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VERBAL AND IDEATIONAL FLUENCY IN SUPERIOR TENTH GRADE STUDENTS[1]

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Among the creative thinking abilities that have been identified by Guilford and others (Guilford, 1957a; Wilson, Guilford, Christensen, & Lewis, 1954), fluency abilities are clearly the most accessible to objective measurement. Dealing as they do only with the quantitative aspect of creative thinking—how many ideas, solutions, and the like can be produced—they are perhaps not as central to the study of creative processes as are such abilities as originality and flexibility, but they represent what is probably the most attainable beachhead for an attack on this difficult domain.

The study of fluency has been limited almost entirely to fluency in verbal performance, but the concept of fluency can readily be extended to other kinds of intellectual performance, as has been done by Guilford in his "Structure of Intellect" (1956, 1957b). In the fields of art and design, for instance, fluency would be manifested in the ability to produce many configurations or designs. In mathematics, engineering, and architecture, it would be manifested in facility in producing or applying formal structurings of elements (as in the ability to find many situations fitting a given mathematical model or the ability to plan many room arrangements within a single building shell).

Probably the most definitive study to date of verbal fluency abilities has been that by Guilford and Christensen (1956), carried out on adult males. In light of the current interest in early identification of creative talent and in the utilization of female talent, it seemed desirable to attempt a replication of the results of this study using younger *Ss* and to explore the possibility of sex differences in the patterning of fluency abilities (something which no previous study in this area has done).

The above considerations led to the formulation of three purposes for the present study: to investigate fluency in the use of nonverbal materials, to compare the verbal fluency factors obtained with younger *Ss* with those obtained with adults, and to compare fluency factors obtained with boys with those obtained with girls.

METHOD

Tests. A battery of 18 tests was assembled, including both reference tests for previously identified verbal fluency factors and new tests designed to tap areas of nonverbal content. Table 1 provides brief descriptions of these tests. The first 10 are tests that contributed most to the identification of verbal fluency factors in the Guilford and Christensen (1956) study.[3] Certain of these tests were modified to adapt them to younger *Ss* (Be-

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[3] As recently revised (Guilford, Fruchter, & Kelley, 1959), the "Structure" would lead to somewhat different hypotheses, but the present study was under way before this revision appeared.

TABLE 1

DESCRIPTIONS OF REFERENCE AND EXPERIMENTAL FLUENCY TESTS

Test	Task	Hypothesized Factor Content
1. Word Fluency, Form A[a]	Write words containing one specified letter.	WF[b]
2. Suffixes	Write words containing a specified suffix.	WF
3. Controlled Associations III	Write synonyms for given word.	AF
4. Simile Insertions	Produce attributes that two given objects have in common.	AF
5. Plot Titles	Write titles for story plots.	IF
6. Brick Uses	List different uses for a brick; score is number listed.	IF
7. Object Naming[c]	Write thing names fitting somewhat restricted classes.	IF
8. Expressional Fluency, Form A[a]	Write four-word sentences; first letter of each word is given.	EF
9. Word Arrangement	Write sentences containing four specified words.	EF
10. Simile Interpretation	Compose more or less complete expressions of the attributes two objects have in common.	EF
11. Product Design	Draw designs for car grilles and lampshades, outlines of car fronts and lamp bases being supplied.	FIF
12. Design Synthesis	Draw different designs using three given figures.	FIF
13. Alphabet Design	Design possible new letters for the alphabet.	FIF
14. Form Completion	Name objects that could be drawn by adding lines to given figures.	FIF
15. Linkages	Draw devices for connecting Objects A and B so that when A is moved in an indicated direction, B will move in an indicated direction	SIF
16. Partitions	Draw different ways to separate objects into pairs by the use of a limited number of straight lines.	SIF
17. Connections	Draw lines connecting specified objects without one line crossing another.	SIF
18. Structural Functions	Produce (verbally) ideas based on the formal relationships between objects; e.g., places to hide a rope, tasks suitable to an 8-foot tall person.	SIF

[a] Published by Sheridan Supply Co., Beverly Hills, Calif., Copyright 1957.

[b] The following abbreviations are used:

WF Word Fluency
AF Associational Fluency
IF Ideational Fluency
EF Expressional Fluency
FIF Figural Ideational Fluency
SIF Structural Ideational Fluency

[c] Based on Thing Listing II.

reiter, 1959), but the changes were minor enough that, except possibly in Test 7, no changes in factorial composition were believed likely. In that test new classes of objects were used which appeared freer of figural or structural content: "old-fashioned" and "dangerous" replaced original items dealing with use, composition, or shape of objects.

