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DIMENSIONS INVOLVED IN DIFFERENCES AMONG SCHOOL MEANS OF COGNITIVE MEASURES

LLOYD G. HUMPHREYS
CHARLES K. PARSONS
RANDOLPH K. PARK
University of Illinois

The widespread use of multiple factor analysis has pushed the concept of general intelligence into the background of the thinking of many psychologists. It is true, of course, when any large number of ability tests are intercorrelated and factored, that multiple first order factors are described. Thurstone (1938) called these factors "primary," which connotes "important." Guilford's research (1967) has multiplied the number of so-called primary factors to perhaps 120, although many fewer factors than this have been described in any one analysis. Nevertheless, multiple factors are obviously present in any large scale test battery. One must carefully select a small subset of heterogeneous ability tests in order to demonstrate Spearman's concept of hierarchical order and the use of a single factor to describe their intercorrelations.

Another ubiquitous phenomenon also is present. In the full range of human talent there are few if any negative correlations between measures of abilities. This is particularly true if one restricts the domain to the cognitive area. Also, if one has a reliable, valid criterion measure of proficiency in an activity having cognitive content, almost any cognitive measure will show a nonzero predictive validity with that criterion. The only reservation required for this statement is that the sample be large enough to avoid large negative sampling errors. Differential validity of a predictor for different criteria can be found, but in the full range of talent the differences required are not readily demonstrated. These observations indicate that there is generality in human cognitive performance underlying the multiple factors.

A hierarchical model of the factors in human abilities reconciles multiple first order factors with the evidence for a general factor. This model has been more popular among British psychometricians than among American and is well represented in the writings of Vernon (1950). A number of American psychologists, on the other hand, have factored in more than one order and perhaps most accept higher order factors in principle. Schmid and Leiman (1967) joined these two factor models by means of a transformation that allows one to translate factors in higher orders into the hierarchical model of Vernon.

Although recognizing that the hierarchical model might not fit the complexities of the interrelationships of human abilities perfectly, Humphreys (1962) recommended it as a useful approximation. The problem with the model is not with the concept of the general factor but with the lack of neatness with which factors are broken out of the hierarchy as one proceeds from the general to the specific. Humphreys (1974) has also discussed the importance of the general factor in research on heritability. Although accepting the reality of Spearman's "g" for descriptive purposes, Humphreys (1971) defines the construct behaviorally rather than as an entity within the organism.

With this as background it occurred to the present authors that the variances and intercorrelations of test means of groups that had experienced unplanned social selection of a cognitive sort would be relevant to the importance of the concept of a general factor in human abilities. The intercorrelations might also shed a little light on the origins of the general factor if sufficient demographic information about the groups could also be obtained. The variances and intercorrelations of school means fit these specifications, and the Project TALENT Data Bank was the natural place to look for data. Since the original testing was done in 1960, before there had been any widespread bussing of urban students, the selective mechanisms that led to children being in one high school rather than another perhaps operated more directly on the characteristics of families and children than would be true today.

The comparison of the variances of school means with the variances of individual students will reveal the amount of selection that has taken place on the measures in the analysis. There may be little or no selection on certain measures, a great deal on others. In contrast, to the extent that there is a general factor in the scores on the very heterogeneous collection of tests administered in Project TALENT, all cognitive measures will have between school variances of substantial size. If the selective forces in different schools operate on different clusters of measures, however, the general factor interpretation cannot be distinguished from multiple group factor interpretation on the evidence from variance ratios.

The intercorrelations of tests in which a group mean is the unit rather than the individual student will provide additional information. The several possibilities are as follows.

First, if group membership were random, the intercorrelations among group means and among individual scores would not differ from each other. This theoretical outcome represents the base line.

Second, if selective mechanisms operate principally on the group or so-called primary factors, these factors will appear in the analysis in easily recognizable form. The size of the loadings may differ from the individual to group means analyses.

Third, if selective forces involve primarily the general factor in intelligence, the intercorrelations of the group factors will increase. These intercorrelations may be so high that group factors will be very difficult to define and will virtually disappear.

Fourth, if selection operates primarily on socio-economic status of the students' families, a large, almost general factor will be obtained on which SES will have a very high loading, with the tests most highly correlated with SES trailing along at somewhat lower levels. Most cognitive tests are correlated with SES, but a few are not. Furthermore, the statistically significant correlations range from less than .20 to values slightly higher than .40. Direct selection on status, if it occurs, will be readily recognized.

