DOCUMENT RESUME

ED 108 096 CG 009 916

AUTHOR Johnson, Mauritz
TITLE Some Concommitants of Verbal-Quantitative Aptitude Discrepency.
INSTITUTION State Univ. of New York Research Foundation, Albany.
PUB DATE 75
NOTE 66p.

EDRS PRICE MF-$0.76 HC-$3.32 PLUS POSTAGE
DESCRIPTORS *Aptitude Tests; Changing Attitudes; *College Students; *Comparative Analysis; *Mathematics; Research Projects; Student Attitudes; *Verbal Ability
IDENTIFIERS *New York State Regents Scholarship Examination

ABSTRACT

Two samples of undergraduates were selected to represent four types with respect to discrepancy between verbal and quantitative aptitude as measured by the New York Regents Scholarship Examination or, in some cases, the CEEB SAT examination. A group designated as V had extremely high verbal scores and very low quantitative scores; a Q group was at the opposite extreme--high in quantitative, low in verbal aptitude. Two non-discrepant groups were also studied: one, designated H, was very high in both aptitudes; another, designated A, was average in both. Analysis of data indicated that low verbal aptitude in particular was associated with low college grades. Attitudes toward literature and mathematics were clearly related to aptitude discrepancy. Marks in these two subjects began to become disparate as early as elementary school and tended to diverge further through school. School-related factors were more often cited for shifts in attitude toward mathematics than toward literature. In the course of their development, the V- and Q-groups were found to be less like each other than like the H- and A-groups. (Author/PC)

SOME CONCOMITANTS OF VERBAL-QUANTITATIVE APTITUDE DISCREPANCY

by
Mauritz Johnson

State University of New York at Albany
1975

THIS STUDY WAS CONDUCTED WITH THE AID OF A GRANT FROM THE RESEARCH FOUNDATION OF THE STATE UNIVERSITY OF NEW YORK

SOME CONCOMITANTS OF VERBAL-QUANTITATIVE APTITUDE DISCREPANCY

Mauritz Johnson

State University of New York at Albany
1975

Without doubt the most common measure used in educational selection, placement, guidance, and instructional adaptation is some general indicator of scholastic aptitude, whether expressed as an IQ ratio or as some kind of norm-referenced score. Some scholastic aptitude tests are a blend of verbal and quantitative items, and the single score makes no differentiation between these two facets of intellectual ability. Other tests, however, yield verbal (or language) and quantitative (or non-language) sub-scores, which may or may not be combined into an overall index.

The Discrepancy Phenomenon

Verbal and quantitative aptitudes are of course highly correlated, perhaps at about the level of .70. Therefore, for most students there is relatively little discrepancy between them. But for a small proportion of students the discrepancy between V-score and Q-score is very great, in one direction or the other. Ordinarily, when we think of deviant cases, we think of those at the extremes of general intelligence -- the very bright and gifted and the very slow and mentally handicapped. But these deviants on the overall scale

Dr. George J. Posner, now at Cornell University, provided valuable assistance and useful suggestions but bears no responsibility for any errors or misinterpretations in this report.

necessarily have relatively little discrepancy between their V- and Q-scores for the mean of two scores cannot be very high (or very low) unless both scores are very high (or very low). The deviants with which this study concerns itself, however, are those who are highly discrepant with respect to V and Q, and though it may seem odd until one thinks about it, these students classify approximately "average" on the overall ability scale, their high sub-aptitude compensating for their low one.

Yet such highly discrepant individuals must, it would seem, be quite different from the majority of "average" students, whose sub-aptitudes are consistent. If one might use a person's arms as an analogy to the two sub-aptitudes, V and Q, then one could envision some individuals both of whose arms were unusually long, or both unusually short, or both quite normal in length. But then there might also be some with a long right arm and a short left one, or vice versa, and while it may well be that the combined arm length of such a person may be quite average, he surely differs significantly from a person with two equal arms of average length. Although it is quite possible to explain disparity of arm length by suggesting that some factor caused one of them to grow exceptionally long, it seems probable that most people would be inclined toward the explanation that something happened to stunt the growth of one of them and that had not this factor interfered, both arms would have become the length of the longer one. Adding the familiar notion of over-compensation, one might refine the hypothesis slightly by predicting that, under normal conditions, the pair of arms would have attained a length somewhat less than that of the longer one.

To return from the physical analogy to the mental situation, one might suggest that in the case of an individual with great V-Q discrepancy, something occurred genetically, experientially, or both, to stultify one sub-aptitude, and that had this not occurred, the individual would have become fairly V-Q consistent at a level somewhat below that of his higher sub-aptitude. Thus, his overall intellectual aptitude would have been considerably higher than his present "average" status. He may in fact have little in common with non-discrepant individuals of average ability.

Purposes of the Study

The purposes of this study were (1) to test this hypothesis that students with great aptitude discrepancy resemble those with consistently high aptitudes more than those of average aptitudes, (2) to identify factors in the backgrounds of highly discrepant individuals which might have been associated with the emergence of the discrepancy, (3) to determine whether there is a particular time in the life of a child when such discrepancy tends to become noticeable, and (4) to ascertain the effect of the discrepancy on college achievement.

Since very little, if any, attention seems to have been given to the phenomenon of aptitude discrepancy and its etiology, this study must be viewed as an exploratory one in search of clues which might merit closer investigation. Its findings are necessarily suggestive, rather than definitive. The establishment of any cause-effect relations with respect to any promising variables would require further study within an experimental design.

Some Previous Studies of Aptitude Discrepancy

Relatively few researchers have investigated discrepancy between verbal and quantitative aptitude. Nevertheless, on the basis of case studies, Wells (1946) suggested that this variable is important in personality structure, and Munroe (1946) found considerable differences in the Rorschach projections of college students with V-Q aptitude discrepancies. Those with high verbal and low quantitative aptitude (V-discrepant) tended to use "human movement" more in their protocols, whereas their opposites tended to use "form" more. Although Munroe concluded that neither group was better "adjusted" than the other, Altus (1952), in a study of 200 college women, not only confirmed that the Q-discrepant type was more "form-bound and literal," but found further that this group was more anxious, straight-laced, conventional, dysphoric, and immature. The suggested explanation was that having initially not learned to read well, they dutifully continued their educational careers in response to various social pressures, but find little pleasure therein.

Sanders et al. (1960) identified a number of differences both between the two discrepant groups and between these groups and subjects who were high in both aptitudes. Differences were reported for college grades, personality factors, reaction time, and metabolism. The V-discrepant group tended to be more imaginative and autonomous, had less endurance, somewhat faster reaction time, and strikingly lower urine flow, and described themselves as rejecting authority and having an intensional or personal orientation and greater ambivalence. Compared

to non-discrepant students, both of the discrepant groups had somewhat lower college grades, but since the V-group took a higher proportion of verbally-oriented courses and the Q-group took a higher proportion of quantitative courses, their grade point averages were similar.

Numerous studies of correlates with quantitative aptitude have been reviewed by Stafford (1972), providing evidence of both hereditary and environmental influences. Q-aptitude appears to be associated with masculinity, affected by parental attitudes and particularly by absence of father, and unlike vocabulary, subject to deterioration with aging. Stafford's own statistical analysis of data on twins produced a bimodal distribution that suggests a sex-linked hereditary factor, the lack of which sets a limit on the development of Q-aptitude even under the most favorable environmental conditions.

Procedures

The study was conducted over a period of four years. Two samples of students participated, one selected from the classes of 1969-72 at State University of New York at Albany and another from the classes of 1974 and 1975 at that institution.

Each sample included four categories of students: a V group with high verbal aptitude scores and low quantitative scores; a Q group, also discrepant but in the reverse direction; a non-discrepant H group whose verbal and quantitative scores were both high; and an A group, also non-discrepant, with both scores approximately average. Thus, only the H group had a high overall aptitude; the other three groups were all average, the A group being consistently so, the V and Q groups exhibiting great discrepancy between the aptitude components.

The tests on the basis of which the participating students were selected are: (1) the New York State Regents Scholarship Examination (RSE) for the classes of 1968-72 and (2) the College Entrance Examination Board's Scholastic Aptitude Test for the classes of 1974-75. Appropriate cutting points were selected to provide maximum separation of the four groups. (The fifth possible group, those with low scores on both aptitude components, was not included because few, if any, such students are admitted to the university.) Figure 1, based on the first four-class college sample, illustrates the distinctions among the four groups studied.

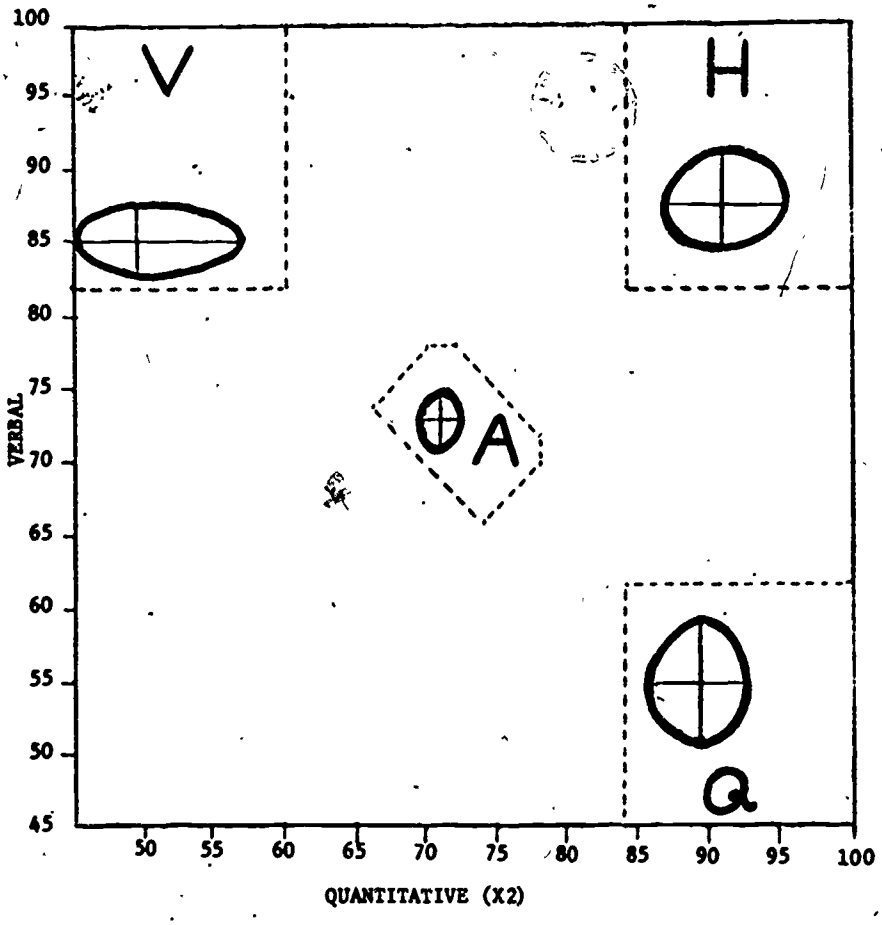

Figure 1. Defined aptitude groups and location of first sample within them.