The remaining eight tests are new tests

developed on the basis of hypotheses suggested by Guilford's "Structure of Intellect" (1956, 1957b).[4] This scheme suggested the existence of two previously unidentified factors which may be labeled Figural Ideational Fluency and Structural Ideational Fluency. Figural Ideational Fluency was interpreted broadly to involve such tasks as thinking of ideas for pictures, completing pictures, varying designs, or recombining elements into various designs. Structural Ideational Fluency was interpreted as involving the production of formal systems as opposed to concrete figures or substantive ideas. Mathematics provides the most obvious example of such content, but it was found impossible to invent divergent production (as opposed to single-solution) items of mathematical content which were sufficiently easy. Instead, tests involving mechanical and spatial relationships were devised, on the premise that in such tests it is formal relationships between objects which are critical rather than objects themselves. A fuller description of the experimental tests and an account of their development is given in Bereiter (1959).

Subjects. The 18 tests were administered to a total of 265 tenth grade *Ss*, 103 boys and 162 girls, in three urban Wisconsin high schools. All had been identified by their schools as academically superior and were enrolled in special classes for such students. One hundred twenty-eight of the *Ss* were volunteers who came to two weekend testing sessions. The rest were selected by their schools for testing during regular school hours.

Method of Analysis. Separate factor analyses were performed for boys and girls, using Rao's (1955) canonical factor analysis method and Lawley's (1940) test for the significance of residuals, as programed for the IBM Type 650 computer by Harris and Pierce (1956). Orthogonal normal varimax rotations were made of the canonical factors.[5]

Results

Nine canonical factors significant at the 5% level were extracted from the correlation matrix for boys and six from the matrix for girls. After rotation, however, six factors that could be regarded as common factors remained for both sexes. These rotated factors are reported in Tables 2 and 3.

As a basis for matching factors obtained for boys with factors obtained for girls, a least squares approximation of the former factor matrix to the latter was carried out (Bereiter, 1959, pp. 69–70, 124–125), the elements of the transformation matrix indicating the contribution of each factor to the approximation. In the following factor interpretations, factors for boys and girls are considered in pairs wherever a clear matching was indicated. The convention of treating loadings with absolute values of .30 or higher as "significant" has been followed.

Factors A and M. Factor A (girls) resembles Factor M (boys) in having substantial loadings on verbal tests that involve the production of fairly commonplace, low level ideas. These tests lend themselves to a routine, "grinding out" method for obtaining a high score. They differ, however, in that Factor M (boys) has its highest loading on a drawing test, Design Synthesis, which has an insignificant loading on Factor A (girls). Of the nonverbal tests, Design Synthesis is the most suited to a grinding out of low level productions, but it remains a question why its loadings should be so different on the two factors.

Two explanations may be suggested. One is that girls may respond quite differently to verbal content than they do to nonverbal content but that boys do not show this distinction—a hypothesis that will be seen to gain support from other factor comparisons as well. The other is that the high loading of Design Synthesis on Factor M may be an incidental consequence of conditions of test administration. Plot Titles, Design Synthesis, and Struc-

[4] The writer wishes to express his gratitude to J. P. Guilford for permission to adapt and use these tests.

[5] The writer is indebted to Henry F. Kaiser, originator of the varimax method, for carrying out these rotations.

TABLE 2

ORTHOGONAL VARIMAX ROTATION OF CANONICAL FACTOR PATTERN FOR 18 FLUENCY TESTS GIVEN TO 162 TENTH GRADE GIRLS

Tests	Factors					
	A	B	C	D	E	F
1. Word Fluency	.09	−.14	.24	.44	.12	.23
2 Suffixes	.07	.11	.08	.61	.07	−.05
3. Controlled Associations	.32	.14	.24	.14	.61	.07
4. Simile Insertions	.34	.28	.48	.11	.27	.04
5. Plot Titles	.69	.04	23	.03	.08	.08
6. Brick Uses	.53	.05	.21	.15	.34	.32
7. Object Naming	.25	.13	.49	13	.38	.16
8. Expressional Fluency	.22	−.07	.62	.20	.22	.14
9. Word Arrangement	.26	.13	.70	.06	.00	.13
10 Simile Interpretation	.67	.03	.29	01	.17	.09
11. Product Design	.30	.47	.29	−.01	.11	.38
12. Design Synthesis	.28	.25	.08	.17	.05	.62
13. Alphabet Design	.14	.62	.23	.09	−.05	.28
14. Form Completion	.34	.07	.19	.20	.34	.36
15. Linkages	.13	.34	.05	.01	.28	.19
16. Partitions	.05	.20	.17	−.26	.12	.43
17. Connections	−.06	.56	−.05	−.02	.08	.01
18. Structural Functions	.60	.14	.14	.16	.20	.34