It should be particularly noted that the preceding discussion of selective mechanisms and the factors on which they operate does not preclude environmental causes of individual differences in either the parents or the children. The mechanisms may operate on the characteristics of both parents and children. There may, for example, be quality differences in the environments experienced by children prior to their appearance in a particular high school. Thus quality differences among the "feeder" grade and junior high schools could affect the mean of a particular high school without any involvement of the characteristics of the children's families.

THE DATA

In Project TALENT approximately 400,000 students in grades 9 through 12 were administered a wide variety of tests in more than 900 high schools selected on a stratified random basis. Tests included a broad band of both cognitive and and noncognitive variables. School principals also supplied a number of demographic facts about their schools. As one might expect, complete information was not obtained on all schools. Test information was available on a more complete nationwide sample than the demographic information.

We requested from the TALENT Data Bank the intercorrelations of means for 83 cognitive measures and a composite measure of socio-economic status of individual students[1] on 10th grade boys and 10th grade girls. For 21 school variables we also obtained intercorrelations and correlations with the tests and the index of SES. By selecting an early high school year, we were able to avoid very largely the problem of loss from the sample because of drop-outs. By selecting the 10th grade rather than the 9th, we avoided the problem of junior and senior high separation. Complete data including means and variances as well as intercorrelations were available for 713 and 678 schools for males and females, respectively.

Twenty-four of the cognitive measures were linear composites of some subset of the remaining; one school variable was inadequately scaled for the computation of product-moment correlations, and one of the two "entering salaries" variables was largely redundant with the other. These variables were, therefore, discarded from the factor analysis. The remaining 59 cognitive tests, one measure of socio-economic status, and 19 school variables were suitable for factor analysis.

METHODS

Means, variances, and intercorrelations of the measures were computed separately for each sex at the Data Bank and shipped to us without identification of the schools. Two types of data were available: raw school means and means adjusted to represent the nation's population of high school students. Since we were interested in schools rather than individual students, and since the adjusted statistics gave greater weight to the large high schools, we decided to base analyses on the raw data. Thus each school, without regard to size, is given equal weight in the variances and the correlations. The two sets of correlations differ less than the variances. The raw data school variances are larger and the raw data correlations are slightly lower than the adjusted. Since we were interested in the general factor in ability tests means, the selection of the raw data served to reduce its size by a small amount.

There are two ways in which the variances of school means can be related to the variances of individual students. The reader familiar with the analysis of variance will immediately think of F-ratios of the mean square between to the mean square within, but a test of significance is not needed. With the size of the samples of both schools and students these would all be very large indeed. A more useful statistic in this case is eta, a descriptive statistic which is equal to the root of the variance between to total variance. In large samples, also, it approaches the population estimate in size so closely that the additional computations required for the latter are unnecessary. This correlational

1. The composite is based on the following items: value of home, family income, number of books in home, number of household appliances, communications equipment, student's room and its equipment, occupation of principal breadwinner, father's education, and mother's education. Weights range from 1 to 4 for student's room to 1 to 10 for each parent's education. The principal correlates of the index among individual boys and girls are the following: general vocabulary and information about literature, music, art, and mathematics. These correlations are slightly higher than .40 for girls, slightly lower for boys.

statistic can be estimated from the summary statistics sent us by the ratio of the standard deviation in the sample of schools to the standard deviation of the total sample of students. Eta estimated in this fashion serves very well to portray the amount of selection on any one measure relative to any other. It serves well to portray the absolute amount of selection. If we had used the adjusted data, etas would have been smaller, but their rank order would have been almost identical.

The factor methods used in the data to be reported can be very quickly summarized, but there was in addition a good deal of preliminary work that will also be described. Our conclusions, however, are based on the following steps. Principal factors were extracted from the 79 × 79 matrix with squared multiple correlations in the principal diagonal. The number of factors decision was ultimately based on finding a meaningful rotational solution with the Varimax program. In preliminary analyses we attempted to use the parallel analysis criterion (Humphreys & Montanelli, 1975; Montanelli & Humphreys, 1976) in a 74 × 74 matrix of tests and school variables and in a 59 × 59 matrix of tests only. The former matrix lacked the socio-economic status measure and four of the present school variables, but the set of tests used in the preliminary research was identical to the final set. Both orthogonal and oblique rotations of various numbers of factors in both matrices were tried before we reached a final decision on the number of factors to be reported. All oblique rotations involved the Binormamin program.

EFFECTS OF SELECTION ON VARIANCES

The range of the estimates of eta for boys is from .30 to .76 and the median is .53 for the 59 test scores that were experimentally independent of each other. Parallel values for girls are .32 to .70 for the range and .52 for the median. The same statistic for the SES measure is .61 for boys and .65 for girls. There appears to be more selection on SES than on the typical test, but some test variables overlap the SES index and no tests show near zero selection effects.

