS

Pretesting

The experimental, visual-memory tests were put through four pretesting tryouts, with the objective of improving appropriate difficulty levels, adequacy of instructions, internal consistency, and factorial affiliation. Three of these were with students in beginning psychology at USC and one was with geometry students in a local high school.

Test Administration and Subjects

The eight-hour battery of 50 tests was organized in booklets so that all subjects took the tests in the same sequence. The battery was administered in four two-hour sessions, February 10, 11, 13, and 14,

1969, from 8:00 to 10:00 a. m., at the Mira Costa High School, Manhattan Beach, California.³ Students in grades 9 through 12 who could be conveniently scheduled for testing were the examinees, about 40 per cent of whom were boys and 60 per cent were girls.

No selection was based upon any test or achievement information. It was assumed that the range of education involved would not be sufficiently related to

³ For arranging the testing and for assistance in carrying out the administration, we are indebted to Dr. Douglas Schwartz, Psychologist of the Redondo Union High School District, and to Mr. Carl Fisher, Mr. Hugh Cameron, & Miss Millie Thomas, Principal, Assistant Principal, and Counselor, respectively, at Mira Costa High School.

Table 4

Unrotated Factor Matrix

Test Name	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	h ²
1. Block Rotation	41	48	07	09	01	-27	16	17	13	07	-05	00	06	-04	-16	01	-16	18	65
2. Books and Authors	54	-40	34	-05	09	-12	09	17	01	-01	07	15	09	09	10	03	08	-15	71
3. Face-Shield Matching	59	-32	-02	-13	06	06	-06	00	05	-19	19	02	13	12	-04	-07	09	-01	60
4. Figural Class Inclusion	44	-01	-06	18	20	-00	25	-19	-17	-11	19	05	02	-00	06	-11	-08	13	49
5. Figural Class Recall	65	17	18	-02	-32	06	02	-18	03	-08	15	13	09	-24	-00	13	-05	-02	75
6. Figural Letter Recognition	61	-12	-16	-11	-07	-04	-20	-18	01	-01	07	-05	07	02	00	-01	08	16	55
7. Figural Relations Recall	78	31	05	-16	-02	04	-12	01	-06	05	02	10	-03	-03	07	03	-09	-13	80
8. Figural Subtraction Recall	71	20	-05	05	-03	11	04	12	03	-04	12	22	11	05	04	-12	-08	02	68
9. Figure Analogies	66	27	11	10	27	02	03	03	09	04	-04	-06	04	06	-00	11	-03	-03	64
10. Figure Classification	38	04	04	20	23	07	08	-03	-16	-16	10	-01	03	-14	26	06	-15	07	43
11. Figure Matrix	50	28	16	13	23	21	-02	05	08	-20	05	-17	08	17	-15	04	00	-12	62
12. Figure Recall	65	27	00	11	-35	-13	03	-18	-03	-01	10	-05	02	-09	06	-03	-08	-13	73
13. Figure Recognition	67	-03	-33	-04	-07	-03	-15	-14	01	13	06	02	14	08	-00	01	-08	-10	67
14. Front View Recognition	59	26	-14	03	-01	-28	-02	-02	-21	10	-26	-02	-01	01	09	-07	08	08	66
15. Hidden Figures	42	26	14	00	01	01	16	-08	04	26	15	-25	-22	11	09	-07	08	00	53
16. Internally Consistent Figures	23	24	00	-05	20	-14	05	-43	15	-13	-18	21	-07	-13	03	05	17	-08	54
17. Make A Figure Test	31	-02	54	-26	07	-07	-13	-20	-17	-07	-14	-10	-01	05	-08	-00	-10	06	61
18. Matrix Trend Recall	46	27	18	03	-23	43	10	04	22	01	-26	-03	03	01	16	-21	-01	01	76
19. Memory for Figural Analogies	66	20	-02	-06	02	28	-24	-04	06	04	-06	15	-15	14	-01	13	00	-02	71
20. Memory for Figural Classes	50	08	02	11	02	19	11	13	-33	09	-16	-03	20	04	-08	00	11	-13	53
21. Memory for Hidden Figures	76	28	-10	-18	-08	00	04	05	-11	-04	11	06	-08	08	-15	09	-04	10	79
22. Memory for Listed Nonsense Words	44	-36	-21	26	07	-03	-01	-31	17	-07	-17	-04	02	-01	-16	-04	05	03	63
23. Memory for Meanings	58	-27	-12	06	26	06	-10	-03	15	06	-08	02	-08	-10	06	-18	-21	-01	64
24. Monogram Recall	61	03	-03	-02	-22	10	04	12	-13	-29	-01	-00	-04	-07	-17	-24	11	-00	65
25. Number-Letter Association	58	-32	04	18	-11	-11	12	00	07	-02	-01	00	03	11	07	12	08	09	56
26. Numerical Operations	27	-04	34	07	13	-06	-14	04	08	06	03	-20	02	-04	06	02	-00	-09	30
27. Object Class Memory	43	20	-11	16	16	11	-08	-08	07	08	05	05	09	-12	-13	10	-00	-08	39
28. Object Recognition	52	04	-28	-28	-06	05	16	-07	-00	02	02	01	-01	04	02	04	15	12	51
29. Orientation Memory	63	02	09	-24	-15	-04	-13	03	11	-13	-01	-14	-06	-07	-05	-03	-05	02	57
30. Paired Associates Recall	58	-43	18	19	-00	-13	05	01	-02	00	-03	02	-05	00	-04	-08	02	-06	63
31. Paired Figure Recall	65	-07	24	01	-29	-05	15	-03	15	-06	-11	04	-10	14	-03	16	-06	-05	70
32. Paper Folding	50	32	-03	-00	11	-17	23	-09	10	-09	12	-18	-10	14	-04	-02	03	-06	56
33. Penetration of Camouflage	27	03	08	-43	29	07	17	02	12	15	08	-12	08	-24	07	06	12	05	53
34. Picture Arrangement	40	18	06	-13	22	13	17	28	14	04	-02	17	-03	-12	-17	01	07	08	49
35. Picture Memory	49	-29	10	-12	-15	-09	20	07	-14	18	03	-03	-15	-20	-09	-04	-08	-07	56
36. Recall of Nonsense Words	55	-28	09	30	-23	09	01	02	15	21	07	-11	19	-09	-02	04	08	06	68
37. Recalled Words	56	-43	10	20	-15	07	07	07	03	-02	03	01	-06	-08	03	07	08	08	62
38. Recognition of Figural Classes	63	09	-21	07	01	12	-08	-08	-13	23	09	-04	08	02	-02	04	05	02	57
39. Related Alternatives	61	-40	06	04	18	-11	-01	15	-03	04	-07	11	-02	-02	00	-04	07	-05	63
40. Remembering Faces	46	-17	-25	-21	06	03	-10	-01	-12	09	-02	-12	14	-06	-05	-21	-04	-03	47
41. Remembering Figural Trends	45	22	-05	16	04	11	15	-12	-26	14	-18	00	08	05	03	-00	01	01	46
42. Remembering Flag-Letter Pairs	64	-20	-07	-17	05	00	15	02	05	-08	-05	06	06	20	19	-05	-09	12	63
43. Remembering Hand-Object Pairs	58	-14	-17	-20	-00	-27	-11	12	-01	04	10	06	07	07	05	03	02	-09	56
44. Remembering Object Orientation	56	-15	-31	03	-05	02	-24	22	02	-02	-13	-16	-08	00	04	18	-09	10	64
45. Remembering Spatial Changes	67	16	-12	-14	-06	-09	-07	08	01	08	-12	10	-16	-02	15	-06	06	-09	63
46. Remembering Symbol Codes	62	-45	-02	-03	12	-17	06	-07	01	-00	-08	-04	-11	00	-07	04	-09	-01	68
47. Sketches	12	-17	49	-32	-01	08	-12	-17	-16	03	-03	-04	18	03	-03	-03	-05	07	51
48. System-Shape Recognition	45	06	-32	01	07	-04	06	12	-12	-27	00	-17	-03	-13	02	04	-06	-15	50
49. Temporal Ordering	50	-02	24	19	17	04	-23	04	-11	04	-04	12	-05	-06	-06	02	-07	10	48
50. Verbal IQ	30	07	15	21	07	03	-26	-04	-06	11	30	08	-28	03	-03	-15	10	04	46
51. Visualization Memory	53	25	11	10	02	-06	-25	14	-07	-22	-06	-13	-01	-15	16	04	22	09	63
52. Sex	-13	55	18	14	-03	-48	-16	09	16	02	02	06	19	03	04	-13	01	04	72

Note. — Decimal points omitted

variances in visual-memory abilities to affect the results of the analysis. Any relations of those abilities to sex of the examinees were taken into account by putting the variable of sex membership into the list of analyzed variables and rotating one factor axis to it. Variances in IQ were similarly handled by including among the intercorrelated and analyzed variables the verbal-IQ index, either from the California Test of Mental Maturity or the Lorge-Thorndike intelligence scale. It turned out that the factor vector for verbal IQ had no significant relation (.30 or higher) to any test of any SI ability in this study (there were no marker tests for ability CMU), and only one test had a significant loading on the sex factor, to be noted in discussions of the aptitude factors.

Eliminating from consideration in the results all students who missed testing sessions without making

them up, or who were otherwise irregular, left 202 in the experimental sample.

Statistical Operations and Results

The usual statistical information concerning particular tests was obtained, including means, standard deviations, estimates of reliability, and rough indications regarding forms of score distributions. The results may be seen in Table 2.⁴ The intercorrelations, given in Table 3, are product-moment coefficients. Three score distributions were grouped into three or four categories, but none was dichotomized.

Eighteen principal factors were extracted, allowing for 16 ability factors plus sex and IQ. Estimates

⁴ The statistical services for this study were supplied by the Health Sciences Computing Facility at the University of California at Los Angeles.

of communalities were used in diagonal entries, starting with squared multiple R's and iterating to stabilized values. Axes were rotated using Case II of Cliff's (1966) method of orthogonal rotations toward congruity with target matrices. The first target matrix had all zero entries except where a particular test was hypothesized for a certain factor. In this case, the target loading was the square root of the test's communality (its total vector length in the common-factor space). After the first rotation under these conditions, it was noted where changes had to be made in order to reduce intolerable negative loadings and to increase clarity of factor structure. When whole-matrix computerized rotations no longer improved the psychological picture, several two-factor rotations were employed to obtain the final rotated matrix. The matrix of principal-factor loadings appears in Table 4 and the matrix of final rotated loadings in Table 5.

INTERPRETATION OF FACTORS

Starting with the six rotated factors of visual memory, which are of primary interest in this study, each of the 16 psychological factors will be discussed in turn. Tests significantly loaded on the factor will be listed in the order of their loadings on it, where "significantly" means a loading of .30 or higher. The numbering of the tests refers to their alphabetical order, as followed in the statistical tables and in the Appendix. Following each test name is the trigram of the SI ability for which the test was constructed or

chosen. Where a test had significant loadings on other factors, that information is given in parentheses, following the loading on the factor under discussion.

