PATTERNS OF MENTAL ABILITY AND SOCIOECONOMIC STATUS

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In a society that supports universal public education and allows a high degree of social and occupational mobility, a positive correlation is inevitable between socioeconomic status (SES) and intelligence. (The term *intelligence* is used here to mean those abilities primarily associated with scholastic aptitude.)

Also, because there is a high correlation (of the order of 0.8–0.9) between phenotype and genotype for intelligence as measured by tests such as the Stanford-Binet,[1, 2] it is inevitable that SES differences in intelligence are due largely to genetic factors.

In reviewing the relevant evidence, the British geneticist C. O. Carter remarked, "Sociologists who doubt this show more ingenuity than judgment."[3] The conclusion that SES intellectual differences have a major genetic component and are not entirely attributable to environmental differences across SES is now practically beyond dispute among scientists who have studied the relevant evidence. The facts of the matter, which have been reviewed in detail elsewhere,[4–8] come from a variety of sources. For example, identical twins separated in the first year of life and reared in widely differing social classes still show greater resemblance in intelligence than unrelated children reared together;[9] the IQ's of children adopted in early infancy show a much lower correlation with the SES of the adopting parents than do the IQ's of children reared by their own parents;[10] the IQ's of children reared in an orphanage from infancy and who have not known their parents show approximately the same correlation with their true fathers' occupational status as that found for children reared by their own parents (0.23 vs. 0.24);[11] the correlation between the IQ's of children adopted in infancy and the education of their true mothers is close to that of children reared by their own mothers (0.44), while the correlation between children and their adopting parents is close to zero;[12] children of low and high SES show on the average an amount of regression from the parental IQ toward the mean of the general population that is precisely predicted by a polygenic model;[6] when full siblings, who have on the average at least 50 per cent of their genetic inheritance in common, differ significantly in intelligence, those who are above the family average tend to move up the SES scale and those who are below the family average tend to move down.[13]

It is noteworthy that intensive efforts by psychologists, educators, and sociologists to devise "culture-free" or "culture-fair" tests that would eliminate SES differences in measured intelligence have not succeeded.[14, 15] There are no standard intelligence tests known which eliminate SES differences. The present paper attempts to throw a new light on the nature of SES differences in intelligence.

Problem and Method.—The research was initially stimulated by the puzzling observation made by many teachers and by the present writer that low-SES children with IQ's in the range 60 to 80 appear to be much brighter socially, on the playground, and in other nonscholastic types of behavior than their middle- or upper-middle-SES counterparts whose IQ's fall in the same range. The question was whether we could devise tests that would measure the apparent difference in adaptability and basic learning capacity between low- and middle-SES children, all of similar low IQ.

Learning tests and intelligence tests: Since most standard intelligence tests contain items intended to assess how much the individual has learned in his natural environment, a more direct and relatively culture-free index of intelligence might be the rate or amount of learning in a novel laboratory task. We have tried this approach with children from 4 to 12 years of age, from widely differing SES groups as determined from father's occupation and neighborhood of residence, and from different ethnic backgrounds—Caucasian, Mexican-American, and Negro. The standard intelligence tests used were the Stanford-Binet, Kuhlman-Anderson, Raven's Colored Progressive Matrices (children's form), and the Peabody Picture Vocabulary Test (PPVT). The learning tests were rote-learning tasks administered under a variety of procedures: free recall of briefly presented sets of familiar objects or colored geometric forms, serial learning and paired-associate learning with pictures of familiar objects, and short-term memory for series of digits.

Results.—The results from a variety of subjects and a battery of tests show a consistent interaction of intelligence, learning ability, and socioeconomic status. The consistency permits a broad summarization, the essential features of which are shown in Figure 1. The low-SES groups in the studies summarized in Figure 1 have been either white,[16] Mexican-American,[17] or Negro[18] children. The findings are essentially the same regardless of race, though it should be noted that in selecting groups of children who are high or low on SES and above or below average in IQ, our samples represent different proportions of each racial population. The groups labeled high-SES were white middle- or upper-middle-class children.

As shown in Figure 1, there is a strong interaction between SES, IQ, and learning ability of the type measured by tasks of free recall, serial learning, paired-

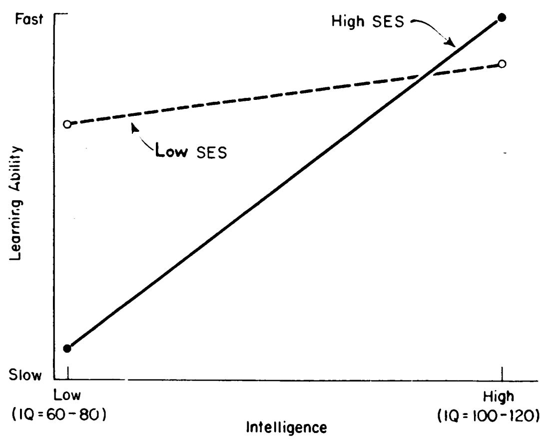

FIG. 1.—Summary graph of a number of studies showing the relationship between learning ability (free recall, serial and paired-associate learning, and digit span) and IQ as a function of socioeconomic status (SES).

associate learning, and memory for digit series. In short, low-SES children in the IQ range from 60 to 80 perform markedly better in these learning tasks than do middle-SES children in the same range of IQ. On the other hand, low-SES children who are above average in IQ do not show learning performance that is significantly different from the performance of middle-class children of the same IQ.