There is also a measurement bias in the comparison of tests and the SES index. The tests administered in Project TALENT were necessarily short because testing time was limited. In one reliability study involving 22 of the longer tests administered to a male military sample (Flanagan et al., 1964), the median was .76. In a second study (Shaycoft, 1967) involving 20 additional tests, the median for boys and girls combined was .68 in the 9th grade and .69 in the 12th. Even so some of the shorter information tests and the highly speeded tests were not included. The nine shortest information tests in a 12th grade sample had a median reliability estimate of only .38. In contrast, although no attempt was made to estimate the reliability of the SES index, there seems little doubt that students could duplicate their responses to the several items on a second occasion with little error. More importantly the items are sufficiently objective and the student respondents sufficiently mature that the correlation with responses obtained from a parent should be very high. Measurement error attenuates all correlations, including these etas.

It was also possible in the data available to us to select composites of individual tests which, using the total number of items included as the criterion, should be substantially more reliable than any one of the components. Sixteen composites met our criterion. The median eta for boys in this set is .675 and for girls .660. The constitution of the composites was such as to produce variables of which most would be expected to load highly on the general factor in intelligence. The selective factors at work in the "assignment" of students to high schools in 1960 affected reliable cognitive variables as a group somewhat more strongly than the reliable SES index. The ones designed to parallel the function measured by general intelligence tests or general academic aptitude tests are also at the high end of these distributions, well above the etas for SES.

It seems clear from these data that there is a great deal of selection with respect to the SES index, but that there is even more selection with respect to composites of Project TALENT tests that were designed to duplicate the functions measured by standard intelligence tests. Apparently selection has taken place on some third variable or variables with which reliable intelligence tests have a higher correlation than the SES index.

PRELIMINARY FACTOR ANALYSES

Because our conclusions are rather heavily dependent on the number of factors we decided to present and interpret, a rather full discussion of the basis for this decision will be given. Parenthetically, however, the importance of this decision in the present research is only slightly greater than in any investigation in which the factor analytic methodology is used. One finds that there is no easy and completely objective basis for the number of factors decision although certain computer programs in wide use appear to offer a simple solution.

Eigenvalues for the first 12 factors in the two preliminary analyses, along with the expected values of the latent roots of random data matrices of the same order and number of observations, are presented in Table 1. Although the variance of the first component is huge, it appears that there are multiple factors in the school means data. The appropriate number of factors to retain and to rotate does not clearly stand out as one inspects this table, but the parallel analysis criterion suggests eight factors in the larger matrix and possibly six in the smaller.

When the eight factors in the larger matrix are rotated orthogonally one very large factor, three moderately substantial, and four small factors are obtained. The first four are interpretable, but the smaller factors require for their interpretation a good deal of imagination, and there is little similarity from one sex to the other. In contrast there is high similarity between the sexes for the four larger factors. Oblique rotation of the same eight factors results in collinearity of several factors for each sex. This outcome suggests that too many factors were rotated.

When only four factors are rotated orthogonally, the same four factors emerge which were the larger ones in the eight factor solution. Oblique rotation reveals the same four factors with factor intercorrelations of trivial size. Since factors defined by cognitive tests in the full range of talent are positively and substantially correlated, this outcome was, at the outset, surprising. The explanation ultimately became obvious.

Orthogonal rotation of six factors in the 59×59 test matrix results in three factors similar to three of the four largest ones in the school variables matrix. Three small factors are also defined. The reduction from four to three of the large or moderately large factors is explained by the fact that one of the four in the larger matrix was defined almost solely by the school variables. Oblique rotation of the same six factors appears to be more interpretable, but the interpretability is spurious. While there is no pair-wise collinearity as was true in the larger analysis, the extraction of a single second order factor produces four first order factors whose communalities approach unity. A first order factor with unit communality furnishes no unique information. When the factors in both orders are

Table 1

Latent Roots in Two Correlation Matrices in Male and Female Samples

	74 X 74 Matrix				59 X 59 Matrix			
	Females	Random Data	Males	Random Data	Females	Random Data	Males	Random Data
1	33.90	.88	36.31	.86	33.12	.75	35.43	.73
2	5.19	.85	6.06	.83	2.71	.70	3.56	.68
3	2.29	.81	2.51	.78	2.02	.66	2.22	.64
4	1.53	.75	1.68	.72	.93	.60	1.05	.59
5	1.08	.72	1.13	.70	.86	.57	.76	.56
6	.86	.68	.84	.67	.65	.54	.56	.52
7	.77	.65	.73	.63	.58	.50	.46	.49
8	.70	.62	.62	.60	.51	.48	.40	.46
9	.57	.59	.55	.57	.42	.45	.36	.44
10	.55	.56	.47	.55	.39	.43	.29	.42
11	.48	.56	.41	.54	.35	.42	.27	.41
12	.43	.51	.38	.50	.27	.38	.23	.37

transformed into a hierarchical orthogonal structure, four of the six group factors become essentially null. Only a general factor and two group factors have appreciable variance.

