Person by situation interactions in academic achievement[1]

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One of the first personality traits to be investigated and measured was that of intelligence, and there is now general agreement that for group data, measures on IQ tests show both durability over time and generality across situations (Anastasi, 1976). Thus, regarding consistency over time, Husén (1951, cited in Anastasi, 1976, p. 327) found a correlation of $r = .72$ between the test scores of 613 third grade schoolboys and the scores obtained by the same persons 10 years later on their induction to military service. Harnqvist (1968) reported a correlation of $r = .78$ between tests administered at 13 and 18 years of age to over 4,500 young men. As far as generality across situations is concerned many investigators of IQ have noted the operation of a large "g" or general factor across different measures. Brown (1970, pp. 342–343), for example, in his discussion of a multiaptitude test, the Differential Aptitude Test (DAT), notes correlations of the magnitude of .51 to .69 among such supposedly separate dimensions as the ability to perceive spatial relations, abstract reasoning ability, and numerical ability. Rushton and Wiener (1975) reported a correlation of $r = .73$ between what were intended to be two quite separate measures of IQ, a verbal and a nonverbal group test, with 30 7-year-olds and 30 11-year-olds.

The success that psychometricians found in producing tests of generality and durability in the field of intelligence was no doubt a great spur to the efforts of their colleagues in the field

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of social behavior. From the 1930s to the 1960s major efforts were made to find paper and pencil equivalents of the IQ test for a variety of traits, such as anxiety, extraversion, dependency, honesty, social intelligence, empathy, psychopathy, etc.

Unfortunately it must be admitted that, in the main, these efforts were not so successful. As Mischel (1968) noted in his major review of the literature, the typical generality across social behavior situations was of the order of .30, a far cry from the correlations of .60 and better found with IQ tests. One possibility for this discrepancy between IQ and other personality tests lies in the amount of concentrated effort and the relatively clear criterion for success found in the IQ research compared to that in other fields of personality. An alternative explanation lies in the differential malleability of individual differences in social behavior compared to cognitive (intellectual) functioning.

Two different methodologies have been used to assess the cross-situational generality of social behavior. One method, and the one relied on primarily by Mischel (1968), involves an analysis of correlation matrices of the same social behavior (e.g., dependency, honesty) across a number of situations (e.g., at home, in the classroom, on the playground). A second, pioneered by Endler and Hunt (1966) involves a variance components analysis in which all the variance in a set of scores is differentially assigned to persons (personality trait), situation, or the Person $\times$ Situation interaction. This variance components method typically finds results very similar to those found using the more traditional correlational analyses. Thus Endler and Magnusson (1976) reviewing a variety of studies using the variance-components paradigm on anxiety, hostility, social perception, conformity, and leisure time activities found that the variance due to persons typically accounted for less than 9 percent of the variance. If there were consistent personality traits across situations this figure should be considerably higher. Endler and Magnusson (1976) also noted that these same studies typically find that situations do not account for very much more of the variance. Instead, it is the Person $\times$ Situation interaction that typically accounts for more variance than either the person or the situation alone.[2] Hence idiosyncratically organized re-

2. One possible criticism of the variance components technique is, as Golding (1975) has pointed out correctly, that under certain circumstances it is entirely

sponses to specific situations appear to be the best reflection of reality.

The studies reviewed above, using the variance-components paradigm, focused on social variables rather than intellectual variables. The correlational studies cited earlier, however, indicated that there was evidence for trans-situational consistency as well as stability over time with respect to intellectual variables. Thus if we applied a person by situation variance components analysis to intellectual variables we would expect a high variance due to persons. A study by Mariotto and Paul (1975) found evidence for this expectation. They investigated the relative effects of persons versus situations for both cognitive and social variables in the real-life functioning of chronically institutionalized mental patients and found that while social behavior appeared to be situationally determined, cognitive behavior manifested consistency across situations.

The studies to be reported here had two main purposes. The first was to investigate whether the generality found in cognitive functioning, when IQ tests were given, is generalizable to aspects of cognitive functioning not specifically dealing with IQ; i.e., were such generalities a result of artificalities produced by IQ tests? The second was to further validate the Endler and Hunt (1966) variance components approach to personality in a context (e.g., intellectual functioning) that predicts a high variance due to persons. All previous research using the variance components paradigm has been concerned with social variables and has found small variance due to persons and situations, and a large variance due to Person $\times$ Situation interactions. The present study focuses on intellectual and cognitive functioning where consistency across situations (high variance due to persons and significant Person $\times$ Situation interactions) is expected.