The Visual-Figural-Memory Factors

MFU - Memory for Figural Units

13. Figure Recognition (MFU)	.57	
40. Remembering Faces (MFU)	.52	
6. Figural Letter Recognition (MFU)	.46	
38. Recognition of Figural Classes (MFC)	.44	(MFC .33)
43. Remembering Hand-Object Pairs (MFI)	.40	(MFI .33)
28. Object Recognition (MFU)	.36	

Four of the five tests designed for MFU, the ability to remember distinct visual forms and other attributes of figures as isolated bits of information, were loaded univocally on the factor recognized for that ability. It happens that these four are recognition tests, whereas the one that failed to appear in this list is a recall test--Figure Recall. This fact is not considered important because elsewhere in this analysis and in the two previous memory analyses by the ARP, care was taken to include both recall and recognition tests for every factor, with the common result that the two kinds of tests go readily on the same factor. There is therefore no compelling indication from ARP findings that one should expect separate recall and recognition factors.

Quick reminders will be given the reader, of the nature of the four tests appropriately loaded on MFU. In Figure Recognition, E studies geometric-type figures, each with its unique features. Recognition

Table 5
Rotated Factor Matrix

Test Name	CFC	CFR	CFT	MFU	MFC	MFR	MFS	MFT	MFI	MSU	MSI	MMU	MMI	DFU	NFT	NMS	SEX	VIO	h ²
1. Block Rotation	02	10	59	04	19	12	05	28	02	02	07	03	-02	00	09	22	30	-11	66
2. Books and Authors	07	05	-03	-02	12	05	06	04	41	04	25	15	60	11	09	17	-09	08	71
3. Face-Shield Matching	15	13	-07	29	06	01	26	06	42	16	06	06	28	10	06	18	-17	16	59
4. Figural Class Inclusion	53	08	19	13	15	00	00	15	10	14	02	15	08	00	09	06	-16	09	49
5. Figural Class Recall	08	-08	06	09	58	20	20	16	29	20	04	16	-03	16	21	14	16	12	75
6. Figural Letter Recognition	07	00	-04	46	11	05	20	25	23	24	18	09	01	11	12	13	-05	12	55
7. Figural Relations Recall	04	17	10	26	40	38	19	39	20	-12	09	17	08	11	24	16	06	09	81
8. Figural Subtraction Recall	22	10	19	23	29	36	15	32	28	07	-09	10	17	-07	06	26	04	11	71
9. Figure Analogies	14	39	24	12	23	29	08	22	09	07	23	05	12	00	25	22	05	-01	63
10. Figure Classification	53	11	-01	-03	19	11	12	13	01	-01	18	10	06	-02	09	10	02	00	44
11. Figure Matrix	13	55	19	02	21	27	22	07	10	09	02	-13	07	08	11	15	-02	09	62
12. Figure Recall	08	-02	23	23	51	21	21	27	17	16	07	18	01	04	13	-16	18	16	73
13. Figure Recognition	03	13	01	57	20	16	11	25	24	14	13	20	05	-08	01	04	-05	03	67
14. Front View Recognition	02	04	27	28	15	13	09	59	-04	11	18	09	11	08	13	-03	01	-12	65
15. Hidden Figures	03	06	37	15	14	28	02	03	-04	-02	21	01	06	00	37	-05	-06	28	53
16. Internally Consistent Figures	06	23	-06	-01	09	-05	-17	29	11	18	-09	17	-12	07	47	-07	12	-13	54
17. Make A Figure Test	01	13	04	-05	06	10	03	07	12	-04	23	09	09	67	15	04	02	05	60
18. Matrix Trend Recall	01	00	13	-01	09	75	22	04	10	23	-11	03	05	06	20	03	10	-01	77
19. Memory for Figural Analogies	-06	26	-06	19	20	46	10	35	22	05	11	10	-10	03	17	25	-10	16	71
20. Memory for Figural Classes	06	11	14	12	34	25	12	26	-05	11	08	-06	32	08	-03	04	-23	-15	52
21. Memory for Hidden Figures	05	08	32	27	34	20	24	43	29	-04	07	06	-07	08	16	23	-14	09	79
22. Memory for Listed Nonsense Words	09	21	-05	23	-03	-06	09	10	14	58	14	33	06	-05	02	00	-13	-03	64
23. Memory for Meaning	19	21	-05	29	-09	19	17	10	09	14	15	50	20	-05	07	21	-04	03	64
24. Monogram Recall	07	00	15	08	19	16	48	33	18	21	-18	09	17	13	03	06	-14	12	64
25. Number-Letter Association	11	-04	09	08	12	07	12	14	36	35	36	12	27	-06	02	07	-10	08	58
26. Numerical Operations	01	20	02	-01	07	09	10	-07	-04	02	28	04	25	16	13	07	16	14	31
27. Object Class Memory	06	29	04	19	32	12	03	15	-05	16	01	10	-03	-11	12	23	02	01	38
28. Object Recognition	04	-10	13	36	11	12	17	22	28	08	03	01	-04	-05	29	09	-24	-07	51
29. Orientation Memory	-07	06	11	21	13	16	43	18	28	05	14	16	05	22	18	11	08	10	54
30. Paired Associates Recall	09	05	04	04	09	02	14	12	21	29	27	34	44	09	-02	07	-12	14	61
31. Paired Figure Recall	-10	02	22	-06	25	27	16	16	48	23	27	21	12	11	10	01	-01	08	69
32. Paper Folding	13	29	44	15	16	05	13	19	17	03	07	01	01	-04	32	-08	00	10	55
33. Penetration of Camouflage	04	-01	05	20	05	02	11	-15	04	-16	07	04	12	09	52	29	-08	-17	53
34. Picture Arrangement	-02	12	23	-03	08	18	12	15	08	-04	-10	06	14	-05	26	47	-08	-10	49
35. Picture Memory	-04	-21	18	10	24	02	21	03	11	01	19	41	28	11	09	08	-23	05	57
36. Recall of Nonsense Words	01	-09	05	19	28	20	16	-09	10	48	29	11	29	-07	-03	18	01	15	68
37. Recalled Words	10	-12	-03	-01	14	11	25	06	24	36	29	22	29	-05	00	17	-17	16	61
38. Recognition of Figural Classes	09	09	07	44	33	24	08	25	00	14	16	05	05	-07	09	16	-16	09	57
39. Related Alternatives	07	10	-04	12	03	03	14	22	21	15	25	29	49	02	05	23	-16	02	64
40. Remembering Faces	-01	07	00	52	-03	09	25	02	11	09	-02	21	16	02	09	12	-06	-06	47
41. Remembering Figural Trends	19	09	17	14	28	33	-05	28	-09	16	09	03	06	05	07	-03	-17	-12	46
42. Remembering Flag-Letter Pairs	25	00	10	27	-04	23	15	18	47	07	19	15	21	03	10	10	-14	-06	63
43. Remembering Hand-Object Pairs	-03	04	03	40	14	-05	18	29	33	-08	20	13	28	-05	05	10	-01	03	57
44. Remembering Object Orientation	-03	07	-04	28	02	16	43	28	12	09	38	14	-01	-18	-10	17	-08	-03	64
45. Remembering Spatial Changes	-06	03	08	26	15	29	20	47	18	-04	11	21	15	-07	26	04	01	04	63
46. Remembering Symbol Codes	08	11	06	19	02	-07	17	13	29	18	35	43	26	08	07	10	-22	-01	67
47. Sketches	-01	-05	-12	04	05	09	-04	-15	12	-04	12	-02	14	63	06	09	-03	03	51
48. System-Shape Recognition	19	19	07	16	20	-02	46	24	08	-04	04	11	03	-16	05	-05	-11	-12	49
49. Temporal Ordering	13	19	-02	-01	14	19	05	28	-03	12	22	18	17	18	-02	32	03	15	47
50. Verbal IQ	06	11	00	04	08	08	-03	22	-12	04	06	10	10	02	08	16	-01	53	47
51. Visualization Memory	12	12	-02	01	16	16	39	44	-04	10	20	-15	13	08	22	11	20	09	63
52. Sex	-08	08	29	-03	03	-09	-19	23	-11	-09	-08	-24	04	03	00	-06	66	03	73

Note. — Decimal points omitted.

tests commonly mix studied elements with like numbers of new but somewhat similar objects or they present multiple-choice items. Remembering Faces presents faces in line drawings. Figural Letter Recognition presents 15 letters of the alphabet, each in a different lettering style. Object Recognition deals with familiar objects, such as an ashtray, a shoe, or a chair, each in a particular style, which must be discriminated from the same objects in different styles on the test page. Perhaps it was the complexity of things in this test that contributed to its lower loading than that involving letter styles.

Figure Recall did not go on MFU as originally planned. E studies ten very simple figures, kept simple by the test writer so as not to tax E's drawing skills when he takes the recall test. This test went univocally on the factor for MFC. It had failed to go along with MFU tests in pretesting, and revising the figures for the analyzed version apparently did not help. It is quite possible that because of the simple geometric components of the objects to be memorized, E puts each object in a different class. For example, he could identify "two overlapping rectangles," "a parallelogram with diagonals," or "a flat pentagon." Remembering the class ideas would then be sufficient basis for remembering the unit. It appears that a figure-recall test for MFU should present figures for study that are not readily categorized.

Two tests not intended for MFU showed substantial relationship to this factor. In fact, they had higher loadings on MFU than on the factors for which they were intended. In rationalizing these outcomes, let it be said as a general statement that test items for all memory abilities contain units, which suggests that remembering those units could possibly help in remembering the relation, implication, or other kind of product. This would be especially true when the units are hard to discriminate in memory. In tests for implications, for example, results suggest that success sometimes depends upon remembering the units, as such, as well as the connections with other units. This is particularly true of recall tests for implications. Things are better controlled in recognition tests, which repeat units from the study page on the test page, leaving more emphasis upon the need to remember connections between units. Another strategy is to utilize the principle of transposability, giving the relation or class represented by new units. It appears that these strategies were generally successful in keeping units variance out of tests for other products.

Remembering Hand-Object Pairs is a four-choice recognition test, not a recall test, yet it has a stronger loading on MFU than on MFI. One reason may have been the difficult discriminations of the hand stimuli, as units. The first member of each pair in this MFI-intended test is a sketch of a human hand in a particular posture, with fingers and thumb extended or not, and, if extended, partially or fully. If a particular hand in the retention test is difficult to identify, this circumstance would add to the difficulty of choosing the correct object to go with it. Difficulty in discrimination of units (in memory) were also involved in the multiple-choice items of this test. Among the four

alternate objects were similar views (styles) of two objects, e. g. , two flashlights and two screwdrivers. The choice of kind of object is probably relatively easy but the discrimination between styles may well involve memory for units, as in Object Recognition, which was univocal for MFU.