We next rotated the first three factors in the 59 × 59 test matrix both orthogonally and obliquely. Orthogonal rotation revealed factors similar but not identical to three of the four in the larger matrix and identical to the three larger factors obtained when six factors were also rotated orthogonally. Oblique rotation of the same three factors revealed three substantially correlated factors. One of these was almost completely determined by the other two, however, so when a second order factor was extracted and the transformation applied, a hierarchical order consisting of one general and only two group factors was again revealed. The three orthogonal hierarchical factors in the smaller matrix, which required factoring in two orders, are almost identical to three of the four in the larger matrix, which were the first order result of Varimax rotation. The explanation, in retrospect, was simple: in the larger matrix most of the school variables were essentially uncorrelated with the cognitive tests. Thus Varimax rotation produced the general factor *among the test* in the first order in the larger matrix, but only approximated the same factor in the first order in the smaller matrix of tests only.

These preliminary analyses converge on a conclusion that there are four replicable and potentially interpretable unrotated factors in the matrix containing both tests and school demographic variables and three factors having similar properties in the matrix of tests alone.[2] We decided, therefore, to extract, rotate, and attempt to interpret four factors in the augmented matrix containing the intercorrelations of 59 tests, one socio-economic index for individual families, and 19 school demographic variables.

THE HIERARCHICAL FACTORS

Only the orthogonally rotated loadings for four factors in the 79 $\times$ 79 matrix are reported. These appear in Table 2. Although this matrix contained five variables not used in the preliminary analyses, the factors are the same as those obtained in the preliminary work. Noteworthy is the size of the contribution to variance of the factor we have labelled "g" as compared to the contributions to variance of the three group factors. Also noteworthy is the high degree of similarity between the factors for males and females. Minor differences will be discussed when individual factors are described.

We have identified the very large factor as Spearman's "g" even though some of the test means have near zero loadings. The highly speeded clerical tests (57, 58, 59), which were scored by counting the number of correct responses, are essentially uncorrelated with the general factor in intelligence. Other data suggest that a correction for incorrect answers would produce positive loadings. Hunting (30) for males and both Hunting and Fishing (31) for females also have loadings that are quite small, but reported reliabilities (Shaycoft, 1967) are only moderate for boys and essentially zero for girls. The obtained, fallible scores on these tests are only slightly correlated with the selective mechanisms that produce the major differences among school means on the vast majority of these cognitive measures. Vocabulary (2) and Reading Comprehension (47) have the highest loadings on "g." A number of measures on which one expects to find sex differences in means also have general factor loadings differing in size. Among these are Physics (7) and Biological Science (8) which have higher loadings for males, and Colors (28) and Etiquette (29) which have higher loadings for females.

It is possible that the present general factor is somewhat biased by the selection of the test variables and the characteristics of the Varimax program. That is, given the large number of highly verbal information tests the general factor may be more verbal than it would have been in a different selection of tests. While the relatively large loadings of Abstract Reasoning (52) and Arithmetic Reasoning (53) are reassuring, an unbiased general factor might have had somewhat larger loadings for these measures.

The mean score on the socio-economic index (60) is a better measure of the family's status than any of the school variables, although many of the latter are related to the social situation of the family. The loading on "g" of the former variable is moderately high, but well below the loadings of most of the cognitive measures. School variables, with the exception of the four in the table described by footnotes, were coded so that large numerical values were coded high and small values low. Thus Rate of College Going (79)

2. We must also conclude that the parallel analysis criterion overestimated the number of meaningful factors in these data. One of the matrices investigated by Humphreys and Montanelli (1975) contained seven major group factors plus a large number of very small, overlapping, nonerror factors (the simulation matrix). Under these conditions the criterion consistently indicated that more than seven factors should be retained. A similar factor structure may underlie the intercorrelations of the means of cognitive measures.