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possible for the stability of rank orders (indicating generality across situations) to be high even in instances where the variance due to persons is small. Golding (1975) suggests that rather than continuing to use the variance components analysis pioneered by Endler and Hunt (1966), generalizability coefficients be calculated instead. However, when Golding (1975) reanalyzed Endler and Hunt's (1966) data using the methods he advocates, virtually identical results were obtained. Thus the picture of reality brought back by the variance components method was substantiated. In any case, the purpose of the present paper is to *contrast* findings in the intellectual sphere with those from the sphere of social behavior. This is best accomplished by using the two methodologies (correlations and variance components) that have been used most extensively, with whatever limitations, in the social field.

Could it be that the results obtained with social behavior variables were artifacts of the measuring instrument rather than due to the content of the variables investigated? An attempted refutation of the Endler variance components approach to personality functioning was attempted therefore to throw light on this question. If the variance components technique reflects artifacts due to the measuring instrument then one would expect low variance due to persons. If it does not then one would expect high variance due to persons in investigating cognitive variables.

Experiment 1

Method

School marks were taken from 91 lower middle-class and middle-class children, aged 10 to 12 (grades 6 to 8) attending a school servicing both urban and rural homes in a community north of Toronto. There were 35 boys and 56 girls. The academic subjects for which marks were available were English language, spelling, mathematics, geography, history, and science, and separate marks were available for the Christmas, Easter, and Summer (Final) terms.

Results

A correlation matrix was computed for the six school subjects over the three time periods. This matrix is shown in Table 1.

The correlations ranged from .25 to .86 with a median correlation (and also a mean) of .56. Thus there appeared to be considerable generality across different academic grades. A variance components analysis was then carried out on the data for both sexes combined. The results of this analysis are shown in Table 2. Fully 49 percent of the variance was due to persons.[3] Situations (different school subjects) accounted for only 4 percent of the variance, and the time of testing (Christmas, Easter, or Summer) less than .5 percent. There was also a highly significant Person $\times$ Situation interaction that accounted for 19 percent of the variance. When the variance components analysis was computed for each sex separately, virtually identical results were found. The generalizability reliability coefficients

3. An interesting figure, given Golding's (1975) criticism of this methodology. See footnote 1.

Table 1. Correlations among school grades for 91 10- to 12-year-olds (decimal points omitted).

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1 Language 1	(1.0)																	
2 Language 2	74	(1.0)																
3 Language 3	65	72	(1.0)															
4 Spelling 1	54	51	71	(1.0)														
5 Spelling 2	50	54	68	84	(1.0)													
6 Spelling 3	67	66	66	78	83	(1.0)												
7 Math 1	52	50	59	62	44	53	(1.0)											
8 Math 2	58	61	59	63	58	64	77	(1.0)										
9 Math 3	58	62	65	59	58	70	69	78	(1.0)									
10 Geography 1	34	43	64	55	59	53	34	48	54	(1.0)								
11 Geography 2	47	56	70	58	68	60	38	60	58	78	(1.0)							
12 Geography 3	44	37	60	57	55	57	40	45	53	74	72	(1.0)						
13 History 1	46	50	64	66	67	61	50	56	59	79	77	71	(1.0)					
14 History 2	45	48	65	54	55	50	43	51	56	71	83	69	86	(1.0)				
15 History 3	48	40	57	57	50	53	49	48	54	66	68	85	81	84	(1.0)			
16 Science 1	35	25	50	55	50	38	37	35	38	54	55	64	62	49	51	(1.0)		
17 Science 2	42	44	58	53	48	42	41	45	50	56	65	51	62	61	47	71	(1.0)	
18 Science 3	33	29	55	43	40	36	35	40	40	50	54	49	47	51	42	44	53	(1.0)

Table 2. Variance components (based on a random effects model) and percentages for each component of academic achievement in six school subjects (situations) across three time periods for a sample of school children aged 10 to 12 ($N = 91$).