Correlations between learning and intelligence measures: We find substantial correlations between our learning tests and IQ or MA (mental age) in middle-class children, but practically negligible correlations in the low-SES groups. This difference in correlations is not attributable to SES differences in the reliability of the tests or in the "range-of-talent" (heterogeneity) of the test scores.

In a study[16] of white children, ages 8 to 13, the average correlation (Pearson r) between an IQ test (PPVT) and serial and paired-associate learning tasks was 0.44 for the middle-SES ($N = 40$) and 0.14 for the low-SES group ($N = 40$). (Corrected for attenuation, these correlations are 0.60 and 0.19, respectively.)

Preschool children, ages 4 to 6, were tested on the Peabody Picture Vocabulary Test and on paired-associate (PA) learning. The correlation between mental age and learning scores (with chronological age partialed out) was 0.10 in the low-SES group ($N = 100$) and 0.51 in the middle-SES group ($N = 100$).[19] In this study the low-SES children were Negro; the middle-SES children were white. Although these groups differed in IQ by 18 points, they showed no significant difference in PA learning ability. In serial learning the correlations with mental age (chronological age partialed out) were 0.10 for the low and 0.36 for middle SES. The groups did not differ significantly in serial learning. The multiple correlation between PPVT mental age and 14 variables (one serial learning test, four paired-associate tests, eight digit series of two to nine digits, and chronological age) was 0.54 in the low-SES group and 0.71 in the middle-SES group.

Digit span tests: Of all the learning and memory tests we have tried so far, memory for digit series produces the most clear-cut results. Groups from low and middle SES differ less on digit span than on any of the other learning measures. Digit span is also a good measure of intelligence. Digit span tests form a part of the well-known Stanford-Binet and Wechsler intelligence scales. At age 2.5 years the digit span test correlates 0.75 (corrected for attenuation) with Stanford-Binet IQ in the normative population.[20] Digit span also correlates 0.75 (corrected for attenuation) with adult Wechsler IQ in the normative population, and in a factor analysis of the subscales of the Wechsler Adult Intelligence Scale, digit span correlates 0.80 with the general intelligence factor common to all the subtests.[21]

In view of these facts, it is most interesting that digit span, like paired-associate and serial learning, shows only meager correlations with intelligence in the lower-class population. It was thought at first that the reason for the low correlation between digit span and IQ in low-SES groups was that the standard intelligence tests were more culturally biased than the digit span test. That explanation now seems inadequate to account for our findings, for the differential with respect to SES was enhanced by the use of one of the least culturally biased of all standardized intelligence tests—Raven's *Progressive Matrices*. This nonverbal test contains none of the cultural or scholastic-type material found in other IQ tests, but we have found that it yields greater differences between low- and middle-SES groups than any other intelligence test that we have used in our research. In a study of children from grades 4 to 6 in an all-Negro school in a low-SES neighborhood and an all-white school in an upper-middle-class suburban neighborhood, the nonparametric correlation (phi coefficient) between digit span and Progressive Matrices IQ was 0.33 for the low SES ($N = 60$) and 0.73 for the upper-middle SES ($N = 60$). The importance of this finding lies in the *difference* between these correlations rather than in their absolute magnitudes, since they are based on extreme groups and thus are not to be regarded as estimates of population parameters.

Some idea of the magnitude of discrepancy between digit-span ability and Progressive Matrices performance as a function of SES can be obtained by comparing the 30 *lowest*-scoring children on digit span in a white suburban school (the lower 6.1% of children in grades 4, 5, and 6) with the 30 *highest*-scoring children on digit span in a Negro ghetto school (the upper 7.9% of grades 4, 5, and 6). The mean digit span test scores (expressed as percent of maximum possible score) were 65.3 for the ghetto group and 38.7 for the suburban group. The corresponding Progressive Matrices scores (again expressed as per cent of maximum possible score) were 64.7 and 72.6, respectively.

SES differences within digit span performance: There is some indication that low- and high-SES children encode the digit series by different mental processes, even though they differ little if at all in their capacity to recall a series of spoken digits. Evidence for different encoding processes emerges when digit recall is scored in different ways.