The MFU variance for Recognition of Figural Classes can be easily rationalized. On the study page, ten classes are presented in the form of sets of three figures each, with an obvious common feature in each set, such as the fact that all contain horizontal stripes, all are composed of simple dotted outlines, or each contains a dot inside a simple, outlined, geometric figure. All E would have to remember is one figure from each set, even without identifying the class idea. He could perform well on the test page by merely looking for a similar figure. Unfortunately, the distractors on the test page are not very similar to the correct figures, which helps to connect them, without interference, with similar figures seen in sets on the study page.

MFC - Memory for Figural Classes

5. Figural Class Recall (MFC)	.58
12. Figure Recall (MFU)	.51
7. Figural Relations Recall (MFR)	.40 (MFR .38; MFT .39)
20. Memory for Figural Classes (MFC)	.34 (MMI .32)
21. Memory for Hidden Figures (MFT)	.34 (MFT .43; CFT .32)
38. Recognition of Figural Classes (MFC)	.33 (MFU .44)
27. Object Class Memory (MFC)	.32

The four tests designed for MFC, the ability to memorize generalized figural concepts, came out together on the same factor, two of them univocally so. Figural Class Recall presents 15 sets of three figures each, each set with a common feature among varying features. On the test page, E is given 15 circles or squares, their contours being in lines of spaced dots. E fills in the contours and other markings, completing each figure in a way to satisfy membership in one of the classes he has seen.

The second univocal test, Object Class Memory, with a near-minimal loading on MFC, presents for study sets of three realistic objects in more than one outline form but with generally similar shape, e. g. , T-shaped, oval, or with elongated appendages. There follows an identification test for single objects that conform to the memorized class ideas. The test follows the same principle as Recognition of Figural Classes, which also went barely significantly on MFC but more strongly on MFU. Object Class Memory was loaded only .19 on MFU, and not significantly on any other factor in this analysis. Its weakness on MFC probably reflects its not having been pretested. It had been constructed at the last moment when it was realized that the other MFC tests all used geometric-type figures.

Of the two complex MFC tests Recognition of Figural Classes had its strongest loading on MFU, as discussed under the treatment of that factor. Memory for Figural Classes had its second loading on MMI. This test presents sets of relatively simple line drawings for study. The semantic component of this test suggests that in their strategies for memorizing, Es often made use of verbalization of the classes represented on the study page, and the memory of

the semantic information attached helped to make better scores.

The presence on MFC of Figural Relations Recall, which had been intended for MFR, is not as easily explained as its approximately equal relation to MFT. Let us consider the latter first. The test presents for learning pairs of triangles each somewhat elaborated in some way, e.g., one with vertical stripes paired with one with horizontal stripes, or one in which the black and white spaces are interchanged. E probably often sees such pairs as representing changes or transformations, and he remembers that information. The option E has for conceiving of paired figures as relations or as transformations has a more general appearance in this analysis, as it has had in others dealing with figural information (Hoffman, Guilford, Hoepfner, and Doherty, 1968). These instances will be seen as we come to factors for MFR and MFT.

Another example of this kind of failure in this analysis is seen in Memory for Hidden Figures. This test was modeled after the test Hidden Figures, which has been a marker for NFT. On the study page of the memory test, E is shown a simple figure and how it is concealed in a more complex figure. On the test page, E is shown the complex figure drawn completely in dotted lines, and he is to pencil in the outline of the simple figure. Although the highest loading is on MFT, as intended, remembering class ideas seems somehow to be an aid in this test. The involvement of class memory in the two tests under discussion may reflect a quite general strategy of cueing items of information to be remembered by attaching them to classes. This kind of rationalization was also suggested in connection with Figure Recall's going on MFC rather than MFU. Incidentally, the minor CFT loading on Memory for Hidden Figures suggests that seeing the transformations is not sufficiently easy, in spite of the demonstrations given on the study page.

It is noteworthy that the three leading tests on MFC are all in the recall format, all three having been designed for different abilities. This might suggest that the factor under discussion is a format affair, representing a recall-memory ability. It can also be said that in the two previous memory analyses, (Brown, et al., 1966; Tenopyr, et al., 1968), there were some tendencies for recall tests to separate from recognition tests. In general, however, the two kinds could be brought together on factors distinguished in terms of ability, not format. Telling against the format-factor hypothesis here is the fact that the other four tests on the factor are recognition tests, and recall tests other than the three in the list did not go on the factor. Only on the factor identified for MFC did such a set of recall tests get together, and other recall tests went with recognition tests on other MFX factors.

MFR - Memory for Figural Relations

18. Matrix Trend Recall (MFR)	.75	
19. Memory for Figural Analogies (MFR)	.46	(MFT .35)
7. Figural Relations Recall (MFR)	.38	(MFC .40; MFT .39)
8. Figural Subtraction Recall (MFT)	.36	(MFT .32)
41. Remembering Figural Trends (MFR)	.33	

Although the separation of this factor from others

was clearer than for MFC, only two of the four tests designed for it were univocal for MFR, the ability to memorize relations between items of information. Matrix Trend Recall came out exceptionally strong for it. On the study page is a 4 X 4 figural matrix, with the same trend in all rows and another in all columns. On the test page a similar matrix is given with ten of the cells blank and, below it, 20 alternative figures, ten of which are to be matched with the matrix cells, indicating that E remembers the trends in what he does. Trends are replicated relations.

A loading of .75 is so high, however, as to arouse suspicions. Since there are only two relations involved in each part of the test, it would seem that they should be very easily remembered. The activity of placing figures within appropriate cells would seem to be a convergent-production task, and, if so, to involve SI ability NFR. A factor for NFR was not marked by tests in this analysis, so this hypothesis could not be tested.

Remembering Figural Trends also presents relations in the form of trends, but in one-dimensional form, one trend at a time. Having studied 10 trends, E is given a recognition test, with the same relations dressed in new figures. Why the two-dimensional presentation of trends appears to be so much more successful for the factor than the one-dimensional one is not easy to explain. Chance success could play a heavier role in the latter than in the former, but this is hardly the reason.

The difficulty with distinguishing between relations and transformations in presenting test items is shown in some of the MFR tests, including Figural Relations Recall, which was discussed in connection with the factor for MFC, and which appears above along with two other tests, both designed for MFT and loading on it. Memory for Figural Analogies presents pairs of figures, each pair evidently interpretable as representing a relation or a transformation, on which a multiple-choice test is given. Figural Subtraction Recall presents pairs of figures, one of which is deducted from the other, leaving a remainder. On the test page E is given a new but similar complex figure from which an analogous part is to be removed. He is to draw a figure showing how the remainder should look. Intended for MFT, with its transformation-by-subtraction operation, this test came out almost equally on MFT and MFR. The analogies involved in it are obvious, and very likely account for the relation to MFR.

It is perhaps worth noting that the two univocal tests for MFR are trend tests, whereas the two MFR tests that also loaded on MFT are in the form of analogies. It may be that giving E the same relation repeated helps to avoid MFT variance. Also to be noted, as will be seen later, is that the MFT tests not involved with MFR variance represent pictorially some three-dimensional objects, whereas those involved with MFR use two-dimensional objects.

MFS - Memory for Figural Systems

24. Monogram Recall (MFS)	.48	(MFT .33)
48. System-Shape Recognition (MFS)	.46	
29. Orientation Memory (MFS)	.43	
44. Remembering Object Orientation (MFS)	.43	(MSI .38)
51. Visualization Memory (MFT)	.39	(MFT .44)

All four tests intended for MFS, the ability to memorize figural arrangements or organizations, led a factor whose identity is undoubtedly for that ability, as had been the case in an earlier analysis (Hoffman, et al., 1968). In the earlier study there were no secondary loadings and no test intended for another ability appeared loaded on the factor. There were no other figural-memory tests present in the test battery, but all the figural-cognition and figural-evaluation abilities were represented.

One of the univocal tests here was System-Shape Recognition. The study page presents an arrangement of nine meaningless, rounded figures, each somewhat elongated. In the recognition test, E is given sets of three figures each from the study page, sometimes arranged the same and sometimes not.

The other univocal test was Orientation Memory, in which E sees ten houses or buildings located within a street map. On the test page, he is given an empty map, with the same houses or buildings (numbered) shown below it. E is to locate the houses or buildings appropriately in the map.

Two other MFS tests had secondary loadings, one on MFT and one on MSI. Monogram Recall presents five monograms of the same three letters. On the test page, given the same three letters, E is to reconstruct the observed monograms. A role for MFT in this test is not obvious. It may be that in studying the monograms, as E goes down the column he may see transitions from one to the next, and remembering these transformations helps to remember the arrangements of letters.

Remembering Object Orientation showed a secondary loading for MSI, a symbolic ability. In this test, E studies 15 familiar objects in a matrix of five rows and three columns. Any two objects have one of eight directions, one from the other. A set of arrows indicates these directions. Given a certain pair of objects on the test page, E selects the arrow that indicates the direction between them. The role of MSI may arise from the use of the arrow symbols, each associated with certain pairs of objects. Having been given the arrows on the study page, E may pair off arrows with pairs of objects, an activity that is similar to the memorizing task in a paired-associates test. The ability involved is MSI rather than MFI because the thing implied is a symbol; its figural properties are incidental.

The appearance of the MFT test Visualization Memory on MFS is probably an instance of the more general difficulty of keeping transformation variance out of figural-systems tests and vice versa. This difficulty is commonly encountered with tests of CFS and CFT. Visualization Memory shows on the study page pairs of line drawings of irregular blocks of wood, with the second member of each pair being a

rotation of the first member. On the test page, E is again shown in an item the same block in its original position, followed immediately by a block of a somewhat different shape lying in a similar orientation. Four optional answers show alternate final positions the new block would have if the same transformation were applied to it as the one applied to the first figure when given on the study page. In both studying pairs of blocks and in examining the new blocks and their alternative, final positions, spatial orientation is involved. This applies in both cognition and memory. No CFS tests were in the experimental battery to determine whether that ability, also, would be involved in Visualization Memory.

In regard to the degree of invariance shown by the four MFS tests in this analysis with results from the earlier analysis, comparison of the loadings tells the story. Corresponding to the four loadings: .48, .46, .43, and .43 in the list above for this analysis, the four from the previous analysis were: .50, .60, .56, and .45, respectively. Considering these results together, we should say that System-Shape Recognition is the strongest one for MFS and Remembering Object Orientation is the weakest.