Source	Variance component	Percent
Person (P)	71.01	49.13
School subject situation(s)	5.62	3.89
Time of testing (T)	0.51	0.35
P × S	27.80	19.23
P × T	2.86	1.98
S × T	1.16	0.81
Residual	35.57	24.61
Total variation	144.53	100.00

were .90 for persons, .87 for situations, .64 for time periods, and .96 for the Person × Situation interaction.

Experiment 2

In order to see whether the consistency due to intellectual functioning across academic subjects found in the 10- to 12-year-old primary school children was in itself a generalizable finding, we decided to repeat Experiment 1 on a high school population. Since in the high school there were more formal and objective assessments of the students' performance, any consistencies found across academic subjects would be much less likely to be due to "halo effects" operating.

Method

School marks were taken from 297 middle-class students, aged 15 to 17, attending their third and fourth years of high school (grades 11 and 12) in a community north of metropolitan Toronto. This initial sample included every student enrolled in those grades during the academic year 1975–76. The academic subjects for which marks were available included English, mathematics, biology, physics, chemistry, geography, history, world politics, French, Latin, and German.

Since each student could select "options," marks were not available for every student for each of these academic subjects. We decided therefore to take only one "science" mark for each student from either biology, physics, or chemistry. We took whichever of these marks came first on the computer output we were working from. Hence, if

a student was taking all three science subjects, only his or her biology marks were taken. If he or she was not taking biology then any available physics marks were taken. If the student wasn't taking either biology or physics, then his or her chemistry marks were taken. In a similar manner we computed a "social science" mark from either geography (a social science subject in this school), history, or world politics. Finally a "second language" mark was tabulated in similar fashion from either French, Latin, or German.

Three marks were taken from each student for each course—a Christmas mark, an Easter mark, and a Final one. The Final mark was not independent of the previous two and therefore was *not* included in the analyses to be reported. Only students having a *complete* set of marks for each term (including Final) were included. All students with missing marks were excluded. Altogether 150 students (76 boys and 74 girls) had a complete set of marks for English, mathematics, science, and social science. When a second language was included in addition, the sample was reduced to 60 students (20 boys and 40 girls). Each academic subject could be taken either at the normal "general" level or at an enriched "advanced" level. Thus a student could be taking 3 of his courses at the general level and 2 of them at an advanced level. To simplify the analyses we have collapsed across levels and treated them as equivalent. This was a conservative procedure which would have the effect of reducing any correlations across the academic courses. Furthermore, we have collapsed across third- and fourth-year students, thus creating a rather more heterogeneous group.

Results

A correlation matrix was computed for the five academic courses across both the Christmas and Easter testing periods. For the interrelations among the academic marks for English, math, science, and social science, the sample size was 150. When a second language was included the sample size was 60. This correlation matrix is shown in Table 3. The correlations ranged from .44 to .80 with a mean correlation of .58 (and a median of .56). If we include the second language the correlations range from .22 to .89 with both a mean and a median of .50. Variance components analyses were also carried out on these data. The results of this analysis for the four main academic courses: English, math, science, and social science are shown in Table 4.

The results of this analysis show that over 50 percent of the

Table 3. Correlations among Christmas and Easter grades in five academic subjects for 150[a] high school students aged 15 to 17 (decimal points omitted).

	1	2	3	4	5	6	7	8	9	10
1 English 1	(1.0)									
2 English 2	75	(1.0)								
3 Math 1	53	44	(1.0)							
4 Math 2	53	49	80	(1.0)						
5 Science 1	48	50	54	54	(1.0)					
6 Science 2	54	53	57	63	75	(1.0)				
7 Social science 1	59	53	50	57	58	69	(1.0)			
8 Social science 2	50	55	49	58	57	72	80	(1.0)		
9 Languages 1	28	39	34	40	34	44	22	23	(1.0)	
10 Languages 2	26	42	37	39	36	36	27	27	89	(1.0)

[a] Sample size for correlations with languages = 60.

variance was due to persons. Situations (different school subjects) accounted for less than 1 percent of the variance, and the time of testing (whether at Christmas or Easter) accounted for less than .1 percent. There was also a highly significant Person × Situation interaction that accounted for 24 percent of the variance. These figures did not differ appreciably if we computed the data for each sex separately, or even if we added in the foreign language and reduced our sample size to 60. In this latter case the variance due to persons was reduced to 48 percent, while situations went up to 5 percent and the Person × Situation interaction increased to 29 percent. The generalizabilty reliability coefficients for the data in Table 4 were .85 for persons, .79 for situations, .56 for time of testing, and .94 for the Person × Situation interaction.