TABLE 3

ORTHOGONAL VARIMAX ROTATION OF CANONICAL FACTOR PATTERN FOR 18 FLUENCY TESTS GIVEN TO 103 TENTH GRADE BOYS

Tests	Factors					
	M	N	O	P	Q	R
1. Word Fluency	.16	.59	.10	.02	.26	.04
2. Suffixes	.02	.24	.06	.04	.54	−.11
3. Controlled Associations	.21	.52	.26	.24	−.02	−.14
4. Simile Insertions	.35	.33	.56	.26	−.08	.05
5. Plot Titles	.70	.25	.23	.11	−.16	.04
6. Brick Uses	.48	.10	.31	.38	.06	.20
7. Object Naming	.24	.32	.23	.16	.28	−.01
8. Expressional Fluency	.09	.51	.06	.16	.27	.12
9. Word Arrangement	.06	.58	.23	.10	.05	.05
10. Simile Interpretation	.42	.24	.41	.36	−.27	.17
11. Product Design	.38	.25	.62	.05	.09	.02
12. Design Synthesis	.74	.00	.20	.03	.15	.11
13. Alphabet Design	.12	.13	.73	.09	.14	.16
14. Form Completion	.35	.20	.19	.60	.12	.12
15. Linkages	.24	.17	.01	.14	−.01	.51
16. Partitions	.02	−.04	.12	.02	−.09	.59
17. Connections	.13	.13	.09	−.02	.00	.11
18. Structural Functions	.68	.20	.09	.32	.10	.09

Note —Three factors, each with only one loading of .30 or more in absolute value, are not reported. The three significant loadings were .55 on Test 17, .30 on Test 8, and .38 on Test 7.

tural Functions were the last three tests administered in the battery, and their intercorrelations were the highest ones obtained for boys. This suggests the operation of some motivational or fatigue factor which was not equally effective on boys and girls. In spite of this discrepancy, the title Production of Low Level Ideas appears to fit the composition of both factors.

Factors C and N. Factor N is the only strong factor for boys determined entirely by verbal tests. It is quite undifferentiated, containing reference tests of all four of the verbal fluency factors identified by Guilford and Christensen (1956). It therefore appears appropriate to label it, following Zimmerman (1953), Verbal Fluency, indicating a general fluency in the use of words or phrases. Factor C (girls) resembles Factor N except that the tests determining it are limited to ones involving the use of words in meaningful contexts. The two tests with highest loadings are reference tests of Expressional Fluency, and the factor appears to fit French's (1951, p. 209) description of that factor as the "ability to think rapidly of the wording for ideas."

Factors D and Q. The only tests having significant loadings on Factor D (girls) are Suffixes and Word Fluency, tests for the familiar Word Fluency factor. Factor D may thus be confidently identified as Word Fluency, which French (1951) describes as "entirely limited to the speed of producing any words which fit certain mechanical restrictions regarding the letters or affixes used" (p. 249). Factor Q (boys) most nearly approximates this factor, but it is specific to the Suffixes tests, so that nothing more can be said of it than that it "suggests" a Word Fluency factor.

Factor E. This factor for girls is determined mainly by Controlled Association, but the significant loadings on Object Naming, Form Completion, and Brick Uses, suggest an underlying task similarity. In all four tests *S* is presented with a stimulus (word or picture) to which she associates verbally, and there is a certain indefiniteness as to what constitutes an appropriate response. Variance on these tests may thus arise not only from differences in command of words but also from differences in the looseness or rigor with which *S*s interpret the given restrictions. On this basis, the factor may be identified with the factors of Associational Fluency that have appeared in personality studies (cf. Cattell, 1953, pp. 193–204).