MFT - Memory for Figural Transformations

14. Front-View Recognition (MFT)	.59	
45. Remembering Spatial Changes (MFT)	.47	
51. Visualization Memory (MFT)	.44	(MFS .39)
21. Memory for Hidden Figures (MFT)	.43	(CFT .32; MFC .34)
7. Figural Relations Recall (MFR)	.39	(MFC .40; MFR .38)
19. Memory for Figural Analogies (MFR)	.35	(MFR .46)
24. Monogram Recall (MFS)	.33	(MFS .48)
8. Figural Subtraction Recall (MFT)	.32	(MFR .36)

All five of the MFT tests were loaded together on the factor for the ability to memorize movements or other changes in items of figural information. Four of them lead the list of eight tests, but only two were univocal. In Front-View Recognition, the study page shows ten block figures, with rectangular and circular components, all with what are called front views turned to one side. The front side is labeled as such. On the test page, the ten block figures are seen squarely from in front, along with 10 distractors.

On the study page of Remembering Spatial Changes, ten paired views of familiar objects are shown, each pair presenting the same object in two orientations in three-dimensional space. E is to remember the movement that would be needed to effect the change. On the test page, each item shows the object in its starting position, followed by a new object in a parallel position. The alternative answers are four other positions of the new object, one of which correctly indicates the final position after the same transformation.

Earlier discussions have reported the unusual number of times MFT variance came into non-MFT tests, particularly into MFR tests and an MFS test. Here we see that MFT tests also commonly have loadings in tests designed for other abilities, including MFC, MFR, and MFS, in three instances. A similar situation prevailed in the analysis of semantic-memory abilities, but none was evident in the analysis of symbolic-memory abilities. In tests of the latter, product category was evidently better controlled. It

has been found that figural thinking in figural-cognition tests sometimes brings in variance in CFT (Hoffman, et al., 1968). Efforts to solve problems visually involve visual manipulations, which are the essence of the function identified as CFT. In places such as the results for factor MFT, it may appear that there is obliqueness in the factor structure. But the fact that there were at least two univocal tests in the list for every MFX factor suggests that the six abilities might still be orthogonal and that it is the failure to achieve product control that allows the factorial complexity of many tests. The control is apparently poorest where transformations are concerned.

MFI - Memory for Figural Implications

31. Paired Figure Recall (MFI)	.48	
42. Remembering Flag-Letter Pairs (MFI)	.47	
3. Face-Shield Matching (MFI)	.42	
2. Books and Authors (MMI)	.41	(MMI .60)
25. Number-Letter Association (MSI)	.36	(MSI .36; MSU .35)
32. Remembering Hand-Object Pairs (MFI)	.33	(MFU .40)

In the original planning of this study, in connection with SI ability MFI it was thought desirable to bring abilities MSI and MMI also into the picture. Besides having item pairs composed of like content--figural-figural, symbolic-symbolic, and semantic-semantic--the use of mixed pairs was also contemplated, with pairs such as: figural-symbolic, figural-semantic, and symbolic-figural. The latter types of items would test the hypothesis that the content of the second member of the pair determines the content category of the factor on which such tests go. Limitation of testing time did not permit the introduction of all these variations.

The most important hypothesis that could be tested was that the three SI abilities, MFI, MSI, and MMI, could be separated by factor analysis. The traditional "rote-memory" or "associative-memory" ability that had been reported a number of times (French, 1951) had evidently cut across content areas, when pairs were mixed as to content as well as when not mixed. In addition to the triad to abilities, MFU, MSU, and MMU, this analysis was the only case in which three memory abilities differing only in content have been represented in the same analysis. We shall see some indications of how the results demonstrated each three-way separation, first in the case of implications memory abilities.

As usual, we see that the four MFI tests come out on their intended factor, three that led the list univocally so. Since the kinds of items of information used in these various tests were quite varied, within the figural category, of course, we can infer that there is much generality in the ability. Only one test designed for MFI, Remembering Hand-Object Pairs, was loaded on another MFX factor, namely MFU. The possible reasons for this were discussed in connection with that factor.

Two tests designed for products other than figural implications appeared in the list--Books and Authors, designed for MMI, and Number-Letter Association, for MSI, both parallel abilities. Where tests cross lines as to content, as in these two instances, the customary rationalization is that Es in sufficient

numbers applied strategies that involve translations or recordings of the information they are memorizing. Thus, in the Number-Letter Association test, some Es could have identified the numbers and letters by figural properties, and they remembered such identifications. In the case of Books and Authors, many Es could have imagined visual appearances of authors' occupations, or more likely, the things associated with them, as in painting pictures, playing baseball, and so on. Such imaginings could have served as cues for remembering the connections. The loading of this test on its intended factor for MMI was still quite large and distinctly higher than its loading on MFI.

Number-Letter Association was a very strong test for MSI in an earlier analysis (Tenopyr, et al., 1966), with no secondary loadings. A factor for MSU was also represented in the battery in that study, without showing a significant relation to this test, such as appears here. It was stated earlier that some MSU variance might well be expected in a recall MSI test. But memory for letters, which E is to supply in the recall test, should not tax ability MSU, except as it involves difficult discriminations among well-known symbols.

The Reference Factors

The ten reference factors were selected from all operation categories other than evaluation, including three for figural-cognition abilities, four symbolic- and semantic-memory abilities, one for a divergent-production ability, and two for convergent-production abilities. We consider first two figural-cognition factors, both clearly not involved significantly in any memory tests.

CFC - Cognition of Figural Classes

10. Figure Classification (CFC)	.53
4. Figural Class Inclusion (CFC)	.53

CFR - Cognition of Figural Relations

11. Figure Matrix (CFR)	.55
9. Figure Analogies (CFR)	.39

CFC is the ability to see class concepts, represented by sets of figures, and CFR is the ability to see relations between particular items of figural information. There is nothing to be said about these quite regular results except to point out that the last two tests have a result parallel to that for tests of MFR. In both instances the test with relations given in two dimensions has a distinctly higher loading for its factor than the test with relations in one dimension only. These results may represent a coincidence, but they may be worth following up.

CFT - Cognition of Figural Transformations

1. Block Rotation (CFT)	.59	(Sex .30)
32. Paper Folding (CFT)	.44	(NFT .32)
15. Hidden Figures (NFT)	.37	(NFT .37)
21. Memory for Hidden Figures (MFT)	.32	(NFT .43; MFC .34)

The two marker tests for CFT, the ability to visualize movements and other changes in space, led on this factor, but Paper Folding had a small, significant loading on the parallel convergent-production ability NFT. Such an involvement has not been known

before when there were opportunities for it (see Hoffman, et al., 1968). It will be noted that there is also a "tradeoff" in the form of CFT variance in the scores from the NFT test Hidden Figures. An unusually high correlation between these two tests might reflect the age and education ranges of the examinees in this study. The inclusion of either an age or an education variable in the factor analysis might have reduced these and other tradeoffs below the level of significance. It can also be noted how the inclusion of a variable for sex membership with its loading of .30 on Block Rotations indicates a male superiority in that test. That difference cannot be attributed to ability CFT, which the test represents, however, for the sex variable has a loading of zero on the other CFT test, Paper Folding. There is something about Block Rotations, other than its CFT component, that is responsible for its relation to sex membership. The relation of Memory for Hidden Figures to CFT was discussed under MFT.

MSU - Memory for Symbolic Units

22. Memory for Listed Nonsense Words (MSU)	.50	(MMU .33)
36. Recall of Nonsense Words (MSU)	.48	
37. Recalled Words (MMU)	.36	
25. Number-Letter Association (MSI)	.35	(MFI .36; MSI .36)

MMU - Memory for Semantic Units

23. Memory for Meanings (MMU)	.50	
45. Remembering Symbolic Codes (MSI)	.43	(MSI .35)
35. Picture Memory (MMU)	.41	
30. Paired Associates Recall (MMI)	.34	(MMI .44)
22. Memory for Listed Nonsense Words (MSU)	.33	(MSU .58)

It is of interest to note the results for MSU and MMU together, for they exhibit some crossings of content lines. Both abilities represented pertain to memorizing isolated, particular units of information, symbolic for MSU and semantic for MMU. This study is the first in which these two abilities were both represented.

Examination of the two sets of tests and their loadings reveals that although in connection with both abilities two marker tests for each one have univocal loadings on their respective factors, there is some trading off between the two sets of tests. There is a MMU test (Recalled Words) on the factor for MSU, and a MSU test (Memory for Listed Nonsense Words) on MMU. In both cases it is a matter of recalling or recognizing single words, meaningful in the one case and nonsensical in the other. There is room for E to remember the meaningful words as symbols, in the case of the MMU test, and to remember invented meanings rather than the symbols in the MSU test.

The lists also show how variations in memory-for-units abilities can also crop up in implications-memory tests, and how sometimes there is a change in content category also in the process. A MSI test (Number-Letter Association) appears on the factor for MSU. A MMI test (Paired Associates Recall) appears on the factor for MMU, and also a MSI test (Remembering Symbol Codes). From experiences in the psychological laboratory, one should expect that learners would favor memorizing in semantic form, and this principle may, indeed, generally apply in memory tests. There was the one instance of a

MMU test (Recalled Words) loading .36 on MSU and .22 on MMU, however. This suggests a problem as to the circumstances under which an individual will favor learning in terms of symbols versus meanings, when he has options for either.

A special reason for including the factor for MMU in this analysis was concerned with the test Picture Memory. This test presents familiar objects in picture form, with a recall test, in which E lists names of the objects. Obviously, E could capitalize on his MFU ability as an aid in memorizing the given information. But the results do not show that this occurred, for the loading for this test on MFU was only .10. Its highest loadings on any figural-memory factors were .24 on MFC and .21 on MFS, which are probably on the borderline for statistical significance.

MSI - Memory for Symbolic Implications

25. Number-Letter Association (MSI)	.36	(MFI .36; MSU .35)
46. Remembering Symbol Codes (MSI)	.35	(MMU .43)

The results for MSI, the ability to memorize connections between arbitrarily paired symbolic items of information, were not very satisfactory. The loadings of the marker tests on it were lower than usual, with that for Numerical Operations being not even significant.

Number-Letter Association, which was strong and univocal on MSI before (Tenopir, et al., 1966), had its variance split about equally with two other factors. Its affiliation with MFI has been discussed. Its affiliation for MSU could mean that E has to remember what letters to use on the test page as well as remembering with what number they had been paired.

A reasonable explanation of the weakness of this factor and the complexity of the two tests for it is needed when the correlation of .53 between these two tests is noted. It appears that in aiming to achieve effective separations of MFX factors from one another, MSI suffered as a consequence. The failure of Numerical Operations to load at least significantly on the factor for MSI, calls for some new questioning of its memory variance. It is different from all other memory tests because it involves no standardized study period just preceding the retention test. At best, scores on this test could only reflect in an indirect and uncontrolled way the learning and fixation of symbolic connections.

The new test, Remembering Symbol Codes, was partly in the right direction, but it apparently has items that are too easily verbalized meaningfully, hence its deviation toward MMU. Its variance for a semantic-units ability rather than a semantic-implications ability, however, is difficult to reconcile with the fact that the test is in a matching format, with all the needed figural units given on the test page.