Somewhat different questionnaires were answered by the two sample groups. The first survey instrument was longer and incl ed open-ended questions about recalled childhood experiences bearing upon respondents' attitudes toward verbal and quantitative activities.

It had been planned to follow up the questionnaire with interviews of a sample of the respondents, but none of them responded that he felt he would have anything further to add that would warrant an interview, and therefore, no interviews were conducted. The responses to the open-ended questions were, in fact, quite thorough and seemed thoughtful, and there may indeed have been little to be gained from time-consuming interviews, considering the exploratory nature of the study.

The second sample was given an instrument in which unpromising items in the original were omitted and no open-ended responses were required.

The college students in the first sample were also asked to authorize their former school principals to supply information on their grades in English and mathematics throughout the elementary and secondary school grades and to furnish the name and address of the principal. (It is interesting to note that a number of them could not even recall his name.) The requests were thereupon mailed to the principals, and while the number of responses was good, their completeness was not. Many schools apparently do not retain records of pupils' performance in the elementary grades, and some schools do not assign any grades other than "S" and "U." Among those who do give norm-referenced grades, the marking system varies, and it was necessary, therefore, to establish a

standard, though arbitrary, conversion system in order to analyze the data. The inaccuracies in this procedure are recognized, although they may not be any greater than the differences in interpretation between schools ostensibly using the same marking system.

Table 1 shows the relative frequency with which students meeting the criteria for the four study groups were to be found in the first university population sampled. Each discrepant group represents less than two per cent of the student body and neither of the non-discrepant groups exceeds greatly five per cent of the total. In all, only 754 students out of more than 6,000 were eligible for participation in the study. The RSE scores which served as selection criteria for the four groups were as follows:

Group	V-score	Q-score	V+Q	V-Q
V	>82	<60*	--	--
Q	<62	>84	--	--
H	>82	>84	--	--
A	--	--	140-150	(-8)-(+8)

*Raw RSE score doubled, since maximum Q-score is 50, whereas maximum V-score is 100.

Table 1
Number and Percent of Students in Each of Four College Classes Meeting Criteria for Groups Studied

Class	Class size	V-group		Q-group		H-group		A-group	
		N	Percent	N	Percent	N	Percent	N	Percent
1969	1344	27	2.0	18	1.3	46	3.4	58	4.3
1970	1504	21	1.4	30	2.0	75	5.0	47	3.1
1971	1504	38	2.5	32	2.1	62	4.1	35	2.3
1972	1755	32	1.8	22	1.3	137	7.8	74	4.9
Total	6107	118	1.9	102	1.7	320	5.2	214	3.5

For the second sample, the cutting scores on the CEEB SAT were:

Group	V-score	Q-score	V+Q	V=Q
V	> 700	< 550		
Q	< 550	> 700		
H	> 700	> 700		
A			> 1230	> 0
			< 1270	< 20

II

Characteristics of Students with Discrepant Aptitudes

True to the cultural stereotype, the V group was predominantly female and the Q-discrepant students were predominantly male. Aptitude discrepancy also proved to be related to college major and grade point average and, as might be expected, to attitude toward literature and mathematics.

Sex and Aptitude Discrepancy

The sex distribution by group is shown in Table 2 for the two samples. The percent of males in the two discrepant groups (V and Q) combined is 46.9, and in the two non-discrepant groups (H and A) it is 40.5, a non-significant difference ($p=.39$). But among all four groups in the combined samples, the Chi square is 54.1, which with df=3 far exceeds the 11.3 associated with .01 probability. There is a significant sex difference among the groups, and it is between the V and Q groups. Females are more likely to be V-discrepant and males, Q-discrepant.

Table 2
Sex Distribution of Respondents, by Sample and Group (in percents)

		Group				
Sample	Sex	V	Q	H	A	Total
First		N=55	N=51	N=63	N=50	N=219
(4 college years)	M	22	75	37	30	40
	F	78	25	63	70	60
Second		N=33	N=36	N=54	N=38	N=161
(2 college years)	M	18	72	56	39	48
	F	82	28	44	61	52
Combined		N=88	N=87	N=117	N=88	N=380
Samples	M	20	74	45	34	43
	F	80	26	55	66	57

Aptitude Discrepancy and College Major

The participating college students were asked to indicate their actual or anticipated major fields of study. All but twelve of the 219 respondents in the first sample listed a major, and all but three of the 161 in the second. Six double majors were reported by the latter group, making the total of responses 164. For analysis, the responses were grouped into five categories: humanities (including arts), mathematics, science (including nursing and medical technology), social science (including history), and business. The two samples differed significantly in their overall distribution of majors, Chi square in Table 3 being 9.66 ($df=4$, $p<.05$).

Table 3
Overall Distribution of College Majors, by Sample

Major	Sample I (1969) (Freshmen-Seniors) N=207	Sample II (1971) (Freshmen-Sophomores) N=164	Combined Samples N=371
Humanities	34	39	36
Mathematics	18	18	18
Science, tech.	15	22	18
Social science	23	17	20
Business	10	4	7

Table 4 reveals that the H-groups in the two samples were remarkably similar with respect to college majors. Compared with the first sample, however, a larger proportion of V-discrepant students in the second sample anticipate a major in the humanities and a smaller proportion in the social sciences; more of the Q-discrepants in the second sample plan on mathematics and science, fewer on business; and among the average students (A), a higher percentage of second-sample

respondents plan to major in humanities and science, and a lower percentage in the social sciences.

There are at least two possible explanations for these differences: (1) a shift in interests occurred in the two years which intervened between the samples or (2) since the second sample consisted only of freshmen and sophomores, their tentative choices are less stable and may later come to resemble more those of the first sample, which included upper classmen.

Table 4
Distribution of College Majors of Four Study Groups in Two Samples (in percents)

	Group							
	V		Q		H		A	
Sample	I	II	I	II	I	II	I	II
	N=51	32	N=49	37	N=62	57	N=45	38
Major								
Humanities	59	75	4	5	34	35	38	47
Mathematics	0	0	41	49	21	19	9	3
Science, tech.	6	13	16	27	19	18	20	32
Social sciences	33	13	10	11	19	25	29	16
Business	2	0	29	8	6	4	4	3

A clue as to which of these explanations is more likely correct is gained by separating the upperclassmen in the first sample from the freshmen and sophomores, as in Table 5. The higher percentage of upperclassmen majoring in business may be attributable to a greater incidence of transfer students in that field. Most of them were Q-discrepant. Aside from business, the only reversal of order is that between sciences and social sciences in the second sample, a tendency which can be noted in Table 4 for all groups except Q.

Table 5
Distribution of College Majors of
Upper- and Lower-Classmen in Two Samples
(in percents)

	1969 Sample (I)		1971 Sample (II)
Major	Upper Classmen N=77	Lower Classmen N=130	Lower Classmen N=164
Humanities	35	31	39
Mathematics	17	18	18
Science, tech.	13	15	22
Social sciences	21	28	17
Business	14	8	4
Total	100	100	100

The differences between the two samples appear, however, to be within, rather than between, two main groupings, (1) humanities - social sciences and (2) mathematics - science - business. In the first sample, 57 per cent were in the first of these categories, compared with 56 per cent in the second sample. Therefore, by using this dichotomization it was possible to combine the two samples to compare the four study groups. It is evident from the totals in Table 6 that the two discrepant groups differ markedly from each other in a way that might be expected and that both differ significantly from the non-discrepant groups.

However, since the discrepant groups also differ markedly in sex composition, and since females have a greater tendency to major in humanities - social sciences (67 per cent in the combined samples versus only 43 per cent of the males), it is necessary to examine the distribution of majors across the four groups separately for each sex. The data in Table 6 show only slight differences between the two sexes. Clearly, aptitude group affiliation is more highly associated with choice

of major than sex is. Moreover, aptitude discrepancy is more significant than overall aptitude level in determining major. The group with the highest overall aptitude (H) does not differ greatly from the average group (A) with respect to choice of major. But each of these non-discrepant groups is distinctly different from both the V- and the Q-group.

Table 6
Distribution of Respondents in Combined Samples Majoring in Humanities or Social Sciences, by Group and Sex (in percents)

Group	Male N=69	Female N=142	Total N=211
V	88*	91	90
Q	16	13	15
H	53	59	56
A	61	71	67
Total	43	67	57

*Read: 88 percent of males in V group majored in humanities - social sciences, etc.

If one were to treat the two discrepant groups as a single entity the average percent majoring in the humanities - social sciences would be 52.5 percent, very similar to the 56 percent of the H-group. The similarity extends to the five categories of majors, as shown in Table 7. The "discrepants," though "average," resemble in their choices of major the H-group more than they do the A-group. Thus, having one extremely high aptitude, either V or Q, results in certain choices of major field; having both aptitudes high permits a choice of fields like that of either of the discrepant groups; but having neither a high V or a high Q aptitude results in a different pattern of choices. It is not, apparently, the average of the two aptitudes that governs the choice, but rather the magnitude of one of them.

