Adoption Data and Two *g*-Related Hypotheses

ARTHUR. R. JENSEN
University of California, Berkeley

Data on the Wechsler Intelligence Scale for Children-Revised (WISC-R) from a now classic adoption study (Capron & Duyme, 1989, 1996) were used to examine the hypothesized relationship between diverse cognitive tests' g loadings and the degree to which the scores on each of the tests is influenced by the socioeconomic status (SES) of the biological parents of the adopted children (a genetic effect) as contrasted with the SES of the adoptive parents (an environmental effect). The analysis shows that the genetic effect is reflected by psychometric g to a greater degree than is the environmental effect, a finding consistent with the hypothesis that the g factor largely reflects the genetic component of variance in cognitive tests. These data also extend previous findings on Spearman's hypothesis that the standardized mean white-black (W-B) difference on various tests is directly related to the tests' g loadings. It was found that the profile of the mean W-B differences on various subtests of the WISC-R (in the U.S. standardization sample) is more similar to the profile of genetic effects on the subtest scores than to the profile of environmental effects, as measured in the adoption study.

Several studies based on MZ and DZ twins have shown that the broad heritability of various cognitive abilities measured by diverse psychometric tests (such as the subscales of the WISC-R) is directly related to those tests' loadings on the g factor extracted from a factor analysis of the various tests (studies reviewed in Jensen, 1987a, pp. 102-104; also Pedersen, et al., 1992). Measures of inbreeding depression on the scores of various tests, which reflect the effect of genetic dominance, are also directly related to the tests' g loadings (Jensen, 1983). These relationships were discovered by correlating the vector of heritability coefficients for the various tests with the corresponding vector of the tests' g loadings. Latent trait models of genetic and environmental effects on the total variance in a battery of diverse tests have also shown that g is more strongly reflective of genetic variance than any of the non-g psychometric factors (Cardon et al, 1992; Luo, et al., 1994). The g factor is also specifically correlated with several physiological variables independently of other psychometric factors (Jensen, 1993; 1997; 1998).

Direct all correspondence to: Arthur R. Jensen, School of Education, University of California, Berkeley, CA 94720.

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The hypothesis suggested by Spearman's observation (1927, p. 379) that the size of the standardized mean white-black (W-B) difference on various cognitive tests is directly related to the tests' g loadings has been borne out in numerous data sets (Jensen, 1985, 1987b). However, the question of whether the mean W-B difference involves genetic as well as environmental influences is still unsettled, although recent studies suggest that both sources of between-groups variance need be taken into account to explain their findings most parsimoniously without violating Occam's razor (Rowe & Cleveland, 1996).

Data from the now classic adoption study by the French geneticists Capron and Duyme (1989) based on a full cross-fostering design can be used to examine further the phenomena described in the previous paragraphs. In their most recent article on this unique adoption study, Capron and Duyme (1996) analyzed their WISC-R data at the level of the separate subtests. Their results provide the material for the present analyses. As Capron and Duyme (1989, 1996) give full details of the study design, the characteristics of the adoption data, and their method of analysis, these need not be spelled out here.

THE STUDY DESIGN

In the full cross-fostering adoption design used in this study, comprising four categories of adopted children, consisted of French children whose biological parents were either of low socioeconomic status (SES) or of high SES had adoptive parents who were either of low SES or high SES. High SES and Low SES groups on the *biological* classification of the adoptees were labeled B+ and B-, respectively. High SES and Low SES of the *environmental* classification of the adoptees were labeled A+ and A–, respectively. There were 10 adoptees in each cell of the 2 X 2 factorial design except for the cell containing the very scarce adoptees classified as B+/A–, which had only 8 subjects (hence a total *N* of 38 subjects). The *N* was limited mainly by the fact that each category of adoptees was selected exclusively from either the highest or the lowest categories of the parents' occupational

Table 1. Design of the Study[a]

		SES of Both Adoptive Parents	
		High *A+*	*Low* *A–*
SES of both biological parents	High B+	A+/A+ (1)	B+/A– (2)
	Low B–	B–/A+ (3)	B–/A– (4)

Notes: [a]From Capron & Duyme, 1996, Table 1, p. 262.