Table 2

Orthogonal Factor Loadings of Cognitive Tests and School Variables

	Variable	"g" M	"g" F	I M	I F	II M	II F	III M	III F
1	Screening	77	71	+27	+20	19	19	-06	+13
2	Vocabulary	96	95	+01	-03	04	02	-09	-06
3	Literature	90	86	-20	-24	04	02	+01	-04
4	Music	83	86	-34	-19	-01	00	-05	-19
5	Social Studies	92	90	-01	-04	05	03	-05	-06
6	Mathematics	89	81	-12	-14	-04	-03	+03	+01
7	Physical Sciences	88	77	+06	-14	01	-07	-15	-07
8	Biological Sciences	78	68	+24	+21	03	-02	+04	+10
9	Scientific Attitude	87	87	+15	+09	07	04	-06	+01
10	Aeronautics	84	67	-08	-12	-04	-03	-19	-11
11	Electronics	82	70	+02	+16	-01	02	-31	-15
12	Mechanics	79	72	+43	+46	06	03	-26	-04
13	Farming	51	64	+76	+62	07	03	-03	+19
14	Home Economics	75	75	+11	+39	-04	-01	-17	-07
15	Sports	87	79	+06	+21	02	-12	-02	+01
16	Art	87	86	-27	-27	05	06	-08	-16
17	Law	86	73	+03	-01	07	02	+09	+10
18	Health	87	84	+01	+08	07	11	-07	-06
19	Engineering	84	75	+14	+27	05	-03	-17	-07
20	Architecture	79	69	-03	+02	-03	01	-03	-00
21	Journalism	83	79	-22	-14	03	06	-00	-12
22	Foreign Travel	81	78	-27	-23	03	-03	-11	-16
23	Military	72	60	-26	-12	05	-01	+01	-01
24	Accounting and Business	88	82	-04	-12	06	07	-03	-05
25	Practical Knowledge	84	81	-07	-06	07	04	-10	-10
26	Clerical	65	67	+18	+09	05	13	-12	-22
27	Bible	66	58	+11	+13	15	10	+29	+42
28	Colors	50	72	-16	-12	05	06	-05	-17
29	Etiquette	66	72	+08	+14	09	-01	-09	-01
30	Hunting	25	17	+77	+42	09	01	-04	+15
31	Fishing	42	08	+48	+14	14	-02	+03	+17
32	Outdoor Activities	89	86	+17	+12	02	-04	-10	+01
33	Photography	81	78	-03	+07	07	16	-09	-00
34	Games (sedentary)	76	72	-32	-18	02	06	-05	-15
35	Theater and Ballet	87	85	-28	-27	03	02	-01	-18
36	Foods	59	67	-53	-36	-12	-04	-01	-29
37	Miscellaneous	87	84	-21	-13	01	00	-07	-11
38	Memory for Sentences	37	48	+17	+06	28	34	+09	+22
39	Memory for Words	66	74	-00	-02	22	23	+11	+05
40	Disguised Words	83	80	-20	-18	29	33	-01	-16
41	Spelling	81	81	-00	-00	09	15	+11	+06
42	Capitalization	80	83	+21	+14	13	13	+07	+09
43	Punctuation	91	90	+12	+04	08	06	+09	+15
44	English Usage	85	84	+09	-02	08	09	+15	+15
45	Effective Expression	82	79	+03	-01	00	05	+07	+02
46	Words Functions	82	82	+07	-00	02	03	+24	+25
47	Reading Comprehension	95	96	-00	-01	03	04	+02	+01
48	Creativity	88	85	+06	+04	06	12	-12	-10
49	Mechanical Reasoning	82	85	+31	+17	11	04	-31	-13

Table 2 (continued)