Table 7
Distribution of College Majors of
Combined "Discrepant" Groups Compared
with Two Non-discrepant Groups
(in percents)

	Group		
Major	V+Q N=169	H N=119	A N=83
Humanities	34	34	42
Mathematics	23	20	6
Science, technology	15	18	25
Social sciences	18	22	23
Business	11	5	4

Aptitude Discrepancy and College Grade Point Average

If aptitude discrepancy is related to choice of college major, it may also have some bearing on students' achievement in college, the dependent variable which aptitude test scores are most commonly used to predict. The respondents in the first sample were asked, therefore, to report their current cumulative grade point average (GPA). Depending on their class status, they reported averages based on from one to four years of college work. The respondents were requested to indicate whether the average they were reporting was exact or estimated. A spot check of reported averages showed that the estimates were extremely accurate, leading to the conclusion that extracting official data from the University's records would not yield an increase in precision commensurate with the effort involved.

The mean GPA for each of the four groups is given in Table 8, together with its standard error. The highest possible GPA is 4.0.

Table 8
Mean Grade Point Averages of Discrepancy Groups

Group	N	Mean	S. E.
V	54	2.79	.058
Q	51	2.57	.058
H	62	2.92	.060
A	47	2.70	.062

The differences between mean GPA's of the six possible group pairings are shown in Table 9, with the standard error of each difference and the corresponding t ratios. Three of the differences are significant at the .05 level or better: GPA's of the H (high aptitude, low discrepancy) group exceed significantly those of both the discrepant Q group (.001) and the non-discrepant A group (.05), and the GPA's of the Q group are also significantly lower than those of the discrepant V group (.01).

Table 9
Differences in Mean GPA Among the Groups

Groups Compared	df	Difference of Means	S. E. of Diff.	t
V-Q	103	+0.22	0.082	2.68**
V-H	114	-0.13	0.083	1.57
V-A	99	+0.09	0.085	1.06
Q-H	111	-0.35	0.083	4.22***
Q-A	96	-0.13	0.085	1.53
H-A	107	+0.22	0.086	2.56*

* - .05 ** - .01 *** - .001

Since groups differ in their major field choices, some groups may follow programs that are more difficult than others or at least may take courses in which high grades are rarer. Thus, the fact that the Q group has the lowest mean GPA may be attributable to their taking many more science and mathematics courses. But with that caution in mind, one may also note that in every significant difference, the higher group

has very high V-aptitude scores. The influence of the V-aptitude compared with the Q-aptitude can be seen vividly in Table 10, where individuals are classified by one aptitude at a time.

Table 10
Relation of V- and Q-scores to GPA

Aptitude	High Aptitude		Average Aptitude		Low Aptitude	
	N	GPA	N	GPA	N	GPA
Verbal	116	2.86	47	2.70	51	2.57
Quantitative	113	2.76	47	2.70	54	2.97

Aptitude Discrepancy and Attitude toward English and Mathematics

The students in the first sample were asked to describe on a five-point scale their general attitude toward literature and reading (English) and toward mathematics when they were students in elementary and secondary school. The results are shown in Table 11, where a "5" indicates the most favorable attitude.

Table 11
Attitudes of First Sample Groups toward English and Mathematics in School (in percents)

Attitude toward Subject	Group V N=55	Q N=51	H N=63	A N=50
English				
Low 1	0	10	0	0
2	2	33	0	0
3	4	26	3	14
4	24	29	37	44
High 5	71	2	60	42
Mean Attitude	4.6	2.8	4.6	4.3
Mathematics				
Low 1	27	0	3	2
2	26	0	3	10
3	27	4	22	20
4	16	20	44	34
High 5	4	76	27	34
Mean Attitude	2.4	4.7	3.9	3.9

A Chi square analysis of the actual numbers of respondents expressing each attitude, with 1 and 2 responses and the 3 and 4 responses combined, indicates that for both English and mathematics differences in attitude among groups are significant at the .001 level (df=6). Most notable are the findings that over 40 percent of the Q-group disliked English, whereas virtually no one in the other groups did; and over 50 percent of the V-group disliked mathematics, whereas the most in any other group was 12 percent of the A group. Figure 2 shows the cumulative frequency lines for the attitudes of the four groups toward the two subjects. The non-discrepant groups are most similar with respect to attitude and the two discrepant groups are most different. The success with which an aptitude test distinguishes groups on the basis of attitudes is shown vividly in Figure 2.

With the second sample, data regarding attitude shifts were obtained in a different manner. Instead of indicating whether, in what direction, and when an attitude change occurred, these respondents were

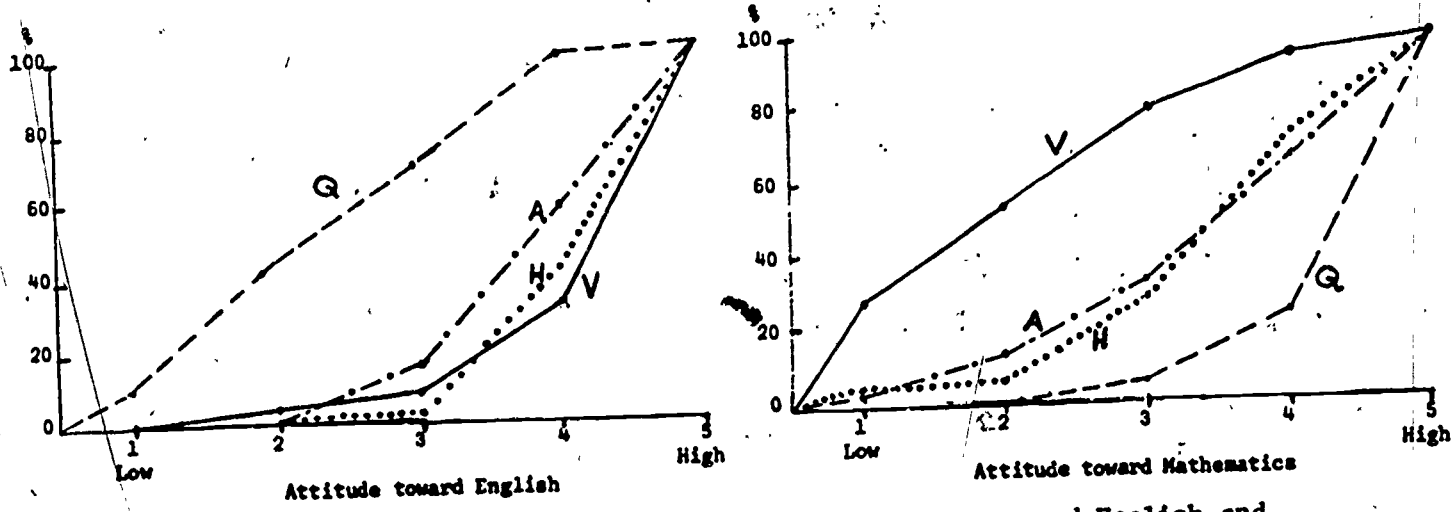

Figure 2. Attitudes of four aptitude groups in first sample toward English and mathematics (cumulative frequencies).

asked to describe their attitudes toward each of the two subjects at three points in time: at the present time (college), at the age of fourteen (secondary school), and at the age of ten (elementary school). The resulting mean attitudes are given in Table 12, a neutral attitude being 3.0.

Table 12
Mean Attitudes of Second Sample Groups
Toward English and Mathematics at Various Ages

	Toward English			Toward Mathematics		
Group	Age 10	Age 14	College	Age 10	Age 14	College
V	4.5	4.5	4.8	3.0	2.7	2.0
Q	3.4	3.1	3.0	4.4	4.6	4.0
H	4.0	4.0	4.3	3.8	4.1	3.3
A	3.7	3.9	4.4	3.7	3.9	3.4

Between high school and college, there appears to be a tendency for attitude toward English to become slightly more favorable in all but the Q group and for attitude toward mathematics to become considerably less favorable, even on the part of the Q group. If an average of the attitude scores at ages ten and fourteen is taken to represent a response similar to that given by the first sample regarding their attitudes while in school, a comparison can be made as in Table 13. The attitudes of Sample 1 are generally somewhat more extreme, but the pattern is identical in both samples. Aptitude and attitude relate perfectly.

Table 13
Mean Attitudes Toward English and Mathematics
in School for Groups in Two Samples

	English		Mathematics	
Group	Sample 1	Sample 2	Sample 1	Sample 2
V	4.6	4.5	2.4	2.8
Q	2.8	3.2	4.7	4.5
H	4.6	4.0	3.9	3.9
A	4.3	3.8	3.9	3.8

III

The Development of Aptitude Discrepancy

It is difficult enough to determine how a trait came into being through a longitudinal study. With an ex post facto design it is even more difficult. An effort was made, however, to determine from school marks and the timing of attitude shifts whether aptitude discrepancy exists throughout childhood or tends to develop at some particular age.

Shifts in Attitude toward English and Mathematics

About 43 percent of the first sample reported a change in attitude toward English during their school years and 54 percent, a change toward mathematics. For the second sample, which described their attitudes at ages 10 and 14 and at present, a change in attitude was defined as different attitude ratings at age 10 and at present. (Any changes from ages 10 to 14 or age 14 to present were ignored if they resulted in the same attitude at present as at age 10). By this definition, 64 percent of the second sample reported an attitude shift toward English and 71 percent toward mathematics. Whether the samples actually differed or the second method detects shifts better, or both, about 20 percent more students in the second sample shifted than in the first, but for both samples there were more shifts with respect to mathematics than English.

When only those students whose attitudes shifted are considered, however, the percents for English and mathematics in the two samples prove to be very similar:

Shifts Toward	Sample I	Sample II
English	92 (44%)	103 (47%)
Mathematics	115 (56%)	114 (53%)
Total	207 (100%)	217 (100%)

Moreover, when the directionality of the shifts in the two samples is considered, the percents are consistent with respect to order:

Attitude Shifts	Sample I	Sample II
More negative toward English:	12%	22%
More positive toward English:	30%	42%
More negative toward mathematics:	31%	46%
More positive toward mathematics:	23%	25%

On the basis of these similarities between the two samples, it should be satisfactory to combine them in order to explore relationships between attitude shifts and the four aptitude groups under study.