Subjects in all cells are adopted children. Biological parents with high SES (B+) or low SES (B–); adoptive parents with high SES (A+) or low SES (A–). The data in each cell are the children's scaled scores on the WISC-R subtests. (Cell means for each of the 10 WISC-R subtests are provided by Capron & Duyme, 1996, Table 4.)

The main effect for *biological* influence is the mean difference between cells (1+2)–(3+4). The main effect for *environmental* SES influence is the mean difference between cells (1+3)–(2+4).

Table 2. Data for Analysis Based on Correlated Vectors

	Disattenuated g Loading[a]			*Hi-Lo SES Diff*[b]		
WISC-R Subtest	*French*[c]	*White*[d]	*Black*[e]	*Bio.*	*Adopt.*	*W-B Diff*[f]
Information	.906	.807	.749	4.78	6.88	0.810
Similarities	.860	.824	.798	11.47	3.01	0.790
Arithmetic	.701	.675	.691	5.25	1.02	0.610
Vocabulary	.696	.726	.724	11.80	2.10	0.880
Compehension	.970	.765	.778	6.11	1.60	0.940
Picture Completion	.537	.631	.713	0.81	1.26	0.790
Picture Arrangement	.628	.626	.600	3.11	0.61	0.770
Block Design	.721	.732	.714	9.45	8.09	0.930
Object Assembly	.669	.638	.711	3.15	4.29	0.820
Coding	.375	.441	.493	1.03	5.65	0.470

Notes: [a] First unrotated principal factor; correction for attenuation based on reliability coefficients in U.S. standardization sample.

[b] The F ratio for the main effect mean difference (on the particular subtest) between groups of adopted children whose *biological* (Bio) parents were either of high SES or of low SES; and between groups of children whose *adoptive* parents were either of high SES or of low SES. (From Capron & Duyme, 1996, Table 3, p. 265.)

[c] First principal factor loadings (corrected for attenuation) based on data from Capron & Duyme (1996, Appendix, p. 273).

[d] First principal factor loadings (corrected for attenuation) based on the correlation matrix for the U.S. *white* standardization data (in Jensen & Reynolds, 1982, Table 2, p. 430).

[e] First principal factor (corrected for attenuation) based on the correlation matrix for the U.S. *black* standardization data (in Jensen & Reynolds, 1982, Table 2, p. 430).

[f] The mean black-white difference in the U.S. standardization data expressed in averaged standard deviation units (from Jensen & Reynolds, 1982, Table 1, p. 425).

level such that the adoptees' biological and adoptive parents were matched in this respect (see Capron & Duyme, 1989, pp. 552-553, for full details on selection of the adoptees.)

Capron and Duyme report a multivariate analysis of variance (MANOVA) of the study design shown in Table 1. The MANOVA was performed on the WISC-R scaled scores for each of ten WISC-R subtests. (The Digit Span test was omitted.) Significant main effects on some of WISC-R subtest scores were evident for both the SES of the biological parents and the SES of the adoptive parents; there were no statistically significant interactions between biological SES and adoptive SES for any of the ten WISC-R subtests. The biological SES effect presumably reflects largely genetic influences; the adoptive SES reflects largely postnatal environmental effects generally associated with SES.

CORRELATED VECTORS

The basis of the following analyses are the six column vectors shown in Table 2, the footnotes of which identify the source of each vector. The term *vector* in the present context always refers to a column of figures based on each of the ten WISC-R subtests.) The g factor of the ten WISC-R subtests is best represented by the first unrotated principal factor. As there was only one large and significant factor (with eigenvalue > 1) in each of the three correlation matrices, a hierarchical factor analysis could not be properly performed. However, alternative methods for extracting a general factor typically yield virtually equivalent results and represent g almost equally well (Jensen & Weng, 1994). Because the relative

Table 3. Correlations (decimals omitted) Between Vectors Shown in Table 2[a] and the First Two Principal Components of the Pearson r Matrix