MMI - Memory for Semantic Implications

2. Books and Authors (MMI)	.60	(MFI .41)
39. Related Alternatives (MMI)	.49	
30. Paired Associates Recall (MMI)	.44	(MMU .34)
20. Memory for Figural Classes (MFC)	.32	(MFC .34)

The picture for MMI, the ability to remember

arbitrary connections between meaningful items of information, was much better than that for MSI. Its three marker tests contributed strongly toward determination of a factor as before (Brown, et al., 1966). In the previous analysis, Paired Associates Recall did not have a significant loading on MMU, but came close. In fact, the three MMI tests listed above previously had no significant secondary loadings. Tests for MFI were not in the Brown analysis, so we cannot say whether the second loading for Books and Authors on that factor is exceptional here. The appearance of Memory for Figural Classes in the list was discussed under MFC.

DFU - Divergent Production of Figural Units

17. Make a Figure Test (DFU)	.67
47. Sketches (DFU)	.63

The study of semantic memory by Brown, et al., (1966) demonstrated rather decisively that there was no confusion between memory and divergent-production tests, in the semantic area, at least. The one divergent-production ability represented here, fluency in simple figure production, tends to support the same kind of expectation with respect to figural-memory and figural-divergent-production tests.

NFT - Convergent Production of Figural Transformations

33. Penetration of Camouflage (NFT)	.52	
16. Internally Consistent Figures (NFT)	.47	
15. Hidden Figures (NFT)	.37	(CFT .37)
32. Paper Folding (CFT)	.32	(CFT .44)

Some confusions among tests of CFT and NFT were quite evident, as shown by the list of tests for those abilities and their factors. The content and product categories are uniform, the crossovers being across operation lines. The location of the factor axis for NFT seems determined well enough by the two individual tests. Penetration of Camouflage has been a consistent marker for NFT, although with quite varied loadings on it. Internally Consistent Figures had been designed for ability EFS in the study by Hoffman, et al., (1968), but it led the list of NFT tests in that analysis, with a loading of .63. Although its loading is lower here, we have verification of its genuine factorial affiliation.

NMS - Convergent Production of Semantic Systems

34. Picture Arrangement (NMS)	.47
49. Temporal Ordering (NMS)	.32

All that can be said with regard to this factor, for the ability to order meaningful ideas, is that the selected marker tests again determined a factor, presumably NMS, and that there is no confusion between NMS tests and tests for any of the memory abilities of this analysis. The revision of Temporal Ordering still shows it to be a weak representative, as it was before (Berger, et al., 1957).

SEX

52. Sex	.56	
1. Block Rotation	.30	(CFT .59)

VIQ - Verbal IQ

50. Verbal IQ	.50
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Relatively clear separation of the two factors above indicates that they are minimally involved in individual differences in the aptitudes measured.

DISCUSSION

Support for the Main Hypotheses

It can be said that this analysis demonstrated the six distinct figural-memory abilities about as well as the average study of its kind. Once again, designing tests in line with SI theory has met with reasonable success. It can now be said that 18 of the 24 expected memory abilities have empirical support, adding to the expectation that when properly investigated, six behavioral-memory abilities will also be demonstrated.

In order to provide a more accurate picture of how well the new tests as a group hit their target, it can be said that of the 26 new figural-memory tests, 22, or 85 per cent, were loaded higher on the factor for which they were intended, within the context of the six factors. This "batting average" is only slightly behind that for the tests used as markers of other factors, based on prior experience. That percentage was 90.

In terms of univocality versus complexity, of the 26 MFX tests, 16 were univocal for their intended factors, 7 had second significant loadings within the context of the six figural-memory factors, and 3 had second loadings outside that category. As usual, the second loadings were within the same content or operation areas, showing that the greatest difficulty is in writing tests so as to control the product intended for the test. It is possible that the crossing of content boundaries by tests is more common in memory tests than in others, because the two-stage feature of memory tests offers more opportunities to recode information to the differential advantage of some examinees.

Some Implications for Test Writing

In view of some of the miscarriages of tests, a few suggestions for the future construction of memory tests appear to be indicated. One test that was intended for MFU went instead on MFC, possibly because the figural objects to be remembered were too simple and too easily categorized. The indication is that in a figural-recall test, particularly, the objects to be reproduced by E should not be easily classified.

It appeared that MFU variance was likely to appear in connection with nonunit tests, such as Remembering Hand-Object Pairs, when the units involved are difficult to discriminate in recall. Whether dealing with relations, transformations, or implications, the units should be sufficiently different to avoid possible confusions.

In tests for memory for classes, the common properties should not be readily cognizable as units, for this can apparently introduce MFU variance, as found with the test Recognition of Figural Classes. Some degree of abstraction should apparently be required.

In presenting pairs of figures for study in tests for MFR or MFT, care should be exercised to induce E to conceive of a relation between the pairs when MFR is being tested, and to conceive of a transformation when MFT is to be tested. Such a miscarriage is apparently most likely when the information is visual-figural.

Recommended Visual-Figural-Memory Tests

Based upon the results of the factor analysis of figural-memory tests, the following can be recommended as representing their respective abilities relatively uniquely. Only those without significant secondary variances are listed, with loadings from .43 to .75 on their intended factors. Others would be suitable in factor-analytic studies, but efforts should be made to minimize the secondary factorial contributions.

MFU	Figure Recognition Remembering Faces Figural Letter Recognition
MFC	Figural Class Recall Figure Recall
MFR	Matrix Trend Recall
MFS	System-Shape Recognition Orientation Memory
MFT	Front-View Recognition Remembering Spatial Changes
MFI	Paired Figure Recall Remembering Flag-Letter Pairs Face-Shield Matching

SUMMARY

Like many other factor-analytic studies conducted by the Aptitudes Research Project, the main interest in this study was the six visual-figural-memory abilities hypothesized from structure-of-intellect theory. The object was to show that by means of specially designed tests those abilities could be demonstrated as distinct from one another and from ten other selected abilities. Twenty-six new tests were designed for the figural-memory abilities and 24 marker tests were used to determine the reference factors for the other abilities.

An eight-hour battery was administered to 202 students in grades 9 through 12 in two-hour sessions on different days. From the intercorrelations, 16 principal components were extracted for intellectual abilities, and the axes were rotated using Cliff's targeted method iteratively until a positive manifold was achieved, with psychologically meaningful factors.

The six hypothesized factors for the six figural-memory abilities were well determined, each with two or more univocal tests from those designed for the respective abilities, although there were some of the customary instances of tests loading significantly on more than one factor having the same operation and content. Discriminations from four memory factors in the symbolic and semantic categories were

fairly good, also from three figural-cognition factors, and three production factors. Thus, the picture of a distinct memory category, constituted as in structure-of-intellect theory, is more firmly established.

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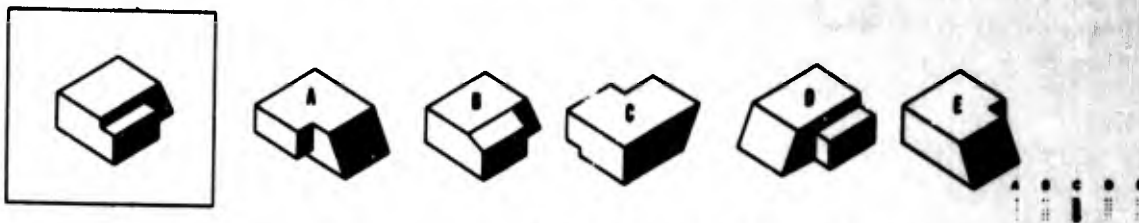
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APPENDIX

DESCRIPTION OF TESTS ¹

1. **Block Rotation - CFT06A.** Select from five alternative blocks the one that is a rotation of the given block.

Sample Item:



Score: Number right minus one-fourth number wrong.

Parts: 2; items per part: 8; working time: 10 minutes.

2. **Books and Authors - MMI01A.** Recall probable occupations for given fictitious persons after studying a page of name-book title pairs.

Sample Study Items:

Brooks - Pictures I Have Painted

Adams - Great Moments in Baseball

Sample Test Items:

Adams baseball player
Brooks artist

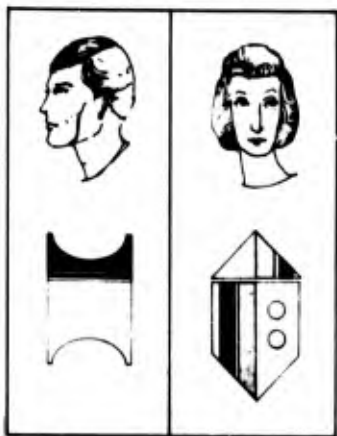
Score: Number of occupations related to the given names; only one point is given for any one name.

Parts: 2; items per part: 15; working time: 8 minutes.

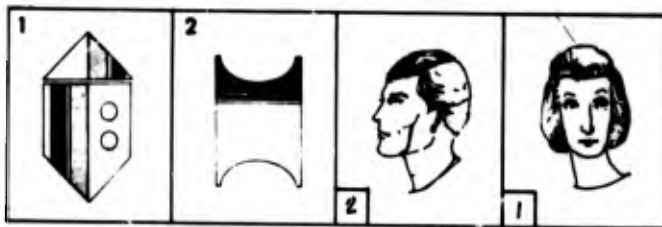
3. **Face-Shield Matching -** studied page.

Match the shields and faces that were paired with each other on a previously studied page.

Sample Study Items:



Sample Test Items



Score: Number of correct matches.

Parts: 2; items per part: 10; working time: 6 minutes.

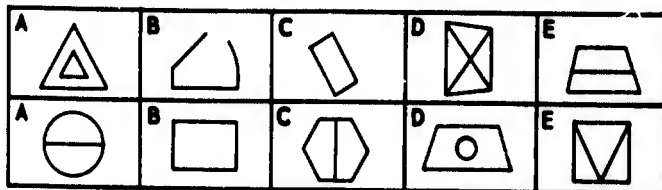
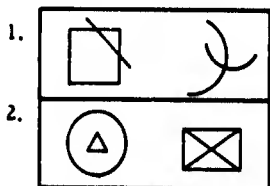
4. **Figural Class Inclusion - CFC04A.** Given two figures that have a common figural property, select from five alternatives the one figure that contains the same property.

Sample Items:

GIVEN FIGURES

ALTERNATIVES

Answers: 1 - D;
2 - E.



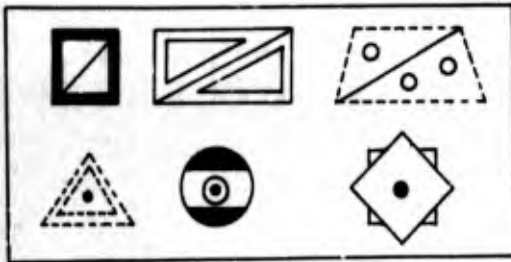
Score: Number right minus one-fourth number wrong.