There are numerous ways to score a digit series. We have used three methods: (a) *span,* the longest series recalled perfectly on 50 per cent of trials (the measure used in the Binet and Wechsler tests); (b) *position,* the number of digits recalled in the correct absolute position; (c) *sequence,* the number of digits correct in adjacent sequence, regardless of absolute position.

Table 1 compares the digit recall of children from low- and upper-middle-class backgrounds. The low-SES children were predominantly Negro; in all cases the parents were receiving assistance from public welfare. The upper-middle SES was made up of white children in private nursery schools. The mean ages were 52 months for the low and 50 months for the high SES, and all the children were between 3 and 5 years of age. The intercorrelations between all the variables shown in Table 1 (plus 16 other variables not directly relevant to the present discussion) were factor-analyzed;[22] only the factor identified as "intelligence" is shown in Table 1.

First of all, we see in Table 1 that although the low- and high-SES groups differ in mental age by 16 months (equivalent to an IQ difference of 19 points), they show no appreciable differences in means or standard deviations in the digit memory tests, scored either by position or by sequence.

The loadings on the "intelligence" factor (so identified because it was the only factor on which PPVT mental age had a significant loading) indicate that digit span performance involves different mental processes or patterns of ability in the

TABLE 1. *Means, standard deviations, and correlations with intelligence factor in low*

Variable	Mean			
	Low-SES		High-SES	
Mental age (mos.)	48.41		64.46	
Binet digit span	3.72		3.63	
Wechsler Intelligence Scales digit span	3.99		4.12	
	Pos.	Seq.	Pos.	Seq.
Digit series 2	1.99	1.99	1.99	1.99
3	2.82	2.85	2.88	2.91
4	3.06	3.20	3.02	3.13
5	2.00	2.46	1.83	2.42
6	1.02	2.01	1.05	1.95
7	0.54	1.53	0.56	1.63
8	0.41	1.66	0.38	1.46
9	0.26	1.71	0.28	1.71

* N = 100 in each group.

two SES groups. Note that digit span has very substantial loadings on the intelligence factor in the high-SES group and that the loadings are highest in the region of the subjects' average memory span (four to five digits). There are no comparable loadings on the corresponding variables for the low-SES group. The low-SES group, however, shows significant loadings on the intelligence factor for digit series that greatly exceed their memory span and only for sequence scoring. We know that when the number of digits presented exceeds the subject's memory span, he resorts to a simpler strategy of merely associating adjacent digits with little regard to absolute position or other relations within the series. A similar change in the encoding process shows up when university students are presented with supraspan series of 12 to 15 digits.[23] This particular form of associative learning by the low-SES group is the only component of digit recall that has any significant correlation with the group's intelligence test performance, and since this component has no appreciable relationship with the intelligence factor in the high-SES group, the intelligence test seems to be measuring different mental processes in the two groups. Table 2 shows the correlations between position and sequence scores for high and low SES. Note that the correlations diminish rapidly in the digit series that exceed the subjects' average memory span, and that the decrease is much more pronounced in the low-SES group. The SES differences in correlations for series lengths of seven, eight, and nine digits are all significant beyond the 0.05 level.

Discussion.—The scatter diagrams for the correlations between associative learning tests and intelligence tests in low- and middle-SES groups suggest a hypothesis that may account for the observed phenomena.

Figure 2 illustrates schematically the forms of the scatter diagrams generally found for the two SES groups when both the learning and intelligence test distributions are cut at the common mean. The asymmetrical form of the scatter diagram for the low-SES group suggests a hierarchical arrangement of mental abilities. The scatter plot is consistent with the hypothesis that the associative learning abilities measured by our tests, which we shall label Level I, are necessary but not sufficient for the development of the abilities measured by standard intelligence tests, which we shall label Level II. If a child is poor on Level I, it *and high socioeconomic groups.**

Standard Deviation		Factor Loadings	
Low-SES	High-SES	Low-SES	High-SES
22.67	19.16	0.504	0.512
1.05	1.07	.047	0.482
1.02	1.12	0.073	0.613

Pos.	Seq.	Pos.	Seq.	Pos.	Seq.	Pos.	Seq.
0.05	0.05	0.09	0.05	0.032	0.032	0.023	0.023
0.40	0.31	0.38	0.29	0.138	0.181	0.214	0.210
1.13	0.88	1.15	0.95	0.023	0.010	*0.877*	*0.870*
1.32	0.98	1.58	1.21	0.157	0.156	*0.563*	*0.511*
1.03	0.83	1.03	0.90	0.340	0.478	0.372	0.273
0.65	0.63	0.84	0.88	0.325	*0.534*	0.072	0.017
0.49	0.71	0.60	0.65	0.138	*0.698*	0.057	0.020
0.37	0.83	0.49	0.91	0.148	*0.760*	0.133	0.194

appears unlikely that he will excel on Level II, but excelling on Level I does not ensure high performance on Level II unless certain other conditions exist. It is on the nature of these other conditions that research must focus if we are to understand the educational problems of children called culturally disadvantaged.