Some bases for deciding whether these attitude shifts are associated with aptitude discrepancy are provided by Table 14. There is an overall consistency in the net changes in attitude in that for both subjects the V and A groups exhibit similar patterns, as do the Q and H groups. What the V and A groups have in common, of course, is lack of high quantitative aptitude, whereas the Q and H groups both do have high quantitative aptitude. Thus, it appears that level of quantitative aptitude, rather than discrepancy, is the leading factor associated with direction of attitude shift. It may also be noted that stability of attitude (absence of shifts) is related to presence or absence of high verbal aptitude. Thus, the V and H groups (both

very high in verbal aptitude) are most stable with respect to attitude toward English and the Q group (lowest in verbal aptitude) is most stable toward mathematics. Nevertheless, there is evidence that aptitude discrepancy also was reflected in attitude shifts, since the Q group stands out as exhibiting the smallest net change in a positive direction toward English and the V group as having the largest net change in a negative direction toward mathematics.

Table 14
Proportion of Aptitude Groups in Combined Samples Reporting Change of Attitude in School (in percents)

Group	More Negative	More Positive	Total Shifting	Net Change
Toward English				
V	8	38	46	+30
Q	29	30	59	+ 1
H	15	30	45	+15
A	12	44	56	+32
Total	16	35	51	+19
Toward Mathematics				
V	49	11	60	-38
Q	26	28	54	+ 2
H	34	28	62	- 6
A	39	25	64	-14
Total	37	23	60	-14

Age of Attitude Change

Respondents in the first sample who reported an attitude change were asked to indicate at what grade level it occurred. With the second sample, it was possible to determine directly whether a change occurred before or after age fourteen. (Changes before and after fourteen which cancelled each other were considered fluctuations and were not counted as shifts. Changes begun before fourteen which

continued in the same direction after fourteen were counted on the basis of when they were first evident, i.e., before fourteen).

Since fewer than ten percent of attitude shifts in the first sample were reported as occurring in the elementary school years, these can be combined with the responses for grades 7-9 for comparison with grades 10-12. Moreover, these two resulting categories can be considered roughly equivalent to those in the second sample representing before and after age 14. To minimize confusion, attitude shifts will be classified as "late" if they occurred in grades 10-12 or after age 14, and as "early" if they occurred before that time.

The data in Table 15 appear to give evidence that aptitude discrepancy is associated with the timing of attitude changes. Most of the outstanding items in the table involve the two discrepant groups. The V group stands out as having the fewest early positive shifts toward mathematics and the most late negative ones. The same is true for the Q group with respect to English. Yet, again the effect of aptitude level appears as a factor related to the timing of attitude changes. This is shown in Table 16. Among those changing attitude toward English early, the V and H groups, both with high verbal aptitude, have the highest net positive changes; whereas among those changing late, it is the Q and A groups, both lacking high verbal aptitude, which make the most positive changes. And as the third column shows, the differentials with reference to presence of positive change and absence of negative change again associate V and H with early shifts and Q and A with late.

Table 15
Timing and Directionality of Attitude Shifts of
Aptitude Groups in Combined Samples
(in percents)

		Toward English				Toward Mathematics			
		Positive		Negative		Positive		Negative	
Group	N	Early	Late	Early	Late	Early	Late	Early	Late
V	88	18	20	1	7	2	9	23	24
Q	87	6	24	22	7	19	8	2	24
H	117	21	9	5	10	15	14	4	30
A	88	12	31	5	8	11	14	11	27
Total	380	15	20	8	8	12	11	10	27

Table 16
Net Directional Attitude Change Related
to Timing of Change, by Group, Combined Samples
(in percents)

	Toward English			Toward Mathematics		
Group	Early	Late	Net	Early	Late	Net
V	+17	+13	+4E	-21	-15	+6L
Q	-16	+17	+33L	+17	-16	+33E
H	+16	- 1	+17E	+11	-16	+27E
A	+ 7	+23	+16L	0	-13	+13E

With respect to mathematics, almost the opposite situation exists. Among early changers, Q and H, the high quantitative groups, have the highest net positive changes. No pattern emerges here among the late changers, but if differentials are again considered, the V group now stands out as least associated with late positive change, i.e., most with early negative.

The general conclusions that can be drawn from this complex analysis are (1) that both aptitude level and aptitude discrepancy are related to the extent, direction, and timing of attitude changes toward English and mathematics, and (2) that discrepancy is a factor even before senior high school in intensifying the effects of aptitude level

on attitude shifts. Discrepancy appears to be more highly associated with attitude shifts pertaining to mathematics than with shifts pertaining to English.

Aptitude Discrepancy and School Marks

In addition to students' recollections of shifts in attitude toward English and mathematics, information regarding possible disparities between their marks in these two subjects might shed some light on the development of aptitude discrepancy. Reports of school marks were obtained from school records for the first sample only.

Usable data on marks in both subjects were secured in 425 instances, or about 64.7 percent of the 657 that would have been available if the marks at three different grade levels had been obtained for each of the 219 students. That the four aptitude discrepancy groups were approximately equally represented is indicated by the fact that the percent of marks obtained varied only from 63 to 67 percent of the potential. The comparability of representation holds at each of the three grade levels (Chi square 2.21, df=9, $p > .95$).

In the analysis of trends in students' marks during their school careers, it became necessary to introduce a new concept to indicate patterns of changes in the extent of discrepancy between English and mathematics grades. It was desired to reflect both the extent of the discrepancy at particular points in the career and the change in the discrepancy between points, all without regard to the magnitude of the actual marks. The frequent unavailability of marks for the elementary grades made it necessary to analyze separately those

cases for which complete data were available and those for whom there were only secondary-school marks. Attention was focused on a mean of the marks for grades 5 and 6, for grades 8 and 9, and for grades 11 and 12. Marks for both English and mathematics were classified into five categories, ranging from high to low. The discrepancy index was the difference, in either direction, between the categories into which the marks for the two subjects fell. Thus, the minimum discrepancy was zero when both marks were at the same level, regardless of whether both were very high, very low, or somewhere between. The maximum possible discrepancy was four, which occurred when one of the two marks was at Level 1 and the other at Level 5.

A divergence index was developed to indicate whether, between two successive three-grade intervals the discrepancy remained constant, increased, or decreased, again regardless of what occurred to the actual marks. Thus, if both marks (English and mathematics) were in Category 5 at one grade level and both were in Category 1 three grades later, there had indeed been a great change in the marks themselves, but there had been no change in the discrepancy between them, which in both instances is zero. After numerous attempts to develop a suitable divergence index which would also reflect directionality of discrepancy, magnitude of discrepancy change, and general level of the marks themselves, it was decided to employ the simplest possible system, which merely indicated whether, after the three-grade interval, the discrepancy was the same as (S), more than (M), or less than (L) it had been three grades earlier. Thus, independent of mark level, and of the direction

and magnitude of discrepancy, three trend patterns were identified, which were labeled, respectively, constant, divergent, and convergent.

When data limitations provided a discrepancy index for only two points, three grades apart, the pattern could be identified very simply, following the procedure just described. When, however, complete data were on hand, providing discrepancy information at three points in the school career, the divergence pattern became more complex, since the pattern between the second and third points might or might not be the same as it was between the first two. In these three-point situations, therefore, nine different trend patterns were possible, namely, MM, MS, ML, SM, SS, SL, LM, LS, and LL. For example, "MS" would indicate that between grades 5-6 and 8-9, English and mathematics marks became more discrepant, but that the discrepancy remained constant between grades 8-9 and grades 11-12. "SS" would indicate that whatever discrepancy was evident in grades 5-6 remained unchanged throughout the remainder of the school career. "LM" would mean that the discrepancy decreased during the first three-grade interval and then increased during the second one, whereas "LL" would mean that it continued to decrease throughout the school career.

Whether nine different discrepancy-trend patterns, so defined, have any real meaning and utility may be questionable. It is possible to reduce them to three or four by considering MS and SM to be early and late manifestations of the "divergent" MM pattern and LS and SL to be corresponding forms of the "convergent" LL pattern. The SS pattern is the "constant" one, and ML and LM can be viewed either as variants of it, or as separate "erratic" patterns.

Table 17
Disparity Between English and Mathematics Marks
in Grades 5-6 in Relation to Aptitude Discrepancy
(in percents)

	Group				
Marks	V N=18	Q N=25	H N=26	A N=20	Total N=89
5-English much higher	11	0	4	10	6
4-English somewhat "	6	0	4	5	3
3-No disparity	83	76	88	85	83
2-Math somewhat "	0	8	4	0	3
1-Math much "	0	16	0	0	4
Mean score	3.3	2.6	3.1	3.2	3.0

Table 18
Disparity Between English and Mathematics Marks
in Grades 8-9 in Relation to Aptitude Discrepancy
(in percents)

	Group				
Marks	V N=44	Q N=38	H N=50	A N=38	Total N=170
5-English much higher	14	0	2	8	6
4-English somewhat "	23	3	0	3	7
3-No disparity	59	42	78	82	66
2-Math somewhat "	5	24	16	5	12
1-Math much "	0	32	4	3	9
Mean score	3.5	2.2	2.8	3.1	2.9

Table 19
Disparity Between English and Mathematics Marks
in Grades 11-12 in Relation to Aptitude Discrepancy
(in percents)

	Group				
Marks	V N=42	Q N=36	H N=50	A N=38	Total N=166
5-English much higher	19	0	10	13	11
4-English somewhat "	29	3	6	16	13
3-No disparity	50	28	78	58	55
2-Math somewhat "	2	22	6	5	8
1-Math much higher	0	47	0	8	12
Mean score	3.7	1.9	3.2	3.2	3.0

Inspection of the mean scores in Tables 17-19 shows that on the whole there are relatively few instances in which English and mathematics marks are disparate; that the disparateness is approximately equal in both directions; that the non-discrepant A and H groups, as expected, tend to be least disparate in marks and more nearly equally disparate in each direction; and that the extent of disparateness increases from one school level to the next. The latter points are illustrated in Table 20, where the percent of disparity is reported. It is also evident there that the Q group begins to exhibit disparity earlier than the V group and reaches the point where almost three out of four have disparate marks in grades 11-12, compared with half of the V group.