	Variable	"g" M	"g" F	I M	I F	II M	II F	III M	III F
50	Visualization Two Dimensions	66	69	+11	+09	26	30	-27	-05
51	Visualization Three Dimensions	77	78	+09	+18	09	14	-29	-12
52	Abstract Reasoning	85	88	-00	+04	00	05	-26	-15
53	Arithmetic Reasoning	90	89	+18	+10	03	02	-04	+04
54	Introductory Mathmatics	87	84	+05	+02	04	02	+05	+14
55	Advanced Mathematics	69	54	-12	-07	-08	-08	+02	-10
56	Arithmetic Computation	66	70	+26	+22	39	27	+04	+16
57	Table Reading	16	13	-11	-12	76	75	+06	+01
58	Clerical Checking	-02	-06	-24	-26	75	71	+11	-07
59	Object Inspection	18	28	-22	-16	76	75	-07	-06
60	Socio-economic Status	76	77	-26	-30	-10	-11	-07	-19
61	No. of Grades in School[a]	18	19	-53	-51	06	05	-09	-17
62	Days in School Year	10	08	-57	-46	-03	01	-25	-42
63	Class Size, Science & Math	-12	-18	-61	-68	19	13	+16	+03
64	Class Size, Other	-05	-10	-31	-35	15	10	+13	+05
65	Hours Homework	16	10	-27	-34	00	01	+24	+06
66	Study Halls	11	10	+27	+16	-06	-05	+11	+14
67	Absentee Rate	-36	-36	-39	-30	10	11	-09	-22
68	Books in Library	23	22	-47	-52	07	03	-07	-08
69	Age of Building	10	11	+05	+12	-01	06	-17	-14
70	Ability Grouping[b]	-15	-14	+52	+52	04	04	+10	+26
71	Starting Salaries	31	35	-41	-18	-11	-01	-59	-70
72	Teaching Experience	03	-01	-37	-42	09	04	+11	+07
73	Senior Class Size	15	08	-77	-71	11	13	-09	-37
74	Delinquency Rate	-10	00	-18	-07	02	01	-39	-28
75	Housing Quality[c]	-34	-38	-32	-20	-05	-02	-02	-18
76	Guidance Program[d]	21	20	-33	-33	-02	-03	-17	-20
77	Drop-out rate, Boys	-29	-26	-40	-28	08	08	-20	-18
78	Expenditures per Pupil	19	23	-32	-06	-15	-04	-52	-67
79	Rate of College Going	41	35	-24	-28	-06	-04	+12	-01
	Variance	36.53	34.42	6.72	5.08	2.56	2.71	2.09	2.42

[a]Small number of grades coded high
[b]Absence coded high
[c]Low quality coded high
[d]Presence coded high

has a moderate positive loading on the general factor. Starting Salaries (71) has a small positive loading while Absentee Rate (67) and Drop Out Rate (77) have small negative loadings. Housing Quality (75) in which the direction of coding reversed the expected direction also has a moderate negative loading.

The near zero loadings of some of the school variables are also noteworthy. The Number of Days in the School Year (62), Class Size (63 and 64), Homework Expected

(65), Presence of Study Halls (66), Number of Books in the Library (68), Age of Building (69), and Experience of Teachers (72) all have loadings close to zero. Per Pupil Expenditure (78) is only slightly related to the general factor. Within the limits of variation found in the United States in 1960, these variables are clearly not causes of the across-the-board differences in test scores. To the extent that some or all were used in a compensatory fashion, they may have reduced somewhat the size of those differences.

Certain features of the present analysis can be compared with factor analyses of these and similar variables measuring individual differences. Shaycoft (1967) analyzed 48 cognitive measures from Project TALENT along with the same measure of socio-economic status. The data were from a longitudinal study including the 9th and the 12th grades. The SES measure had a relatively low communality, .38 for males and .44 for females in 18 factors. Its communality in the present analysis is also low relative to the cognitive tests. The social selection responsible for the differences among school means has increased communalities for all variables, but has not operated primarily on the SES index.

Shaycoft presented orthogonal factors only, so that a comparison of general factor loadings of these same cognitive and socio-economic measures is not possible. The maximum general factor loading for SES would be the square root of its communality which is an unrealistic estimate in the light of its numerous negative group factor loadings, including some not trivial in size, in the Shaycoft analysis. The expected general factor loading following hierarchical rotation of the Vocabulary test would be substantially higher than that for SES. A reasonable inference from the data of Atkin et al. (1977) is that the size of this loading would be .8 as a maximum. This figure is based on the factor loadings of the highly reliable Verbal Aptitude score from the School and College Ability Test at four grade levels in the rotations most similar to the present Varimax rotations. If the SES general factor loading were as low as .40, the correlation of about .40 between the Vocabulary Test and the SES index would have to be described by the addition of secondary loadings on the group verbal factor. A general factor loading in the neighborhood of .50 for SES seems more probable. This would allow for combinations of small positive and negative loadings for the Vocabulary test and SES, respectively, on factors other than the verbal one.

The part correlations between SES and "g," in which the variances of Vocabulary and Reading Comprehension are alternately controlled in SES but not in "g," are of trivial size in both the sexes in the group means analysis. The largest of these correlations is .14 for boys when Reading Comprehension is controlled and the smallest is .07 for boys also when Vocabulary is controlled. If we make similar computations based on the best guesses concerning general factor loadings in individual student analyses, the assumption of a .40 general factor loading for SES leads to a partial correlation of .15 while the assumption of .50 produces a partial of .33. One must assume a general factor loading of less than .40 in individual differences data in order for the partial correlation between SES and the general factor to shrink beneath those for the school data. Such analyses increase the strength of the case against primary selection on the social status of families. It also follows that it is difficult to make a case for socio-economic causation for the general factor.