Experiment 3

The findings of the first two experiments were striking. Fully 50 percent of the variance in academic performance was due to persons. Furthermore, this result was robust over a number of different analyses performed on the data. The interesting question arises as to how robust this phenomenon is. What are the limits to which it can be pushed? In this last experiment we decided to look at a restricted range of academic performances. Specifically, we wondered what the intercorrelations would be across academic situations for Faculty of Science students enrolled at York University.

Table 4. Variance components (based on a random effects model) and percentages for each component of academic achievement in four academic subjects (situations) across two time periods for a sample of high school students aged 15 to 17 ($N = 150$).

Source	Variance component	Percent
Person (P)	90.38	52.66
Academic subject situation (S)	11.58	0.92
Time of testing (T)	0.13	0.08
P × S	40.49	23.59
P × T	3.31	1.93
S × T	0.08	0.05
Residual	35.67	20.78
Total	171.64	100.00

Method and Results

Final year marks were taken from every student enrolled in the Faculty of Science at York University for the year 1974–75. There were a total of 1,012 such students who had marks altogether on several hundred courses. This initial sample was first reduced by our decision to examine the relation only among the courses in which 31 or more students were enrolled. This sample was reduced even further by our decision to examine the relations only among those courses in which 10 or more students were enrolled *in common.* There was a possible total of 30 such courses and the correlations of marks among these are shown in Table 5. The correlations ranged from –.11 to .95 with a mean intercorrelation of .62 (and a median of .63). Thus it is quite clear that there is considerable cross-situational generality across different academic situations for the university students. Due to unequal numbers in the cells of the matrix and to the large number of missing data points it was not feasible to also carry out a variance components analysis on this data.

Discussion

Individual differences in cognitive (intellectual) functioning across different academic situations show remarkable cross-situational generality. The mean correlations across situations were .56, .58, and .62 for three samples drawn respectively from a primary school, a high school, and a university. These figures contrast with the correlations of .3 that are typically found across social behavior situations. A variance components analysis carried out on the first two samples showed that in both cases fully 50 percent of the variance in the marks was attributable to con-

Table 5. Intercorrelations among marks in Faculty of Science courses in which 10 or more students were enrolled in common. (Decimal points have been omitted; sample size ranged from 10 to 184 with a mean of 30.)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
1 BIOLOGY	(10)																													
2 GENETICS	65	(10)																												
3 BIOCHEMISTRY 1	–	57	(10)																											
4 CELL BIOLOGY	75	72	52	(10)																										
5 ANIMAL PSYCHOLOGY	–	60	67	80	(10)																									
6 ECOLOGY	81	74	60	72	69	(10)																								
7 BIOMETRICS	–	–	72	–	90	–	(10)																							
8 BIOCHEMISTRY 2	–	78	43	77	86	36	92	(10)																						
9 PLANT PHYSIOLOGY	–	86	65	75	90	79	85	–	(10)																					
10 CHEMISTRY	–	–	–	–	–	–	–	–	–	(10)																				
11 COMPUTER SCIENCE	–	–	–	–	–	–	–	–	–	–	(10)																			
12 MACHINE STRUCTURE	–	–	–	–	–	–	–	–	–	–	94	(10)																		
13 DATA PROCESSING	–	–	–	–	–	–	–	–	–	–	95	56	(10)																	
14 LIBERAL SCIENCE	–	–	–	–	–	–	–	–	–	–	–	–	–	(10)																
15 POPULATIONS	–	–	–	–	–	–	–	–	–	–	–	–	–	–	(10)															
16 NUTRITION	64	–	–	–	42	–	–	–	–	–	–	–	–	66	–	(10)														
17 ENERGY	60	57	–	55	–	44	–	–	–	–	–	–	–	–	–	–	(10)													
18 TECHNOLOGY	–	–	–	–	–	–	–	–	–	–	–	–	–	–	57	–	–	(10)												
19 PHYSICS 1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	(10)											
20 ATOMIC STRUCTURE	35	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	(10)										
21 PHYSICS 2	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	(10)									
22 PSYCHOLOGY	48	72	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	60	–	(10)								
23 PHYSICAL SCIENCES	59	–	–	–	–	–	–	–	–	–	77	–	–	–	–	–	20	–	–	–	–	–	(10)							
24 BIOLOGICAL SCIENCES	90	85	–	–	–	–	–	–	–	–	62	–	–	–	–	–	39	–	67	83	–	64	79	(10)						
25 MATHS 1	63	–	–	–	01	–	–	–	–	–	68	–	77	–	–	–	55	–	54	66	–	77	83	76	(10)					
26 MATHS 2	47	34	–	03	–	15	–	–	–	23	–	–	–	–	–	–	90	–	–	–	–	–	61	80	72	(10)				
27 MATHS 3	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	70	38	–	10	–	52	–	21	(10)			
28 MATHS 4	50	68	–	–	–	–	–	–	–	–	67	–	–	–	–	–	63	–	70	–	–	87	74	75	83	65	57	(10)		
29 SCIENCE 1	–	–	–	–	–	–	–	–	–	81	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	(10)	
30 SCIENCE 2	58	–	–	–	–	–	–	–	–	79	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	80	(10)