Table 20
Disparity Between English and Mathematics Marks
at Three School Levels, by Group
(in percents)

	Group				
School Level	V	Q	H	A	Total
Grade 4	17	24	12	15	17
Grade 8	41	58	22	19	34
Grade 12	50	72	22	42	45

The data in Tables 17-19 suggest that only if quantitative aptitude is very high do mathematics marks exceed English marks, whereas English marks can exceed mathematics marks even with average verbal aptitude. If both aptitudes are very high, the math marks tend to be higher in grades 8-9 and the English marks higher in grades 11-12. Coarse as these data are, they furnish evidence that aptitude discrepancy may be associated with marks as early as fourth grade.

The distribution of changes in mark disparity for each of the four study groups between grades 5-6 and 8-9 and between 8-9 and 11-12 is shown in Table 21.

Table 21
Changes in Disparity Between English and Mathematics Marks in School in Relation to Aptitude Discrepancy, by Group (in percents)

	Between Grades 5-6 and 8-9				Between Grades 8-9 and 11-12			
		More	Same	Less		More	Same	Less
Group	N	Disparate	Disparity	Disparate	N	Disparate	Disparity	Disparate
V	17	29	59	12	42	36	38	26
Q	23	48	43	9	36	39	50	11
H	27	30	63	7	51	20	63	18
A	20	20	65	15	38	34	55	11
Mean	87	32	58	11	167	32	52	16

The mean proportions of each type of shift are remarkably similar during the middle school and high school years. During each of these two periods, over half maintain the same disparity in marks between the two subjects, and of those whose mark-disparity does change, more than twice as many become increasingly disparate as become less so. Still, in 11 to 15 percent of the cases, at the two levels, the marks do become less disparate. And, as Table 22 shows, while there is a somewhat greater tendency for the marks of students with high aptitude discrepancy to become increasingly disparate over a four-year period, it is not statistically significant (Chi square 1.46, 1.99; df=1; $p < .20$), but there is remarkable consistency in the tendencies at the two school levels.

Table 22
Percent Whose Grades Became More Disparate

Aptitude Status	Between Grades 5-6 and 8-9 N=87	Between Grades 8-9 and 11-12 N=167
Discrepant (V, Q)	40	37
Non-discrepant (H, A)	26	26

When only the 87 cases for which marks were available over the entire period from grades 5-6 to grades 11-12 are considered (Table 23), not one single case continued throughout to become less disparate in marks (LL). All but one instance of mark convergence between grades 8-9 and 11-12 involved students whose marks had already become increasingly disparate in the earlier four years and then reverted to a less disparate status during the high school years (ML). On the other hand, nearly one out of three continued or began to diverge during the secondary years (MM, SM, LM), twice as many as converged (ML, SL, LL). The distribution for the Q group in Table 23 appears to differ from that of the other three groups. This is more apparent in Table 24, where trends have been categorized into the four patterns mentioned earlier, showing 65 percent of the Q group exhibiting mark divergence. The fact that both the V and H groups tend to show steady, rather than divergent, patterns and the A group displays considerable divergence suggests that it is the lack of high verbal aptitude, rather than presence of high quantitative aptitude, that is associated with divergence in marks.

Table 23
Shifts in Mark Disparity
Between Grades 5-6 and 11-12, by Group
(in percents)

Between Grades 5-6 and 8-9	8-9 and 11-12	Aptitude Discrepancy Group V N=17	Q N=23	H N=27	A N=20	Total N=87
M	M	0	17	4	0	6
M	S	0	22	7	10	10
M	L	29	9	19	10	16
S	M	18	26	7	30	20
S	S	41	17	52	35	37
S	L	0	0	4	0	1
L	M	6	4	4	5	5
L	S	6	4	4	10	6
L	L	0	0	0	0	0

Table 24
Patterns of Mark Disparity Shifts
Between Grades 5-6 and 11-12, by Group
(in percents)

Pattern	Aptitude Discrepancy Group V N=17	Q N=23	H N=27	A N=20	Total N=87
Divergent (MM, SM, MS)	18	65	19	40	36
Convergent (LL, SL, LS)	6	4	7	10	7
Steady (SS)	41	17	52	35	37
Erratic (ML, LM)	35	13	22	15	21

A clue as to whether it is aptitude discrepancy or aptitude level that is most closely associated with the pattern of mark disparity can be obtained by comparing various correlations based on the data in Table 23. Of all the resulting coefficients in Table 24, the two lowest relate to verbal aptitude, suggesting that neither the discrepancy between the aptitudes nor the status of quantitative aptitude is as likely to be linked with changes in mark disparity throughout school as whether

one has an extremely high or, especially, an extremely low verbal aptitude. This finding is, of course, consistent with other indications of the distinctiveness of the Q group with respect to disparity between mathematics and English marks.

Table 24
Correlations Between Mark Disparity Patterns
and Aptitude Status

Factor	Correlates	r
Aptitude Discrepancy	V+Q vs H+A	.87
High verbal aptitude	V+H vs Q+A	.63
Low verbal aptitude	Q vs V+H+A	.43
High quantitative aptitude	Q+H vs V+A	.89
Low quantitative aptitude	V vs Q+H+A	.85

IV

Relation of Background Factors to Aptitude Discrepancy

Since aptitude discrepancy appears to be a phenomenon of some significance for both achievement and interests, it would be instructive to locate factors in the backgrounds of students that are associated with its incidence and potentially with its origin. Six factors are explored here, having to do with home, school, and community. These are size of home town and graduating class and the occupational, educational, socio-economic, and linguistic status of parents. Most of the data presented were supplied by the responding students in the first sample, only the factor of father's education being pursued with the second sample.

Size of Home Town

The respondents classified their home towns into one of six categories, but since only fifteen fell into the smallest and largest categories, these were combined with the adjacent categories, giving four for analysis. The means in Table 25 indicate that the consistently high aptitude (H) and the discrepant (Q) groups tend to come from smaller home towns. What these groups have in common is a high quantitative aptitude. A Chi square analysis shows that the differences are not, however, significant at the .05 level. (Chi square=13.99; df=9; $p > .10$)

Size of Graduating Class

School size and size of graduating class can of course be expected to be fairly highly correlated with size of home town, and with the present data the correlation between size of class and town is in fact .56. The relationship with the aptitude discrepancy distribution is, however, even less marked than was the case with home town size. As Table 26 indicates, only a slight tendency for consistently high aptitude subjects (H) to come from smaller classes is discernible, and this might be explained by the tendency of college admissions offices to accept top students from a large number of schools. Chi square here is 5.34 with df=6, which has a probability in excess of .50.

Education of Parents

There would appear to be more opportunities in the home for the parents' educational background to influence the children's verbal aptitudes than their quantitative aptitudes. It might be expected, then, that children's high verbal aptitude would be associated with high educational attainment on the part of one or both of the parents. The respondents classified their parents' highest educational level into one of five categories. The pattern of fathers' educational levels is almost identical for the non-discrepant H and A groups. Quite different patterns emerge for the discrepant groups (V and Q), however, and these groups also differ from each other (Table 27). Among the V group, nearly half of the fathers at least attended college, whereas among the Q group, only a quarter of them did. Analysis shows father's

education to be a significant factor in distinguishing the discrepant groups from each other (Table 29, Chi square=5.92, df=1, $p < .05$) whereas it does not significantly distinguish discrepants from consistents (Table 28, Chi square=0.69, df=1, $p > .30$).

For the four groups taken as a whole, mothers' educational attainment, shown in Table 29, was virtually the same as fathers', but differences among the groups were almost undetectable. The Chi squares corresponding to those reported above are 0.14 for discrepant versus consistent (df=1, $p > .70$) and 0.004 for V versus Q (Table 30, df=1, $p > .90$). Despite the presumably powerful influence of the mother in molding the child, her educational level seems to have no effect whatever on the child's aptitude pattern.

Table 25
Size of Home Town, by Group
(in percents)

	Group			
	V	Q	H	A
Population	N=54	N=51	N=63	N=50
1 (Farm)	0	10	10	8
2 (500-5000)	17	20	29	12
3 (Suburban)	37	37	38	40
4 (5000-50,000)	22	12	8	8
5 (50,000-500,000)	20	12	8	8
6 (Over 500,000	4	10	3	12
Mean Population	3.6	3.3	2.9	3.4

Table 26
Size of Graduating Class, by Group
(in percents)

	Group			
Class Size	V N=55	Q N=51	H N=62	A N=50
1 (1-99)	13	22	18	14
2 (100-199)	18	16	23	12
3 (200-499)	40	41	43	42
4 (500-999)	29	15	16	22
5 (1000+)	0	12	0	10
Mean Size	2.9	2.9	2.6	3.0

Table 27
Fathers' Education, by Group
(in percents)

	Group			
Educational Level	V N=55	Q N=51	H N=63	A N=50
1 (Non-HS grad)	18	35	24	26
2 (HS grad)	35	41	33	32
3 (Entered Coll)	18	10	19	18
4 (Coll grad)	18	8	13	12
5 (Adv degree)	11	6	11	12
Mean Education	2.7	2.1	2.5	2.5

Table 28
Aptitude Discrepancy and Father's Education

Aptitude Status	N	Percent Fathers Beyond High School (Levels 3-5)	Mean Education
Discrepant (V, Q)	107	36	2.4
Non-discrepant (H, A)	112	42	2.5
V	55	47	2.7
Q	51	24	2.1

Table 29
Mothers' Education, by Group
(in percents)

Educational Level	Group V N=54	Q N=51	H N=62	A N=50
1 (Non HS grad)	11	20	16	26
2 (HS grad)	54	47	47	38
3 (Entered coll)	17	12	13	14
4 (Coll grad)	15	18	19	18
5 (Adv degree)	4	4	5	4
Mean Education	2.5	2.4	2.5	2.4

Table 30
Aptitude Discrepancy and Mother's Education

Aptitude Status	N	Percent Mothers Beyond High School	Mean Education
Discrepant (V, Q)	105	34	2.4
Non-discrepant (H, A)	112	37	2.4
V	54	35	2.5
Q	51	33	2.4

As a further exploration of the effect of parental education, the combined educational status of father and mother was determined and its relationship to aptitude status was examined. The results are given in Tables 31 and 32. Dichotomizing the data at a combined level of 4 (high school graduation) or less against more education than this, the Chi square with respect to discrepant versus consistent groups is essentially zero. With respect to V- versus Q-discrepancy, it is 2.09, df=1, with a probability exceeding .10.