Parts: 2; items per part: 12; working time: 7 minutes.

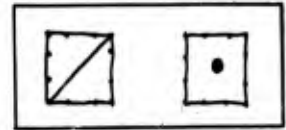
¹ The code symbol immediately following each test name indicates the hypothesized factor content of the test at the stage of test construction. The additional trigram (SPS) for some of the tests indicates that the test is copyrighted by Sheridan Psychological Services, Inc., Beverly Hills, California, and was adapted with permission.

5. **Figural Class Recall** - MFC01A. Sketch (recall) within faint outlines of figures the common elements of groups of previously studied figures.

Sample Study Items:



Sample Test Items:



Score: Number of sketches indicating recall of the studied class properties.

Parts: 2; items per part: 15; working time: 9 minutes.

6. **Figural Letter Recognition** - MFU01A. Choose (recognize) the type-face of each letter printed on a previously studied page.

Sample Study Items:



Sample Test Items:

	A	B	C	D
1.	<i>l</i>	<i>i</i>	<i>i</i>	<i>i</i>
2.	<i>n</i>	<i>n</i>	<i>n</i>	<i>n</i>

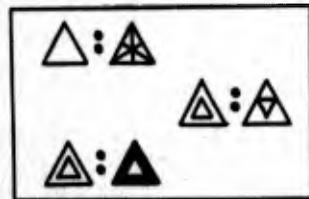
Answers: 1 - B; 2 - C.

Score: Number right minus one-third number wrong.

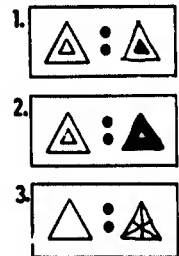
Parts: 2; items per part: 15; working time: 4 minutes.

7. **Figural Relations Recall** - MFR03A. Sketch (recall) the second figures of previously studied pairs of related figures.

Sample Study Items:



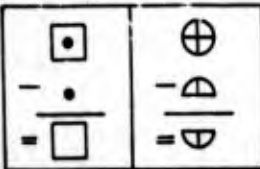
Sample Test Items:



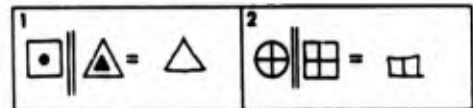
Score: Number of sketches that indicate recall of the pair relationships.
Parts: 2; items per part: 12; working time: 6 minutes.

8. **Figural Subtraction Recall** - MFT01A. Remember ways in which figures were transformed by subtraction on a study page; then, on a test page, given a cue figure and a new figure, perform a subtraction on the new figure that is the same as that previously studied for the cue figure.

Sample Study Items:



Sample Test Items:

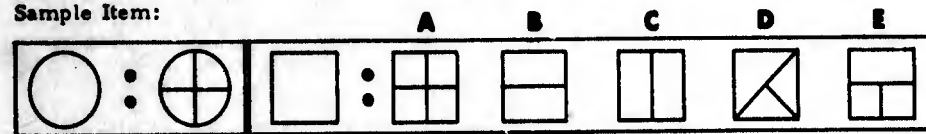


Score: Number of sketches indicating recall of the transforming subtraction.

Parts: 3; items per part: 10; working time: 9 minutes.

9. **Figure Analogies** - CFR01A. Given a first pair of figures that are related, complete a second pair of figures, by choosing one of five alternative figures, so that their relationship is the same as that in the given pair of figures.

Sample Item:



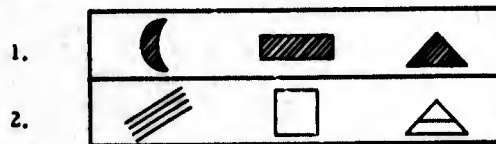
Answer: A.

Score: Number right minus one-fourth number wrong.

Parts: 2; items per part: 15; working time: 10 minutes.

10. **Figure Classification** - CFC01A. Recognize classes of figures, then match alternative figures to these classes.

Sample Items:



1.

2.

A.

B.

C.

D.

E.

Answers: 1 - C; 2 - A.

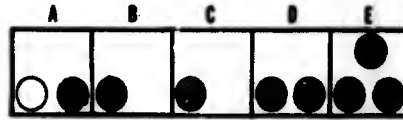
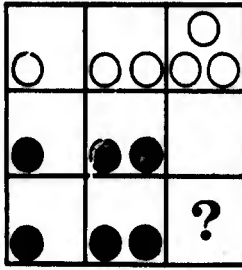
ALTERNATIVES

Score: Number right minus one-fourth number wrong.

Parts: 2; items per part: 10; working time: 6 minutes.

11. **Figure Matrix - CFR02B.** Recognize the figural trends in the rows and columns of a 3 x 3 matrix of figures, and then select the alternative figure that can replace the question mark.

Sample Item:



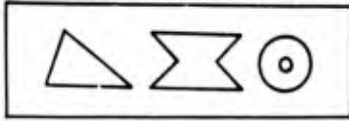
Answer: E.

Score: Number right minus one-fourth number wrong.

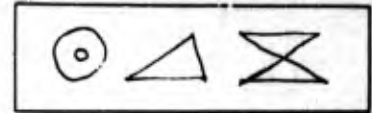
Parts: 2; items per part: 12; working time: 8 minutes.

12. **Figure Recall - MFU02A.** Sketch (recall) geometric figures that were previously studied.

Sample Study Items:



Sample Test Responses:

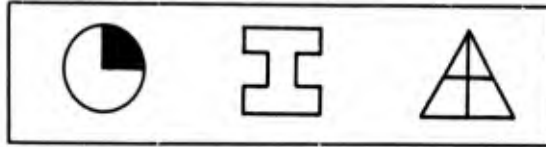


Score: Number of sketches indicating recall of the studied figures.

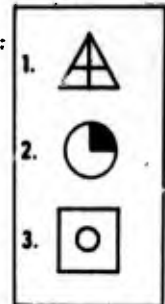
Parts: 2; items per part: 10; working time: 8 minutes.

13. **Figure Recognition - MFU03A.** On a test page containing many figures, recognize those geometric figures that were previously studied.

Sample Study Items:



Sample Test Items:



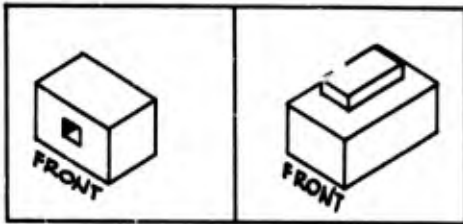
Answers: 1 and 2 were studied; 3 was not.

Score: Number right minus number wrong.

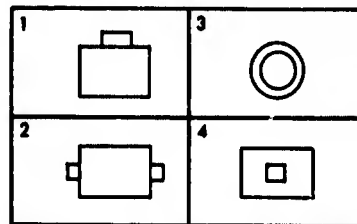
Parts: 2; items per study page: 15; items per test page: 30; working time: 5 minutes.

14. **Front-View Recognition - MFT02A.** Study three-dimensional figures so that front-views of them can be recognized on a test page.

Sample Study Items:



Sample Test Items:



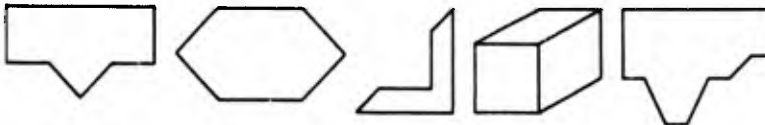
Answers: 1 and 4 were studied; 2 and 3 were not.

Score: Number right minus number wrong.

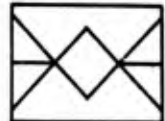
Parts: 2; items per study page: 10; items per test page: 20; working time: 6 minutes.

15. **Hidden Figures - NFT04B.** Determine which one of five basic figures is hidden in each figural item.

Basic Figures



Sample Item:



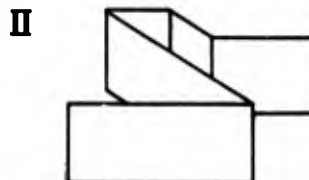
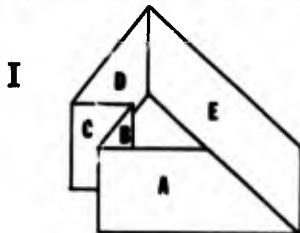
Answer: Basic Figure A.

Score: Number right minus one-fourth number wrong.

Parts: 1; items: 15; working time: 3 minutes.

16. **Internally Consistent Figures - NFT05A.** Determine whether or not figures made from connected rectangular planes are internally consistent, that is, whether they could actually exist in three-dimensional reality.

Sample Items:



Answers: I is not internally consistent; II is consistent.

Score: Number right minus number wrong.

Parts: 2; items per part: 12; working time: 4 minutes.

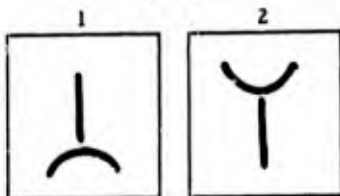
17. Make a Figure Test - DFU02B. Use all and only the given lines to draw many different figures in a series of blank squares.

Sample Item:

Given these lines:



You could make these figures:



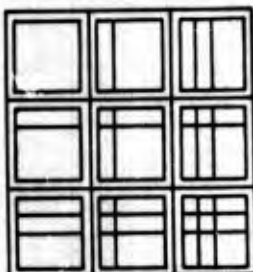
Score: Number of acceptable responses. Responses were judged by criteria of orientation, contiguity, overlapping, and pattern.

Parts: 2; items per part: 1; working time: 4 minutes.

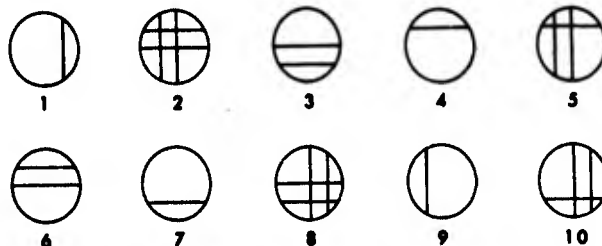
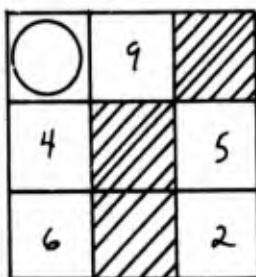
18. Matrix Trend Recall - MFR01A. Place figures into empty squares of a matrix so that the matrix has the same row and column trends as a previously studied figure matrix.

ALTERNATIVE FIGURES

Sample Study Matrix



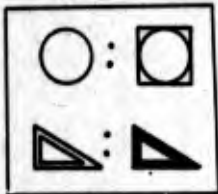
Sample Test Matrix



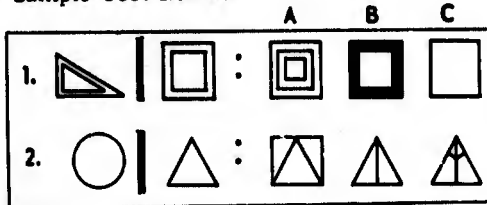
Score: Number of correctly placed figures.
Parts: 2; items per part: 10; working time: 5 minutes.