Factor P. This factor for boys has some similarity of pattern to Factor E, above, but not enough to justify matching them. It is also similar to another factor for boys, Factor M, which was identified as Production of Low Level Ideas; all four of the tests having significant loadings on P also have significant loadings on M. Because of this ambiguity, the factor must be left unidentified, but it is suggested that it may represent some component of low level idea production that is accounted for by freedom in associating to stimuli.

Factors B and O. Factor B (girls) is loaded by four nonverbal tests, two of which were intended to have figural content and two of which were intended to have structural content. The most obvious characteristic which they have in common is that they require *S* to devise some configuration out of nothing, so to speak, as opposed to Design Synthesis and Partitions, in which *S* is told what figures to use. On this basis the factor may be identified as Figure Production.

Factor O (boys) is loaded by two tests involving figure production, but

also by the two simile completing tests. This combination suggests that a relevant variable might be the esthetic or "arty" character of the tests—the one kind having to do with designs, the other with figures of speech. It is interesting to note in this connection that Simile Interpretation, as well as a simile completing test not greatly different from Simile Insertions, had significant loadings on Originality in the Guilford and Christensen (1956) study. Factor O may therefore be some kind of esthetic aptitude or originality factor whose nature cannot be more clearly described because suitable measures of such factors were not included in the study.

Factor F. This factor for girls seems to be a logical complement to Factor B (girls); whereas B is determined by tests in which figures must be produced out of nothing, F is determined by tests in which figural elements are supplied. In Design Synthesis and Partitions, the tests with highest loadings on the factor, the elements entering into the designs are completely specified and the task is simply one of placing or arranging the elements. To a lesser extent this is true even of the three verbal response tests loading the factor—Form Completion, Structural Functions, and Brick Uses. They seem to involve ideas about the placement or arrangement of elements. There is a suggestion here of structural content, but because of the factor's complementary relationship to Factor B, it seems more appropriate to identify it as Figure Manipulation.

Factor R. Factor R (boys) is a doublet composed of two of the nonverbal tests included to measure Structural Ideational Fluency. A doublet, based as it is upon a single correlation coefficient, is weak evidence on which to base a new factor identification; but, assuming the correlation not to be spurious, the factor clearly fits the description of Structural Ideational Fluency as a fluency in producing mechanical and spatial ideas—Partitions being a spatial test and Linkages being mechanical.

Discussion

The results of the present study are dominated by sex differences which are so sweeping that any matching of factors for the two sexes is tenuous. The most obvious general sex difference is that the factor structure is much less clear for boys than for girls. This may be only an effect of the selection of tests, however; for if different dimensions do exist for the two sexes, it may merely be that the tests chosen were more appropriate for isolating dimensions for the girls.

In the verbal area the factors for boys show signs of immature development—a general factor plus rudiments of other verbal factors. In the idea producing area, however, the situation may be reversed. The idea producing factors for girls seem to be differentiated on rather simple-minded bases. One involves verbal tests and the other two involve nonverbal tests which are differentiated according to whether design elements are supplied or whether they must be made up. It thus appears that the more concrete aspects of the tasks are what matter with girls and that more abstract aspects of test content make less difference. For boys, on the other hand, the concrete aspects seem of little importance: verbal and nonverbal tests share high loadings on several factors. Instead, the abstract aspects seem to be the bases for differentiation of factors—the kinds of ideas required, whether original or routine, esthetic or commonplace, figural or structural.

The possibility that these differences are due to sampling error or bias must

be considered. Estimating the standard error of a factor loading remains an unsolved problem. *N*s of 103 and 162, as used in the present study, yield quite reliable correlation coefficients, however, so that it seems unlikely that sampling error could account for such extensive differences. Bias in the selection of *S*s is an even less likely explanation. Bias might be present; criteria for placing boys and girls in special classes, while ostensibly the same, might be somewhat different in practice. Such biases could do mischief in the comparison of mean scores, but it would take an extraordinarily biased selection to yield groups in which the correlations between variables were atypical. It therefore seems warranted to look for some psychological explanation for the sex differences.