The correlation between father's and mother's education is .46. But while the father's education is significantly related to the direction of discrepancy (V or Q), the mother's is unrelated to either the existence or direction of discrepancy (Tables 28 and 30). It appears that father's education is positively related to the existence

of a high verbal aptitude and negatively related to high quantitative aptitude, with or without discrepancy. Since two of the groups (V and H) had high verbal aptitudes and two did not (Q and A), and since two groups (Q and H) had high quantitative aptitudes and two did not (V and A), a comparison of the mean parental educational levels of these combinations would shed light on this question. These comparisons are shown in Table 33, together with the previously discussed comparisons based on existence and direction of discrepancy. For high verbality and high quantitativeness, father's education shows a stronger relationship than mother's, and indeed, the influence of mother's educational level, slight as it is, acts to enhance both aptitudes. Even more striking is the association between low father's education and low verbal aptitude.

Table 31
Parents' Education, by Group
(in percents)

Combined Educational Level	Group V N=54	Q N=51	H N=62	A N=50
2-3 (Non-HS grad)	20	35	21	28
4-5 (HS grad)	37	37	44	38
6-7 (Entered coll)	30	20	19	22
8-10 (Coll grad)	13	8	16	12
Mean Education	5.2	4.4	5.1	4.9

Table 32
Aptitude Discrepancy and Parents' Education

Aptitude Status	N	Percent Parents Beyond High School	Mean Education
Discrepant (V, Q)	105	50	4.8
Non-discrepant (H, A)	112	50	5.0
V	54	57	5.2
Q	51	41	4.4

Table 33
Father's, Mother's and Combined Education
and Aptitude Status

Aptitude Status	Mean Education		
	Father	Mother	Combined
High Verbal (V, H)	2.6	2.5	5.1
Not High Verbal (A, A)	2.3	2.4	4.7
High Quantitative (Q, H)	2.3	2.5	4.8
Not High Quantitative (V, A)	2.6	2.4	5.0
Low Verbal (Q)	2.1	2.4	4.5
Not Low Verbal (V, H, A)	2.6	2.4	5.0
Low Quantitative (V)	2.7	2.5	5.2
Not Low Quantitative (Q, H, A)	2.4	2.4	4.8
Discrepant (V, Q)	2.4	2.4	4.8
Non-discrepant (H, A)	2.5	2.4	5.0

Since the data on father's education indicated that the most critical factor was whether or not the father had ever attended college, the questionnaire used with the second sample included this specific question. The results given in Table 34 indicate remarkable similarity among the groups. While the slight differences are not significant and the earlier finding of association with V-discrepancy is not supported, it may be noted that 56 percent of the H group's fathers attended college but only 47 percent for the Q group, which is at least consistent with the finding of greater association with high verbal aptitude.

Table 34
Father's Attendance at College,
by Group in Second Sample
(in percent)

Group	N	Father Attended College
V	33	52
Q	36	47
H	54	56
A	37	52
Total	160	52

Table 35
Father's Occupation, by Group
(in percents)

Occupational Level	Group V N=55	Q N=50	H N=62	A N=50
1 (Unskilled)	13	14	10	18
2 (Skilled)	29	28	31	14
3 (Managerial)	26	38	24	40
4 (Semi-prof)	5	6	8	8
5 (Professional)	27	14	27	20
Mean Level	3.1	2.8	3.1	3.0

Table 36
Father's Occupation and Education,
by Group
(in percents)

Occupational and Educational Levels	Group V N=55	Q N=50	H N=62	A N=50
Both 1 or 2 (Low)	35	38	35	28
Both 4 or 5 (High)	22	8	21	20

Socio-economic Status

Each student was asked to classify his father's occupation into one of five categories. Some question can be raised as to how correctly these categories were interpreted, as the professional category included a few fathers with no college background and, indeed, one who did not complete high school. The correlation between father's

educational level and his occupational classification was .46, precisely the same as between his educational level and his wife's. The relationship between father's occupation and educational level was, however, more curvilinear, attributable perhaps to incorrect responses on occupation, but also possibly due to the occurrence of "self-made" men.

Although the Q group has the lowest mean father's occupation, the differences among the groups are very slight. Combining the two extreme categories at each end to produce a df=6, the Chi square is 6.81, which has an associated probability in excess of .30 (Table 35). In whatever way father's educational level acts to favor V-discrepancy, it apparently does so only partially through the socio-economic benefits it creates. The effect, in other words, may be more direct, such as through the language used by the father, his greater use of verbal communication, and his display of interest in reading and literature.

When the cases in which educational and occupational level of father were both high (Levels 4 and 5) or both low (Levels 1 and 2) were isolated, the picture shown in Table 36 emerged. Once more the Q group stands out, having the highest percentage in the low status category and the lowest in the high. Q-discrepancy is clearly not associated with high occupational and educational status of father.

Foreign Home Language

The possibility that having parents of foreign birth might produce a language situation in the home that would depress children's verbal aptitude while not affecting their quantitative aptitude prompted the inclusion of a question on this matter. Among the 219 students,

there were, however, only 14 whose fathers were from a non-English-speaking country and 15 whose mothers were (both parents in eight of these cases). The number was obviously too low to be of any consequence in explaining the phenomena under study, although almost 20 percent of the Q group had a foreign-born parent. For the record, of the 21 students with one or both parents in this category, sixteen were discrepant (6V, 10Q) and five were non-discrepant (4H, 1A), a difference which a goodness of fit test shows not to be compatible with a hypothesis of a chance distribution (Chi square=5.35, df=1, $p < .05$). The fact that an equal number of these children with a foreign-born parent had very high verbal aptitude (V, H) and very low (Q) prompts the speculation that in such homes either very great emphasis may be placed on linguistic development or the language environment may be deficient. In every case but one, verbal aptitude was either very high or very low.

V

Origins of Aptitude Discrepancy

It is possible that aptitude discrepancy is present at birth. It is also possible that it is entirely the result of environmental factors. Even if discrepancy is innate, however, it may well be amplified by certain experiences. There is of course no way of determining in this study what the situation actually is.

But in either case -- innate or not -- it would seem that events in the life of the child must play some part in either aggravating or actually initiating the aptitude discrepancy which obviously exists later and apparently is detectable very early. These events might be expected to have some connection with shifts in attitude toward literature or mathematics, whether these shifts be causes or effects of aptitude discrepancy.

Students in the first sample who reported that their attitudes toward the subjects had at some time undergone change were asked, therefore, to describe any events or factors that might have been responsible for the change. A total of 126 reasons were reported to account for the 92 changes in attitude toward literature and 172 explanations for the 115 attitude shifts toward mathematics. This works out to about 1.4 reasons for each change toward literature and 1.5 for mathematics.

The 298 responses were classified into fourteen categories with at least five instances in a category, plus an additional group of 22 that did not meet this criterion (Table 36). Four of the categories were unique to literature and six to mathematics, while four were common to both: (1. Influence of some teacher(s) -84, 2. interference or reinforcement from some outside activity of interest -24, 3. the acquisition or lack of certain skills -16, and 4. the influence of peers -15.) These four common reasons accounted for nearly half (47%) of those given. Inclusion of the single most important unique reason in each subject raises the total to 70 percent (5. the nature of the literature used in literature instruction -24, 6. the abstractness or challenge of mathematics content -47).

The fourteen categories were consolidated into four:

Teacher:
- 1, above

Subject:
- 5 and 6, above
- class pace
- applications realized or not realized
- boredom or tedium of subject

Self reference:
- 2 and 3, above
- awakening or re-awakening
- public recognition of ability or lack thereof
- basic ability or interest present or absent

Influence of others:
- 4, above
- family influence

The distribution of the four aptitude groups in the first sample among these four categories is given in Table 37.

Table 36
Categorization of Factors Related
to Attitude Change Given by First Sample

Factor Category	Number of Instances		
	Literature	Mathematics	Total
Peer influence	10	5	15
Teacher influence	36	48	84
Certain skills acquired (or lacked)	7	9	16
Outside activity or interest	17	7	24
Instructional materials used	24	0	24
Family influence	7	0	7
Self-awakening	7	0	7
Diversion, escape	7	0	7
Class pace	0	11	11
Content abstractness, challenge	0	47	47
Applications realized (or not)	0	11	11
Achievement (or lack) recognized	0	8	8
Boredom, tedium of subject	0	6	6
Basic ability or interest (or lack)	0	9	9
Other (unclassifiable)	11	11	22
Total	126	172	298

Table 37
Reasons Given by First Sample for
Attitude Change, by Group and Subject
(in percents)

Literature	V N=37	Q N=26	H N=34	A N=29	Total N=126
Reason					
Teacher	38	15	23	35	28
Subject	21	8	15	31	19
Self	30	50	29	14	30
Others	8	19	18	10	14
Misc.	3	8	15	10	9
Mathematics	N=45	N=38	N=51	N=38	N=172
Teacher	24	26	31	29	28
Subject	40	50	39	47	44
Self	27	16	18	16	19
Others	0	3	6	3	3
Misc.	9	5	6	5	6

The "teacher" factor was the leading one associated with attitude shifts toward literature, whereas with respect to mathematics, some aspect of the "subject" itself was most often reported. Of the 298 responses for the two subjects, these two school-related factors ("teacher" and "subject") accounted for 183 (61%).

As the "total" columns in Table 37 reveal, the distribution of reasons is quite different for the two subjects (Chi square: 28.3, df=4, $p. < .001$), and therefore they must be considered separately. Inspection of the data for mathematics shows that the four groups are remarkably similar, the order being almost identical for all groups. With respect to literature, however, the Q and H groups are noticeably different from the other groups. This is most clearly illustrated by the rank-order intercorrelations among the groups shown in Table 38. Apparently, possession or lack of a high Q-aptitude is related to the

attitude toward literature to a greater extent than is either aptitude discrepancy or level of V-aptitude.