19. Memory for Figural Analogies - MFR02A. Identify (recognize) pairs of figures on a test page that have the same relationships as previously studied figure pairs.

Sample Study Items:



Sample Test Items:



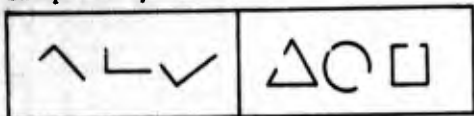
Answers: 1 - B; 2 - A.

Score: Number right minus one-half number wrong.

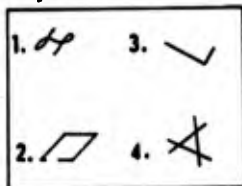
Parts: 3; items per part: 10; working time: 7 1/2 minutes.

20. Memory for Figural Classes - MFC02A. Indicate whether or not figures on a test page contain properties in common to one of the figure groups on a previously studied page.

Sample Study Items:



Sample Test Items:

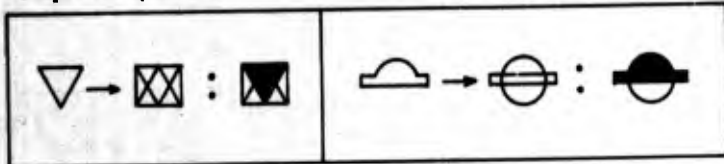


Score: Number right minus number wrong.

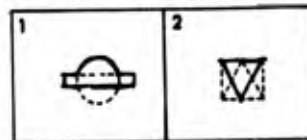
Parts: 2; items per study page: 15; items per test page: 30; working time: 9 minutes.

21. Memory for Hidden Figures - MFT03A. Indicate with solid lines the figure that was embedded in each dotted figure on a previously studied page.

Sample Study Items:



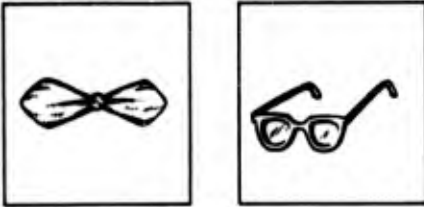
Sample Test Items:



Score: Number of sketches indicating recall of the appropriate hidden figure.
Parts: 3; items per part: 10; working time: 9 minutes.

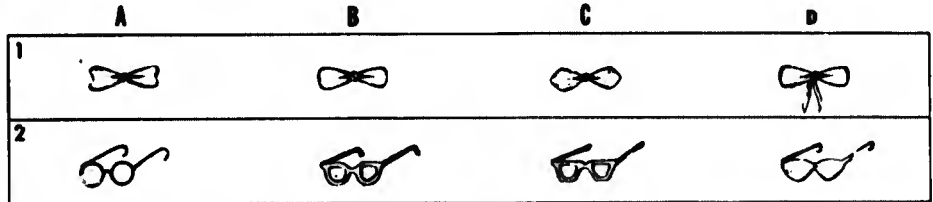
29. **Object Recognition** - MFU04A. From four similar pictured objects, choose the one that is exactly the same as an object on a previously studied page.

Sample Study Items:



Answers: 1 - C; 2 - B.

Sample Test Items:

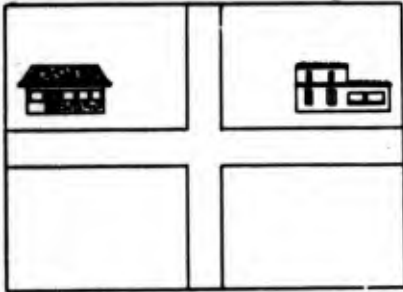


Score: Number right minus one-third number wrong.

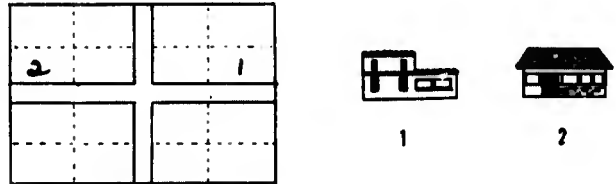
Parts: 2; items per part: 15; working time: 5 minutes.

29. **Orientation Memory** - MFS03A. Place buildings in a network of streets so that they are in the same position as on a previously studied page.

Sample Study Item:



Sample Test Items:



Score: Number of buildings correctly placed.

Parts: 2; items per part: 10; working time: 5 minutes.

30. **Paired Associates Recall** - MMI03A. Recall the second member of previously studied word-word paired associates.

Sample Study Items:
 SUCCEED HEAVY
 BEVERAGE NOW
 PERFECT WORD

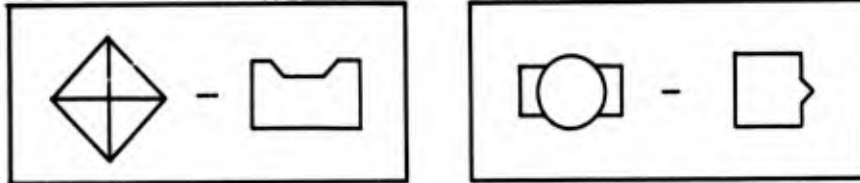
Sample Test Items:
 BEVERAGE *now*
 PERFECT *word*
 SUCCEED *heavy*

Score: Number of words correctly paired.

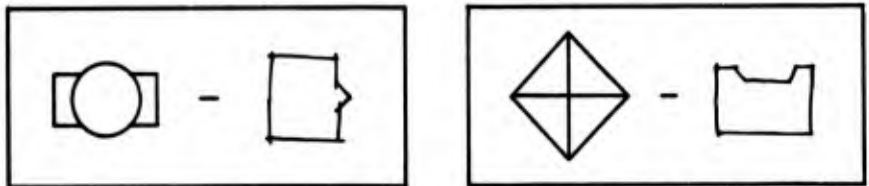
Parts: 3; items per part: 12; working time: 6 minutes.

31. **Paired Figure Recall** - MFI04A. Sketch (recall) the second member of previously studied figure-figure paired associates.

Sample Study Items:



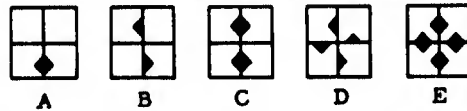
Sample Test Items:



Score: Number of figures correctly sketched.

Parts: 2; items per part: 10; working time: 7 minutes.

32. **Paper Folding** - CFT07B. Select the alternative that shows what a folded and cut piece of paper would look like when it is unfolded.



Answer: C.

Score: Number right minus one-fourth number wrong.

Parts: 2; items per part: 10; working time: 10 minutes.

33. Penetration of Camouflage - NFT02B. Circle the human faces camouflaged in the lines of a realistic drawing.

Sample Item:

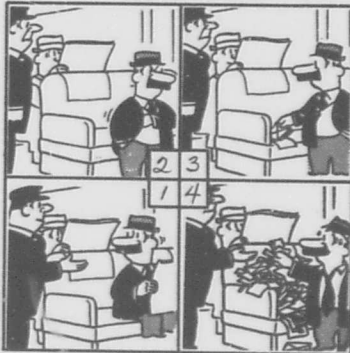


Score: Number of hidden faces circled.

Parts: 2; items per part: 2; working time: 6 minutes.

34. Picture Arrangement - NMS02D. Order a set of four pictures so that they make a meaningful sequence of events.

Sample Item:

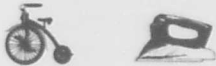


Score: Number of correctly ordered sets; no partial credit given.

Parts: 3; items per part: 6; working time: 6 minutes.

35. Picture Memory - MMU04A. List (recall) names of common objects pictured on a previously studied page.

Sample Study Items:



Sample Test Responses:

iron
tricycle

Score: Number of items correctly reported.

Parts: 2; items per part: 20/19; working time: 5 minutes.

36. Recall of Nonsense Words - MSU13A. Recall previously studied nonsense syllables.

Sample Study Items: GAJ
DUF
NYT

Sample Test Items:

Duf
Gaj
Nyt

Score: Number of nonsense words correctly recalled.

Parts: 2; items per part: 15; working time: 7 minutes.

37. Recalled Words - MMU05A. List (recall) words presented on a previously studied page.

Sample Study Items: VIOLIN

Sample Test Responses:

brave
violin

COURAGEOUS

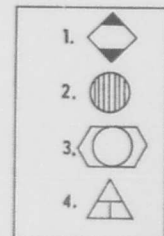
Score: Number of correct words, or synonyms reported. Parts: 2; items per part: 20; working time: 5 minutes.

38. Recognition of Figural Classes - MFC04A. Indicate whether or not figures on a test page have a property common to some group of figures on a previously studied page.

Sample Study Items:



Sample Test Items:



Answers: 2 and 3 have common properties; 1 and 4 do not. Parts: 2; items per study page: 10; items per page: 20; working time: 4 1/2 minutes.

39. Related Alternatives - MMI04A. Choose (recognize) objects that are related to persons' jobs, based upon studying a page of name-job pairs.

Sample Study Items:

SMITH - Bricklayer

JONES - Radio Announcer

Sample Test Items:

JONES

- A. Microphone
- B. Watch
- C. Tire
- D. Brick

SMITH

- A. Piano
- B. Microphone
- C. Brick
- D. Typewriter

Answers: Jones - A; Smith - C.

Score: Number right minus one-third number wrong.

Parts: 2; items per part: 15; working time: 8 minutes.

40. Remembering Faces - MFU05A. Indicate whether or not faces on a test page are the same as faces on a previously studied page.

Sample Study Items:



Sample Test Items:



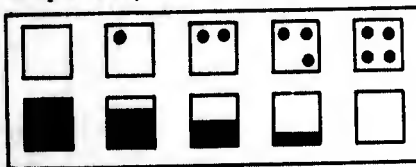
Answers: 1 and 3 are the same as those studied; 2 and 4 are not.

Score: Number right minus number wrong.

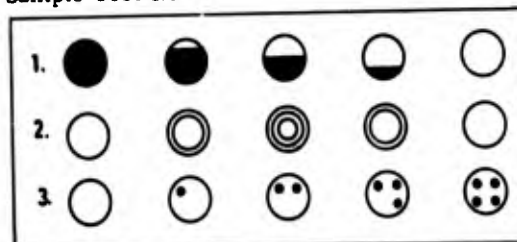
Parts: 2; items per study page: 10; items per test page: 20; working time: 5 minutes.

41. Remembering Figural Trends - MFR04A. Indicate whether or not trends in sets of circles on the test page are the same as trends in sets of squares on a previously studied page.