Group Factor I apparently distinguishes rural and small town schools from urban schools. Tests that appear on the factor and are common to both sexes are Mechanical (12), Farming (13), and Hunting (30) information. The girls add Home (14) information and the boys add Fishing (31) information. Screening (1), a low level vocabulary test, also has a small loading. Foods (36), which is quite cosmopolitan in content, has a substantial negative loading, and there are numerous smaller negative loadings which are associated with large urban schools. Loadings of the school variables are very informative, but are best described by the variable after reflection. A negative sign is placed before the variable number in these cases. High means on the tests having positive loadings accompany schools having many grades, (−61) a short school year (−62), small class size (−63, −64) little homework (−65), low absentee rate (−67), few books in library (−68), little ability grouping (70), inexperienced teachers (−72), small senior class, (−73) no guidance program (−76), low drop-out rate (−77), and below average rate of college going (−79).

This school means factor is similar to factors that were described in Shaycoft's analysis of Project TALENT tests based upon individuals. She inserted multiple correlations (unsquared) in the principal diagonal of a 99 × 99 matrix, which included measure of socio-economic status of the family in addition to the test-retest data on the 49 tests. Eighteen factors were rotated orthogonally, but a number included specific variance only. Eight common factors were described in the 9th grade measures of which one was designated Rural and a second Hunting and Fishing. A plot of the two, however, reveals a good deal of similarity. We have factor analyzed the same 9th grade intercorrelations using squared multiples in the diagonal of the matrix.[3] This change avoided the problem of specific factors. We believe that seven factors can be supported. Six are identical to those published by Shaycoft while the seventh merges her Rural, and Hunting and Fishing, factors. This factor is not, of course, one of Thurstone's primaries, and few psychologists would be willing to add it to a list so designated, yet it appears as a dimension of both individual and school differences and thus may be more important socially than so called primary factors.

Group Factor II is defined solely by the cognitive variables. The three highly speeded clerical tests (57, 58, and 59), have by far the highest loadings on the factor. Visualization in Two Dimensions (50) and Arithmetic Computations (56), both also speeded, have small to moderate loadings. Somewhat related also are the two Rote Memory tests (38 and 39) and Disguised Words (40) which contain elements of fluency. A very different type of test with a similar small loading is Screening (1), a very easy vocabulary test.

The measures high in this factor also regularly define a factor in analyses of data from individuals. Clerical Speed would be a common name. It is not as easy to identify, however, when defined by school means and by the mix of tests described above. If it were a specialized commercial high school factor, one would expected to find some of the information tests appearing on it. Accounting (24), Practical Knowledge (25), and Clerical (26) information are these possibilities, but they have near zero loadings.

There is a basis for looking in a very different direction for the identification of this

3. This analysis by Humphreys and Parsons is unpublished. The number of factors decision was a difficult one due at least in part to the fact that the size of the several independent samples on which various subgroups of correlations were based varied from one subset to another. Varimax rotation of nine factors resulted in seven meaningful factors of reasonable size and two factors contributing minimal variance. Among the rotated factors were ones that could be labelled verbal comprehension, spatial visualization, and quantitative ability. The sampling which was essential to the conduct of the research, discouraged us from any attempt to factor in the second order and define a general factor.

factor. While almost all of the Project TALENT tests show substantial race differences, the tests that appear on this factor produce the smallest differences. As a matter of fact, blacks equal or exceed whites in the number of attempts on the three tests which have the highest loadings (Humphreys, Lin, & Fleishman, 1976). For purposes of computing school means these tests were scored by counting the number of correct responses. While a formula score which penalized errors produces large race differences, the number correct reduces those differences because of the influence of the number of attempts. That this factor might represent largely black high schools is a reasonable hypothesis. The small loadings of the rote memory tests and the easy vocabulary test are in line with this interpretation. The personal characteristics which produced large numbers of attempts may also affect performance on Disguised Words. Absence from this factor of school variables is congruent with the data in the Coleman (1966) report.