Apparently the associative functions of Level I are not significantly affected by cultural deprivation as this term is usually defined, for the abilities of Level I are distributed in about the same way among children of low and middle SES.

The relative importance of hereditary and environmental factors for Level II processes is still obscure, although the high heritability for tests like the Progressive Matrices and other good measures of abstract intelligence suggest that Level II functions have a genetic basis as well as being influenced by environmental factors. In brief, it seems unlikely that Level II abilities develop solely out of the interaction between Level I abilities and environmental influences.

A theoretical formulation: A tentative theory is proposed to account for the empirical findings and to give direction to further research.

The theory states that the continuum of ability to perform on tests, ranging from simple associative learning to conceptual problem solving, is the phenotypic[24] expression of two functionally dependent but genotypically independent types of mental processes, which may be labeled Level I and Level II. Level I processes are essentially associative and are best measured by tests such as digit span and serial rote learning; Level II processes involve transformations or complex operations performed on the stimulus input and are perhaps best represented in tests such as the Progressive Matrices and Cattell's Culture-Fair Tests. The biological or structural basis of Level I and Level II are seen as independent but functionally related in such a way that the growth rate and the asymptote of the child's performance on Level II depend upon his status on Level I. For

TABLE 2. *Correlation between position and sequence scoring of digit series test.*

	Series Length							
	2	3	4	5	6	7	8	9
SES								
High	1.00	0.98	0.93	0.93	0.85	0.60	0.47	0.39
Low	1.00	0.95	0.91	0.90	0.83	0.29	0.16	−0.01

example, short-term memory is necessary for solving Progressive Matrices, but the covert mental processes of generalization, abstraction, and symbolic mediation needed for the Matrices are not needed for digit memory.

The theory also states that Level I and Level II abilities are distributed differently in upper and lower socioeconomic classes. Level I is distributed approximately the same in all SES groups, whereas Level II is distributed about a higher mean in the upper classes than in the lower. This hypothesis is illustrated in Figure 3.

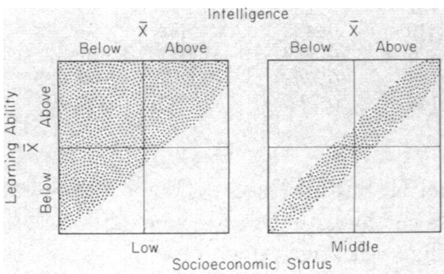

FIG. 2.—Schematic illustration of the essential form of the correlation scatter-diagram for the relationship between associative learning ability and IQ in low-SES and upper-middle-SES groups.

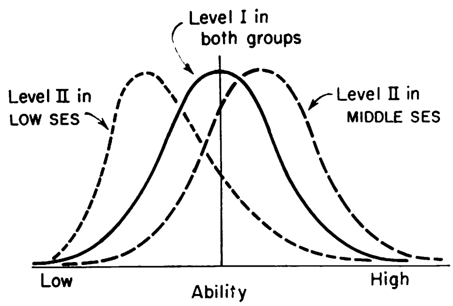

FIG. 3.—Hypothetical distributions of Level I (*solid line*) and Level II (*dashed line*) abilities in middle-class and culturally disadvantaged populations.

To summarize, the empirical findings are understandable in terms of three hypotheses: (*a*) the genotypic independence of the processes called Level I and Level II, (*b*) the functional dependence of Level II upon Level I, and (*c*) the differential distribution of Level I and Level II genotypes in upper and lower social classes, as shown in Figure 3.

The findings are important in several ways: they help to localize the nature of the intellectual deficit of children called disadvantaged; they bring a sharper focus to thinking and research on the nature-nurture problem as it relates to social class and racial differences; they show that to whatever extent environmental deprivation affects mental ability, all abilities are not equally affected; and they emphasize the need for standard tests that cover a broader spectrum of mental abilities than is sampled by current standard tests of intelligence.

Children who are above the general average on Level I abilities but below the average on Level II performance usually appear bright and capable of normal learning and achievement in many situations, although they have inordinate difficulties in school work under the traditional methods of instruction. Many such children who are classed as mentally retarded in school later become socially and economically adequate persons when they leave the academic situation. On the other hand, children who are below average on Level I, and consequently on Level II as well, appear to be much more handicapped in the world of work. One shortcoming of traditional IQ tests is that they make both types of children look much alike. Tests that reliably assess both Level I and Level II are needed in schools, personnel work, and the armed forces. Equally important is the discovery or invention of instructional methods that engage Level I more fully and provide thereby a means of improving the educational attainments of many of the children now called culturally disadvantaged.

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