Sample Study Items:



Sample Test Items:



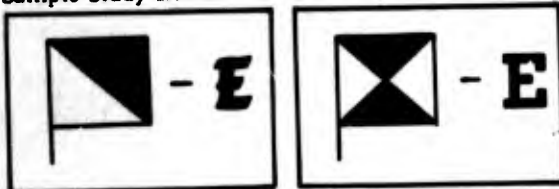
Answers: 1 and 3 have trends like those on the study page; 2 does not.

Score: Number right minus number wrong.

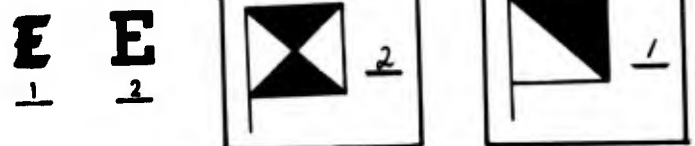
Parts: 2; items per study page: 10; items per test page: 20; working time: 6 minutes.

42. Remembering Flag-Letter Pairs - MFI02A. Match the letter type-faces associated with flags on a previously studied page.

Sample Study Items:



Sample Test Items:



Score: Number of correct matches.

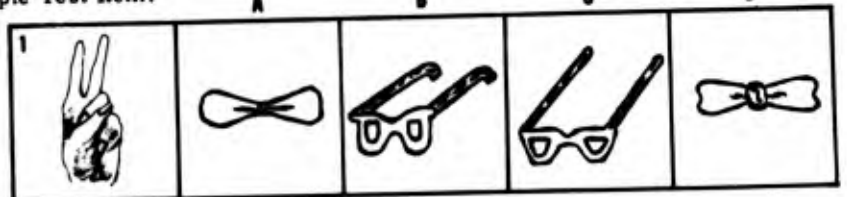
Parts: 2; items per part: 10; working time: 6 minutes.

43. Remembering Hand-Object Pairs - MFI03A. Indicate which of four alternative objects was paired with a given hand on a previously studied page of hand-object pairs.

Sample Study Item:



Sample Test Item:



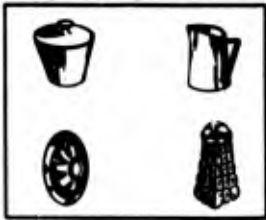
Answer: D.

Score: Number right minus one-third number wrong.

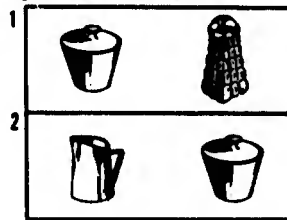
Parts: 3; items per part: 10; working time: 6 minutes.

44. Remembering Object Orientation - MFS02A. Given pairs of objects, select the arrow that indicates the direction from the first object to the second on a previously studied page.

Sample Study Items:



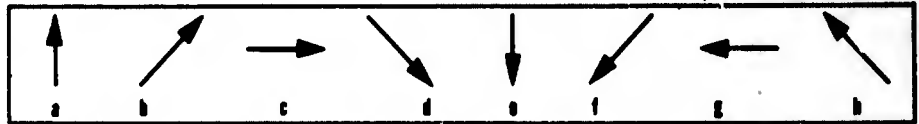
Sample Test Items:



Answers: 1 - d; 2 - g.

Score: Number right minus one-seventh number wrong.
Parts: 2; items per part: 16; working time: 8 minutes.

Test Page Alternatives:



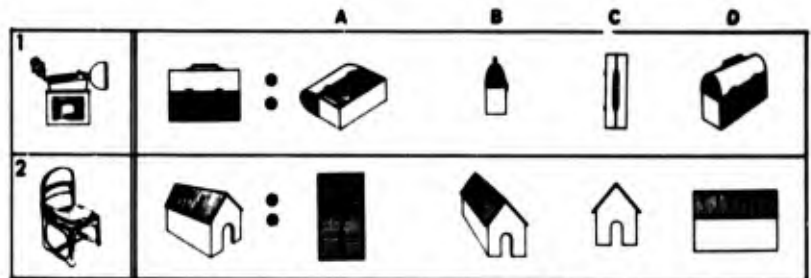
45. Remembering Spatial Changes - MFT04A. Select a three-dimensional repositioning of an object so that its change in position is the same as the one undergone by the cue object on a previously studied page.

Sample Study Items:



Answers: 1 - B;
2 - D.

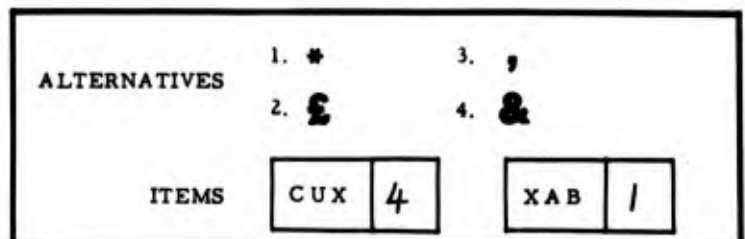
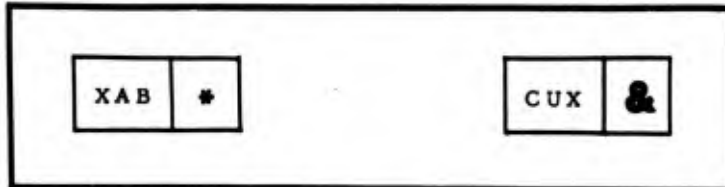
Sample Test Items:



Score: Number right minus one-third number wrong. Parts: 3; items per part: 10; working time: 7 1/2 minutes.

46. Remembering Symbol Codes - MSI09A. Match symbols to the nonsense syllables with which they were paired on a previously studied page.

Sample Study Items:

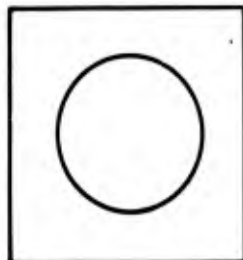


Score: Number of correct matches.

Parts: 2; items per part: 10; working time: 5 minutes.

47. Sketches - DFU01C (SPS). Add figural details to several replications of the same basic design to produce a variety of recognizable objects.

Sample Item:



Given this blank figure:

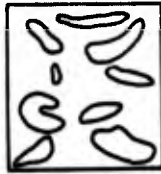
Possible responses:



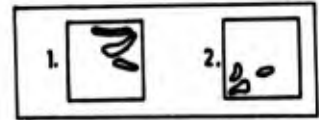
Score: Number of different recognizable objects produced. Parts: 3; items per part: 12; working time: 6 minutes.

48. **System-Shape Recognition - MFS04A.** Indicate whether groups of shapes have the same position and orientation to each other as they had on a previously studied page.

Sample Study Item:



Sample Test Items:



Answers: Group 1 has the shapes in the same positions as on the study page; Group 2 does not.

Score: Number right minus number wrong.

Parts: 2; items per part: 15; working time: 6 minutes.

49. **Temporal Ordering - NMS04A.** Indicate the appropriate order of steps in the completion of a described project.

Sample Item: Fixing a Flat Tire:

While you are driving along a busy highway late one night, your right, rear tire goes flat. The steps described below are some of those to be performed.

- a. Set out flares.
- b. Tighten nuts of wheel.
- c. Block wheels so car won't roll.
- d. Raise car with bumper-jack.
- e. Replace flat with spare.
- f. Unlock the trunk to get wheel blocks.
- g. Take bumper-jack out of trunk.

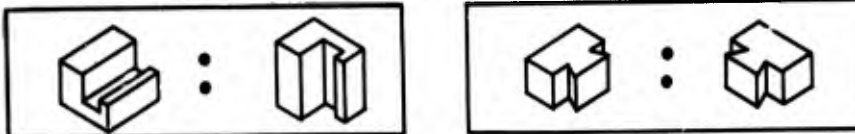
1. The steps that should precede step d include: a c f g.
2. The first two steps of this plan, in order, are: a f.
3. The last step of this plan should be step: h.

Score: Number of steps correctly indicated for each item. Parts: 3; items per part: 10; working time: 12 minutes.

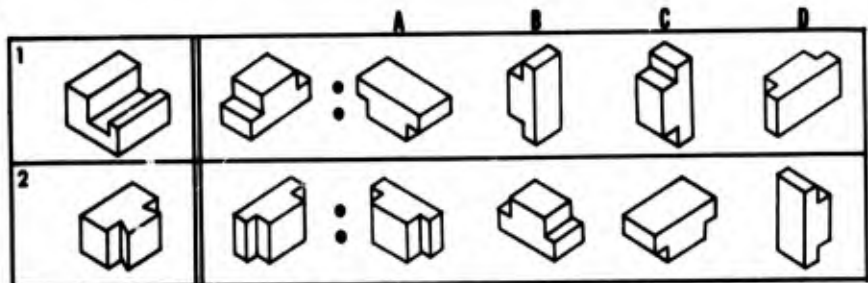
50. **Verbal IQ.** Language IQs from the California Test of Mental Maturity, 1963 Long Form were assigned for 31 examinees. The CTMM Language IQ probably represents the SI factors: CMU, CMC, CMR, and CMS. Verbal IQs from the Large-Thorndike Intelligence Test were assigned for 164 examinees. The factor composition of this IQ scale appears to be: CMU, CMS, MMU, MMT, EMR, and EMI. Sample mean verbal IQ scores were assigned to the 7 examinees for whom neither CTMM nor Large-Thorndike scores were available.

51. **Visualization Memory - MFT05A.** Select a three-dimensional repositioning of a geometric figure so that its change in position is the same as the one undergone by the cue object on a previously studied page.

Sample Study Items:



Sample Test Items:




Answers: 1 - C;
2 - A.

Score: Number right minus one-third number wrong.

Parts: 2; items per part: 10; working time: 6 minutes.

52. **Sex.** Girls were assigned the code value of 0; boys were assigned 1.

Unclassified
Security Classification

DOCUMENT CONTROL DATA - R&D							
<i>(Security classification of title, body of abstract and indexing annotation must be entered when the overall report is classified)</i>							
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13. ABSTRACT The main interest in this study was the six visual-figural-memory abilities hypothesized from structure-of-intellect theory. Those abilities were to be demonstrated as distinct from one another and from ten other abilities by means of 26 new tests designed for the figural-memory abilities, and 24 marker tests for the reference factors for the other abilities. (U) The test battery was administered to 202 high-school students. From the test intercorrelations, 18 principal factors were extracted and rotated to psychological meaningfulness. The six hypothesized factors for the six figural-memory abilities were well determined, each with two or more univocal tests from those designed for the respective abilities. Discriminations from four memory factors in the symbolic and semantic categories, three figural-cognition factors, three production factors, and factors for verbal IQ and sex were fairly good. Thus, the picture of a distinct memory category, constituted as in structure-of-intellect theory, is more firmly established. (U)							
14. KEY WORDS Factor Analysis Figural Memory Intelligence Memory Tests		LINK A		LINK B		LINK C	
		ROLE	WT	ROLE	WT	ROLE	WT

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