sistent individual differences residing in persons regardless of the situations they found themselves in. This figure contrasts markedly with that found for social behaviors and personality traits where the figure rarely gets above 9 percent (see Endler & Magnusson, 1976). It would appear that human nature differs in its malleability across situations. Whereas social behavior appears to change to some extent from situation to situation, this is far less the case for cognitive functioning.

One rationale for this state of affairs is that suggested by both Magnusson and Endler (Endler, 1977; Magnusson, 1976; Magnusson & Endler, 1977). They suggest that the consistency of mediating or intervening variables depend on whether such variables are structural, content, or motivational in nature. In this formulation, structural variables refer to information processing variables such as intelligence and cognitive complexity;

content variables refer to stored or situationally determined information (e.g., the content of aggression arousing situations); while motivational variables refer to drives, needs, motives, etc. With respect to information processing structural variables, there is coherence in terms of the strategies used to select and process content and motivational variables. However, the manifestation of the content and motivational variables may vary from situation to situation. Thus, although one would expect substantial Person × Situation interactions for both structural variables on the one hand and content and motivational variables on the other, one would expect high individual consistency for structural variables and low individual consistency for motivational and content variables. Endler and Hunt (1969) found that for the motivational and content variable of anxiety, the median variances due to persons across 22 samples of males was 4.44 percent, and that across 21 samples of females was 4.56 percent. In the present study on academic achievement (a cognitive variable) the variance due to persons was 49 percent, thus confirming Endler's (1977) contention that there is high consistency for cognitive (structural) variables and low consistency for content and motivational variables. It should be noted that in the Endler and Hunt (1969) study where there was low individual consistency, the Person × Situation interaction variance with respect to anxiety (a motivational and content variable) was 9.14 percent for males and 9.31 percent for females. In the present study where there was high individual consistency, the Person × Situation interaction variance with respect to academic achievement (a structural variable) accounts for almost one-fifth (19 percent) of the total variance.

The above analysis also ties into the heredity versus environment controversy. It suggests that cognitive, intellectual functioning is less modifiable (or at least has been less modified in our samples) by the environment than has social behavior and motivational variables. This line of reasoning rests on the assumption that those factors which are modifiable by the environment will show a different patterning over different environments (situations) due to different experiences in those different situations. That this has not occurred, despite the presumably different environments that occur in different academic situations (across several years of schooling from primary school to uni-

versity), suggests that the environment is having less effect on these particular dependent variables.

Summary

Three studies found high consistency in academic achievement across situations. In Experiment 1, a mean correlation of .56 was obtained across six academic disciplines for 91 primary school children. A variance components analysis revealed that the variance due to Persons was 49 percent and to the Person × Situation interaction, 19 percent. Situations accounted for only 4 percent of the variance. In Experiment 2, a mean correlation of .58 was obtained across four academic disciplines for 150 high school students. Variance components analysis revealed that the variance due to persons was 53 percent and the Person × Situation interaction, 24 percent. Situations accounted for only 1 percent of the variance. In Experiment 3, a mean correlation of .62 was obtained across disciplines among final year Faculty of Science students at York University.

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