Table 38
Rank-order Intercorrelations of Reasons for Attitude Change Among Aptitude Groups in First Sample

	Literature				Mathematics		
	Q	H	A		Q	H	A
V	.42	.72	.87	V	.90	.87	.90
Q	-	.90	-.02	Q	-	.97	1.00
H	-	-	.32	H	-	-	.97

Teachers and the nature of the subject account for only 23 percent of the reasons advanced for change of attitude toward literature by the Q group (compared with 59 percent of V group), whereas self-references and the influences of others constitute 69 percent of the Q group's reasons (V group -- 38 percent). This suggests that school-related factors may be more influential in determining attitudes of verbal-oriented students toward literature than of those who are quantitatively oriented. However, since the attitude changes of these two groups can be expected to be opposite in direction, reasons for negative and positive shifts must be analyzed separately.

In such an analysis it would be useful to include the data from the second sample. A different mode of response was used with that sample, however. Instead of citing experiences associated with their attitude shifts, the respondents were presented with the leading reasons elicited from the first sample and asked to check which, if any, pertained to their changes in attitude. The reasons presented for literature had to do with teachers, the subject itself, the student himself, and the influence of peers. For mathematics,

however, three of the reasons were "school-related," since both the abstractness and the value of the subject, as well as the teacher factor, were included, and no reference was made to "self." The response pattern is shown in Table 39.

Table 39
Reasons for Attitude Change Checked
by Second Sample, by Group and Subject
(in percents)

Literature	V N=25	Q N=40	H N=35	A N=42	Total N=142
Reason					
Teacher	24	35	20	29	27
Subject	28	20	37	40	32
Self	20	15	17	10	15
Peers	8	8	9	12	9
None of above	20	22	17	10	17
Mathematics	**N=36**	**N=34**	**N=65**	**N=41**	**N=176**
Teacher	17	36	26	27	26
Subject					
Abstractness	37	30	37	37	36
Value	40	27	28	27	30
Peers	0	0	2	0	1
None of above	6	6	8	10	7

The similarity of the two samples with respect to a number of other variables has been demonstrated in earlier sections of this report. Further evidence can be adduced by noting whether the response patterns of the two samples with respect to reasons for attitude shifts differed in relation to (1) aptitude groups and (2) subject and direction of shift. Tables 40 and 41 compare the two samples on these two bases.

Table 40
Percent of Reasons for Attitude Change
Advanced by Each Aptitude Group in the Two Samples

Sample	N	V	Q	H	A
First	298	28	21	29	22
Second	318	19	23	31	26

Chi square=6.09 df=3, $p < .25$

Table 41
Percent of Reasons for Attitude Change
Advanced in the Two Samples, by Subject and Direction
of Shift
(in percents)

		Literature		Mathematics	
Sample	N	Positive	Negative	Positive	Negative
First	298	32	11	26	32
Second	318	31	14	19	37

Chi square: 7.18, df=3, $p < .10$; Lit. vs Math=0.35, df=1, $p > .50$
Pos vs Neg=4.28, df=1, $p < .05$

More responses were made by the second sample, even though it was smaller. However, as indicated earlier, a shift in attitude was recorded for a larger proportion of the second sample than of the first (67.5% vs 47.5% of the possible shifts). When the number of reasons per recorded attitude shift is calculated, the two samples are remarkably similar -- 1.44 for the first sample, 1.46 for the second -- even though the mode of response differed both for the shift itself and for the reasons. Moreover, in each sample the number of reasons given by the various aptitude groups is consistent with the distribution of the sample across the groups. Goodness of fit tests yielded Chi squares of 1.02 and 1.85 for the two samples, which with 3 df have probabilities in excess of .70 and .50 respectively. That the response patterns of the various groups are quite similar in the two samples is shown by the

Chi square in Table 40 which is not sufficiently large to permit rejection of the hypothesis that the responses are independent of sample. Similarly, when the samples are compared for number of positive and negative responses (Table 41), no significant difference exists for literature, the Chi square having a probability of .30. In the case of mathematics, however, the samples do differ significantly at the .05 level. This suggests that, while the samples might appropriately be combined in the case of literature, they would have to be treated separately for mathematics.

To check this decision, the two samples were compared with respect to proportion of reasons which were "school related." In the first sample, 61 percent of the reasons offered were school-related, whereas in the second, 7 percent of those chosen were of this kind (see Table 42). The Chi square of 17.76, with a probability of less than .01, indicates that the nature of the responses was not independent of samples. If this difference were due to the difference in response mode between the two samples (open-ended vs choice among options), it should be present for both subjects. The Chi squares in Table 43 show that the difference is significant only for mathematics. The explanation, therefore, may not lie in the difference in response modes, but in the fact that two of the five reasons presented for literature were "school-related," whereas for mathematics, three were. In any event, on the basis of both numbers and nature of responses, it would appear necessary to treat the two samples separately with respect to further analysis of reasons for shifts in attitude toward mathematics, but on both bases, combining the samples is justified for literature.

The combined data for literature in Table 44 indicate that the aptitude groups do differ significantly with respect to reasons for positive shifts, but not for negative ones. The Q group stands out as being different from the others, but is most similar to the H group. The one element they have in common is high Q-aptitude, not low V-aptitude.

Table 42
Percent of School-related Reasons
by the Two Samples

Sample	N	Percent School-related Reasons
First	298	61
Second	318	77

Chi square=17.76, df=1, $p < .01$

Table 43
Percent of School-related Reasons
by the two Samples, by Subject

	Literature		Mathematics	
Sample	N	Percent School-related Reasons	N	Percent School-related Reasons
First	126	48	172	72
Second	142	59	176	92

Chi square=3.12, df=1, $p < .10$ Chi square=23.37, df=1, $p < .01$

Table 44
Percent of School-related Reasons Given by Combined Samples
for Shifts in Attitude Toward Literature,
by Direction and Group

	Positive Shift		Negative Shift	
Group	Total Reasons	Percent School-related	Total Reasons	Percent School-related
V	52	62	10	30
Q	35	43		42
H	47	55	22	32
A	57	72	14	50

Chi square=3.12, df=3, $p < .05$ Chi square=1.64, df=3, $p < .75$

The data for the two samples separately with respect to mathematics are presented in Table 45. Since over 90 percent of the second sample's responses were school-related, no Chi squares could be, or needed to be, computed; there were obviously no differences among the groups. Even in the first sample, in which respondents could offer their own reasons, over 70 percent were school-related and in neither direction are the groups significantly different. Nevertheless, it may be noted that with respect to mathematics, it is the V group that exhibits a differing response pattern, whereas with literature it was the Q group.

Table 45
Percent of School-related Reasons Given by the Two Samples for Shifts in Attitude Toward Mathematics, by Direction and Group

	First Sample				Second Sample			
	Positive Shift		Negative Shift		Positive Shift		Negative Shift	
Group	Total Responses	Percent School-related	Total Responses	Percent School-related	Total Responses	Percent School-related	Total Responses	Percent School-related
V	9	33	36	72	8	75	28	100
Q	26	73	12	82	14	100	20	90
H	27	70	24	71	19	84	46	93
A	15	80	23	74	18	83	23	96

Chi square=6.41 ($p < .10$) (df=3) Chi square=0.72 ($p < .90$) (df=3)

A clue to whether the one high aptitude or the other low one is associated with the differing patterns may be obtained by consolidating groups which share one of the factors. The data in Table 46 are drawn from the combined samples for positive shifts toward literature, the only situation in which significant differences were found among the aptitude groups.

Table 46
Relation of Extreme Aptitudes to Reasons Given
for Positive Attitude Shifts
Toward Literature
(in percents)

Reason	High Q (Q, H) N=82	Not High Q (V, A) N=109	Low V (Q) N=35	Not Low V (V, H, A) N=156
School-related	50	67	43	63
Other	50	33	57	37

Chi square=4.92, df=1, $p<.05$ Chi square=4.22, df=1, $p<.05$

Both high Q-aptitude and low V-aptitude are significantly related to the tendency to give fewer school-related reasons for becoming more favorably oriented toward literature. The Q group, of course, has both of these characteristics.

V

Some Conclusions Regarding Similarities and Differences

An effort was made to identify some characteristics associated with extreme discrepancy between verbal and quantitative aptitudes. College students with extremely high verbal and low quantitative aptitudes, designated the V group, were compared with a Q group possessing the opposite discrepancy, i.e., high quantitative-low verbal. Both groups were contrasted with two non-discrepant groups, one in which both aptitudes were very high (H) and one in which they were both average (A),

Some of the features of the two discrepant groups will now be summarized. Then, similarities with the two non-discrepant groups will be examined.

The V Group

Whether it may be viewed as regrettable or as merely predictable, the typical V-type individual is female. Of those in the samples studied, most majored in the humanities in college; not one in either sample majored in mathematics. They reported having disliked mathematics in school, and the dislike increased throughout the school years. Between grades four and twelve a growing disparity was discernible between their English and mathematics marks, favoring, of course, the former. Their fathers tended on the whole to have had more than an average amount of education, which may partially account for their high V aptitude, but leaves unexplained their extremely low Q aptitude. Nor did careful analysis of reasons offered for adopting a negative attitude toward mathematics suggest any explanation for the phenomenon.

The Q Group

As the polar opposite of the V group, the students with high quantitative and low verbal aptitudes tended to be males, primarily majoring in mathematics, with but a few in the humanities. Whereas the V group earned better than average grades in college, the Q-discrepant students appear to pay for their low V by receiving lower grades even than students with consistently average aptitudes. Throughout school the Q group increasingly disliked English, and the disparity between their marks in mathematics and English can be noted as early as grade four. This disparity increased throughout the school years, so that by the twelfth grade it was exhibited by 75 percent of the group. The Q group's negative attitude toward English and positive attitude toward mathematics were discernible well before age fourteen. There was a tendency, though statistically not significant, for Q-types to come from smaller than average home towns, and their fathers were less likely to have attended college. One or both parents of about a fifth of this group were born in a non-English-speaking country, almost as many as for the three other groups combined. Several factors here -- the fewer home town cultural advantages, the father's lower educational level, and parental unfamiliarity with English -- are at least plausible contributors to a verbal deficiency on the part of a child whose high Q-score gives evidence of otherwise superior intellectual potential.