Attempts have been made to describe group Factor III both with the signs of the loadings as presented in the table and with signs reflected. The more compelling interpretation is based on the former in spite of the small number of positive loadings, but if the demographic variables are again reflected there are a larger number of positive loadings to use in interpreting this factor. It may characterize traditional church-related schools. Bible information (27) accompanies a short school year (−60), low starting salaries (−68), low rate of juvenile delinquency (−71), and low expenditures per pupil (−74). Being traditional these schools omit from their curricula experiences which are assessed by spatial and mechanical tests for boys and information about exotic foods for girls. The opposite end of this dimension, which is more clearly defined by the reflection mentioned above, would presumably represent urban technical schools on which spatial and mechanical tests for boys and information about foods for girls would have nonzero positive loadings. Since the loadings of the tests are small, this interpretation requires that level on the general factor be more important for enrollment in technical schools than the profile of abilities important in technical education. School authorities frequently shunt students into technical curricula on no other grounds than failure in the academic curriculum.

IMPLICATIONS OF THE FINDINGS

Means of cognitive tests not only vary widely from one high school to another, but the predominant tendency is for the differences to be consistent in size, within limits set by differences in reliability, for most tests. Selection is almost entirely on the general factor in human abilities and not on group or so-called primary factors. Furthermore, socio-economic status of the families is not in itself a major cause of the differences among schools, but it does accompany the school differences.

What are some of the more potent causes for the general factor differences among schools? There is no direct evidence in our data, but other information can be brought to bear on the issue. Differences in the proportional representation in the schools of several different minority groups, of whom black students would be the most numerous, would contribute to general factor differences. Area differences, to which the South would make the major contribution, and rural-urban differences would also produce general factor differences. All of these demographic variables are correlated with socio-economic status, however, so that any additional increment would be small.

On the assumption that the variables just discussed probably do not completely account for the phenomenon, it would be worthwhile to look further afield. Are some grade schools, from which the high school draws its students, more effective schools?[4] Are high test scores the only objective signs of these hypothetical differences in effectiveness? Do intelligent parents who are ambitious for their children choose to live where they can send their children to these effective schools? Is this ambition and willingness to move only moderately related to objective indices of socio-economic status? Are there population genetic differences among the areas served by high schools that are not revealed by a measure of social status? It is at least a very reasonable hypothesis that the mean intelligence level of the parents would be more highly correlated with the general factor than the mean index of socioeconomic status. These questions have no answers at present, but we are relatively certain that there is no simple social factor which explains the large, consistent, across-the-board differences among school means of cognitive variables. Somehow the whole social fabric is selective with respect to the general in human cognitive abilities.

Since social selection is primarily on the general factor in the "assignment" of children to high schools, it follows that this fact constitutes additional evidence for the importance of the general factor in human affairs. In drawing this conclusion there is no necessary implication that "g" is a thing or an entity. Acceptance of the evidence for Spearman's "g" does not require acceptance of Spearman's explanation, mental energy, or any other explanation that suggests a unitary something underlying the behavioral phenomena. Thomson's multiple bonds approach is much more acceptable. The present senior author in his Thomsonian description of the nature of the general factor (Humphreys, 1974) coined two terms to accompany *polygenic* which furnish a thumbnail characterization of this point of view. Intelligence, to the extent that it is heritable, generally is acknowledged to be *polygenic,* but it is also characterized as being *polyneural* anatomically and *polybehavioral* in its manifestations in performance. Since there is general acknowledgment that intelligence is to some extent environmentally determined, it is useful to add a fourth term to the list. The causes of intelligence are also *polyenvironmental,* and these causes may have multiple neural effects and be manifest in the same multiple ways behaviorally as the genetic ones.

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4. Possible quality differences among high schools are disregarded for two reasons. For one thing we have 10th grade data only. For another there is precious little evidence for differential gain from school to school as measured by the Project TALENT tests between grades 9 and 12. While Shaycoft (1967) concluded that small differential gains had been demonstrated, her conclusion was based on analyses of covariance. Fallible covariates do not control adequately for initial differences in abilities when selection is on an unmeasured variable. Analyses of raw gains (Humphreys and Park, currently being prepared for possible publication) show little evidence for differential gain from school to school.

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AUTHORS

HUMPHREYS, LLOYD G. *Address:* Department of Psychology, University of Illinois, Champaign, Illinois 61820. *Title:* Professor of Education and Psychology. *Degrees:* B.S. University of Oregon, M.A. Indiana University, Ph.D. Stanford University. *Specialization: Psychological and Educational Measurement.*

PARSONS, CHARLES K. *Address: Department of Psychology, University of Illinois, Champaign, Illinois 61820. Title:* Research Assistant. *Degrees:* B.A. University of Minnesota, M.A. University of Illinois. *Specialization:* Psychometric Theory.

PARK, RANDOLPH K. *Address:* Department of Psychology, University of Illinois, Champaign, Illinois 61820. *Title:* Graduate Student. *Degrees:* B.A. California State University, Long Beach.