At a low level of inference, these findings say simply that the tests used in the present study did not measure the same things for boys and girls. Any suggested explanation of this difference must necessarily go well beyond the data, but the following hypothesis is advanced as one that predicates a minimum of discontinuity in basic mental organization between the sexes. One aspect of fluency that would seem to be especially significant among people of relatively high general mental ability is one related to inhibition. Among intelligent *S*s, those who perform best on a particular fluency test are likely to be ones who are least intimidated, bewildered, or otherwise inhibited by the nature of the test. The impression that the writer acquired while administering these tests, and one that should not surprise teachers of tenth grade children, was that the girls responded with much more emotion to the immediate and superficial aspects of each test than did the boys—with greater extremes of delight, despair, bewilderment, enthusiasm, or indignation as the case might be. It is possible that these initial reactions had an influence on performance that was only partly offset by the effect of the less obvious intellectual content of the tests. Thus tests that were superficially alike—e.g., ones involving drawing figures, ones involving arranging figures, ones involving listing words—tended to be more highly correlated with each other than tests that tapped the same ability but in different ways. (This is similar to the heterotrait-monomethod versus monotrait-heteromethod distinction discussed by Campbell and Fiske, 1959. Boys, on the other hand, being less affected by the immediate impressionistic aspects of the test, may have revealed more individual differences in ability to handle particular kinds of intellectual content. If this hypothesis is sound, then it would be predicted that sex differences in factor structure would tend to diminish with increasing age, as girls become less emotionally reactive to such things as tests.

The prevalence of sex differences obscures results bearing on the other two concerns of this study—the existence of fluency factors with nonverbal content and the comparability of verbal fluency factors in younger *S*s with those obtained in studies of adults. Verbal and nonverbal tests identified different factors for girls, but the hypothesized Figural and Structural Ideational Fluency factors were not discernible. For boys, on the other hand, there was no clear separation of verbal and nonverbal content, but a weak Structural Ideational Fluency factor could be distinguished. All that may be said in general of the results is that the inclusion of nonverbal tests led to the appearance of more fluency factors than had appeared in studies limited to verbal tests, but that the

nature of these additional dimensions remains unclear.

In contrast to recent studies using adult males (Guilford & Christensen, 1956), the present analysis of verbal fluency abilities in tenth grade boys yielded not four verbal fluency factors but only a single general one. For girls, factors appeared which could be identified with the four factors previously obtained. Except for Word Fluency, however, the factors differed from those obtained by Guilford and Christensen in a number of ways that can be only briefly summarized here. Expressional Fluency appeared to be more general than its counterpart in the Guilford-Christensen study, involving the whole meaningful use of language rather than just the use of phrases and larger units of expression. Associational Fluency emerged as a factor more closely related to the concept of association as it is used with clinical tests, implying a facility in associating to a stimulus, rather than an ability to use words meaningfully, as had been implied by Guilford and Christensen. In the verbal ideational fluency factor, the ideas involved were of the type generally thought of as ideas—solutions to problems, simple inventions, etc.—rather than ideas in the sense of elements in logical categories, as in Guilford and Christensen's definition.

Expressional Fluency is the only factor for the girls which suggests less mature intellectual development than the corresponding factor for adults. The other factors are definable in simpler terms and are, we would argue, at least as meaningful and well-defined as the factors obtained in other studies. Before further research can resolve these differences and proceed to clarify dimensions of fluency involving nonverbal tests, it would appear essential to explore further the extent and stability of the sex differences revealed in this study.

Summary

A battery of 18 tests, consisting of 10 reference tests for verbal fluency factors and eight new tests designed to measure hypothesized factors of fluency in the production of figural and mechanical and spatial ideas, was administered to 103 male and 162 female academically superior tenth grade students. Factor analyses by a maximum likelihood method and analytical rotations were carried out on data for boys and girls separately.

Quite different factor patterns were obtained for the two sexes. For girls the reference factors of verbal fluency—Word Fluency, Associational Fluency, and Expressional Fluency—were substantially replicated, but for boys only a general verbal fluency factor appeared. Three idea producing factors emerged for both sexes. For girls the characteristics which appeared to determine the factorial composition of the ideational tests were (*a*) whether they involved writing or drawing and (*b*), in the case of drawing tests, whether the elements used in the drawings were specified or left to the subject's improvisation. For boys the critical characteristic appeared to be the nature of the ideas involved. One factor was loaded by tests calling for the production of commonplace ideas, another by tests involving more esthetic ideas, and a final factor was loaded by tests of mechanical and spatial content. The verbal factors obtained for girls suggested certain simplifications in the definition of previously identified factors. The factors obtained in the area of nonverbal ideational fluency abilities indicated that such a domain of fluency abilities does exist and is accessible to measurement; but the important dimensions of that

domain did not appear to have been isolated.

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