Indeed, one can speculate that given strong encouragement to excel in school, a child faced with an obstacle on the verbal side might over-compensate and develop quantitatively even further than would otherwise be the case. No similar set of explanatory factors emerged to help account

for the opposite V-discrepant condition. Without evidence, it is tempting to suspect an opposite explanation, i.e., instead of overcompensation, neglect. In an exceedingly rich verbal environment, some children may become so absorbed in, and rewarded by, verbal activity that they neglect numerical activity, and if, in addition, there is neither encouragement in that direction nor reward from it, the neglect may lead to difficulty and the difficulty to distaste, followed by avoidance and greater aversion. The consequences of difficulty with mathematics are nowhere near as great in school as those of verbal deficiency, however, and a far greater social stigma is attached to the latter than to the former. Thus, the Q group should probably be of particular concern, and schools, it would seem, should direct special efforts toward pupils who manifest in the early years a superior ability in arithmetic coupled with difficulty in language development. A marked differentiation of interest with respect to verbal and quantitative activities may be unexceptional in the adolescent period, but in the early years of the elementary school, it might be an indication of a growing aptitude discrepancy which schools might wish to try to prevent from getting too extreme.

Similarities Among Groups

It was hypothesized that students with great aptitude discrepancy (V and Q groups) resemble those with consistently high aptitudes (H group) more than those of average aptitudes (A group). Since the groups were compared on at least 29 variables, the hypothesis may be expected to receive support for some variables and not for others. Therefore, it is necessary to see whether the preponderance of the evidence is supportive or not.

The method chosen to obtain indicators of similarities among groups was to calculate rank-order intercorrelations on those variables for which data were classified into five to nine categories. If the order of magnitude among the categories was identical or similar for two groups, i.e., the rank-order correlation coefficient was high, the groups were assumed to "resemble" each other more than two groups for which the coefficient was lower (or negative). On those seven variables for which data were only dichotomized, Phi coefficients were calculated. These are not directly comparable with rank-order Rhos, since similarity between groups is greatest when the association between the variable and group affiliation is lowest, i.e., Phi nearest to zero, rather than nearest to +1.0, as in the case of Rho. For consistency in interpretation, therefore, the coefficients for the six pairs of groups on the 29 variables given in Table 47 are either in the form of Rho or (1-Phi), as appropriate.

If the six coefficients for each variable are then ranked in order from greatest to least resemblance, the resulting ranks are distributed by group as in Table 48. With ten degrees of freedom the Chi square of 30.42 is significant at the .01 level, indicating that resemblances among the aptitude groups tend to be fairly consistent. The median rankings in Table 47 demonstrate that the two discrepant groups, V and Q, are most dissimilar, and the two non-discrepant groups, H and A, are the most similar. The fact that the two types of groups are distinguishable on many of the variables studied can be considered to be evidence of the validity of the construct, "aptitude discrepancy."

Table 47
Rho and (1-Phi) Coefficients (X100)
Between Pairs of Groups on 29 Factors

Factor	Categories	VQ	VH	VA	QH	QA	HA
Background							
Sex	2	47	74	85	72	60	89
Hometown size	6	80	60	74	84	64	66
Class size	5	90	70	70	70	70	60
Father's occupation	5	62	100	30	62	68	30
Father's education	5	90	90	82	100	97	97
Mother's education	5	60	70	60	90	100	90
Parental education	9	88	92	71	92	69	69
Background median		80	74	71	84	69	69
Developmental							
Change in attitude toward English	2	67	82	95	84	71	87
Change in attitude toward mathematics	2	65	72	77	93	87	94
Timing of positive change toward English	2	72	77	80	50	94	58
Timing of negative change toward English	2	46	77	72	59	64	95
Timing of positive change toward mathematics	2	52	70	75	81	73	92
Timing of negative change toward mathematics	2	58	61	80	94	74	79
Reasons for positive change-English(Sample 1)	5	50	62	57	57	-07	52
(Sample 2)	5	87	97	90	90	63	82
Reasons for negative change-English(Sample 1)	5	15	07	52	45	15	82
(Sample 2)	5	37	52	50	55	27	87
Reasons for positive change-mathematics(Sample 1)	5	17	02	-27	97	87	95
(Sample 2)	5	27	70	67	82	72	97
Reasons for negative change-mathematics(Sample 1)	5	57	90	97	32	50	87
(Sample 2)	5	67	97	97	70	70	00
Change in Eng.-math. mark disparity	5	40	100	40	40	100	40
Developmental median		52	72	75	70	71	87
Effects							
English-math mark disparity, Grade 4	5	15	82	100	32	-35	82
Grade 8	5	10	10	57	80	22	62
Grade 12	5	-30	82	90	-32	-10	67
Attitude toward English(college)	5	-30	97	87	-42	-13	90
Attitude toward mathematics(college)	5	-82	-72	-70	90	95	95
College grade point average	6	81	89	94	64	93	83
College major	5	-90	70	80	-60	-50	70
Effects median		-30	82	87	32	-10	82

Table 48

Degree of Similarity of Groups
on 29 Factors

	Groups						
Rank	VQ	VH	VA	QH	QA	HA	T
1-2.5 (Most similar)	2	12	13	13	7	16	63
3-4	6	8	10	8	12	6	50
4.5-6 (Least similar)	21	9	6	8	10	7	61
Total	29	29	29	29	29	29	174

The median ranks also suggest that the V and Q groups resemble the H group almost equally, whereas V resembles A somewhat more than Q does. On 14 factors the V group is more like the H group than Q is and on 13 the Q group is more like the H group than V is; with respect to the A group, V is more like it on 20 factors, whereas Q is more like A on only 8. Thus, the important difference between the discrepant V and Q groups may not be so much their respective high aptitudes, which they both share with the H group, but rather their low aptitudes, and of these the more significant is the low verbal aptitude of the Q group.

The relationships among the three sets of factors provide some evidence that either the "background" factors selected for study were not as appropriate as the "development" factors or the influence of the former is overshadowed by that of the latter. The rank-order correlations of the median correlations for the six group pairings among the three sets of factors were:

Between "background" and "effects" : -.60
Between "background" and "development" : -.37
Between "development" and "effects" : +.77

The suggestion is that at least some groups with similar backgrounds develop differently and become quite dissimilar with respect to the effects studied here. These effects are apparently highly predictable from

developmental data. Closer examination of the median correlations in Table 47 reveals relatively consistent or slightly increasing similarity among the V, H, and A groups. Where the Q group is involved, the pattern is quite different. Very similar in background to the V group, the Q group's development is least similar to the V group's and on the dependent variables (effects), the two are quite dissimilar. Again, what characterizes the Q group and none of the other three, is extremely low verbal aptitude. The Q group is most similar, both in background and effect, to the H group, with which it shares a high quantitative aptitude.

Further Research

The results of this investigation are far from being clear and consistent, but they repeatedly focus attention on the Q-discrepant group. Because of the great preponderance of males in this group (and even more of females among the V-discrepants), comparisons with the mixed sex H and A groups in this study may have obscured some significant features. It might be profitable in any further research on the discrepancy phenomenon to hold sex constant in making comparisons.

Future studies should probably focus on the pre-collegiate population. An exploratory investigation of a ninth grade revealed marked differences in attitudes toward mathematics and English on the part of Q-discrepant students, but V-group did not display the expected strong opposite attitudes. Of further interest was some rather striking evidence of the lower educational and occupational status of the fathers of the ninth grade Q group. It is possible that many of these students never get to college, although in the right major fields they might succeed. This not only suggests the desirability of longitudinal studies of these children as they proceed through school, but also raises a social policy question: Should such discrepancy be valued and encouraged in the name of diversity or should efforts be directed at

keeping it minimal to reduce disadvantage and increase equality of opportunity? The present study did not indicate that "background" factors, other than sex, were as highly related to eventual status as were those intervening in "development." Since the latter are far more subject to intervention that the former, it would appear that a changed social policy could be implemented, if desired. That the Q group tends to attribute neither positive nor negative shifts in attitude toward literature to school-related factors may suggest that the school is failing to do something it should, rather than doing something wrong. The strong link between sex and the effects studied here may indicate that the offending or deficient practices are associated with sex stereotyping in the schools. Some detailed case histories of pupils with similar backgrounds might shed some light on why some ended up in the non-discrepant H group while others of same sex became discrepant in one direction or the other.

If it is decided that efforts to minimize aptitude discrepancy are either undesirable or futile, the question remains as to whether the discrepancy should be taken into account in instruction. An ATI study using discrepant status as the personalogical variable (Johnson and Posner, 1971) showed no significant disordinal interaction with treatments emphasizing verbal and symbolic presentation modes for learning class-reasoning principles at the college level. Nevertheless, 23 of 26 indicators were in the direction hypothesized for the interaction. Further study might provide a firmer basis for deciding whether differential instructional approaches for V- and Q-discrepant students would be worthwhile. Possibly even more important would be an investigation into how the two groups differ in the way they process information and acquire higher-order cognitions.

Undoubtedly there will always be some who will resist a strategy of capitalizing on strengths in lieu of correcting deficiencies and others who will reject the homogenizing effect of compensatory efforts in favor of cultivating idiosyncracy whenever it manifests itself. In either case, however, it is important to identify aptitude discrepancy as it begins to become discernible and to distinguish those characterized by it from those who are consistently "average."

References

Altus, W. D., Personality correlates of Q-L variability on the A.C.E. Journal of Consulting Psychology, 1952, 16, 284-291.

Johnson, M. & Posner, G. J., Testing the Effect of Verbal-Quantitative Aptitude Discrepancy on the Learning of Deductive Reasoning Through Programmed Instruction, Final Report, U.S.O.E. Project No. 9-B-054, Albany, SUNY at Albany, 1971.

Munroe, R. L., Rorschack findings on college students showing different constellations of subscores on the A.C.E. Journal of Consulting Psychology, 1946, 10, 301-316.

Sanders, M., Meffered, R. B., & Brown, W. H., Verbal-quantitative ability and certain personality and metabolic characteristics of male college students. Educational and Psychological Measurement, 1960, 20, 491-503.

Stafford, R. E., Hereditary and environmental components of quantitative reasoning. Review of Educational Research, 1972, 42, 183-201.

Wells, F. L., Verbal excess over quantitation: two case studies. Journal of Psychology, 1947, 23, 65-82.