Vector		F_g	W_g	B_g	*Bio*	*Adp*	*W-B*
French *g*	(F_g)		921	841	547	014	667
White *g*	(W_g)	927		919	700	040	722
Black *g*	(B_g)	818	927		585	-073	750
Bio.	(Bio)	673	746	673		099	514
Adopt.	(Adp)	224	333	236	200		039
W-B Diff	(W-B)	602	559	657	553	316	
P.C. I		912	974	937	744	031	827
P.C. II		-040	003	-131	164	990	005

Note: [a]Pearson r matrix above diagonal; Spearman rank-order correlation (r_s) below.

magnitudes of factor loadings are affected slightly by variation in the reliability coefficients of the various subtests, the g loadings in Table 2 have all been corrected for attenuation, using the subtest reliability coefficients based on the U.S. standardization sample.

Table 3 shows the Pearsonian correlations (r) and Spearman's rank-order correlations (r_s) among the six column vectors in Table 2. (In Table 3 the three vectors of g loadings are labeled F_g [based on French adoption data], W_g [based on Whites in the WISC-R U.S. standardization sample], and B_g [based on Blacks in the WISC-R standardization sample]; the vectors showing the effects of SES of the biological and of the adoptive parents on the adoptees'WISC-R subtest scores are labeled *Bio* and *Adp*, respectively; the vector of the standardized mean White-Black differences [from the U.S. standardization samples] on each of the WISC-R subtests is labeled W-B Diff.) Each correlation coefficient between the six vectors in Table 3 is based on an N of 10 (i.e., the number of WISC-R subtests).

Most important to note in Table 3 is the distinct bimodality of the relative magnitudes of the correlations between the various vectors. This clearly reflects the difference between the effects of biological and postnatal environmental factors on WISC-R performance. The results of this analysis are quite consistent with the two hypotheses indicated in the Introduction, viz., (1) The g factor is more reflective of biological or genetic sources of variance than of environmental sources associated with SES; and (2) the size of the standardized mean W-B differences on various tests are related to the tests' g loadings and reflects a biological or genetic source of between-groups variance at least as much as it reflects environmental factors associated with SES.

The consistency of the data with these hypotheses can be seen simply by inspecting the correlations in Table 3. It is made especially clear by obtaining the first two principal components (labeled P.C. I and P.C. II in the last two rows of Table 3) of the matrix of Pearsonian correlations (i.e., the correlations in the upper triangle of the matrix in Table 3). P.C. I, which has its largest values on the g vector for each of the three population groups, clearly reflects the g factor of the WISC-R battery. Note that all but one of the six vectors represented in this matrix fall clearly within the sphere of g. The one and only small and nonsignificant loading found on P.C. I represents the effect of the environment provided by the *adoptive parents* (labeled *Adp* in Table 3), which has a loading of only .031. In marked contrast, the P.C. I loading for the effect of the *biological parents* (labeled *Bio* in Table 3) is .744.

On the other hand, the second principal component (P.C. II in the last row of Table 3), which clearly represents both non-g and nongenetic sources of variance, has its one and only large loading (.990) on the vector representing the postnatal environmental effect of the adoptive parents (labeled *Adp* in Table 3).

Of course, if the g factor extracted from the French version of the WISC-R that was used with the sample of 38 French adoptees in the Capron and Duyme study did not represent essentially the same g factor as those obtained from the white and the black U.S. standardization samples, these results would be moot. In fact, however, the three g factors are highly congruent, as indicated by the high intercorrelations between the g vectors (shown in Table 3) and by the coefficients of congruence between the g factors, all three of which are +.99, a value which is conventionally interpreted as indicating virtual identity of the compared factors.

Factor scores[1]

Another way of contrasting the relative influences of the children's biological and environmental backgrounds on the g factor is to calculate estimated g factor scores for the entire sample and then observe the difference in mean factor scores for the high versus low groups in the biological classification (i.e., groups B+ versus B- in Table 1), on the one hand, and the difference in mean factor scores for the high versus low groups in the environmental classification (i.e., groups A+ and A-), on the other. The g factor scores were obtained by Bartlett's (1937) method (explicated by Harman, 1976, pp. 379-381). The advantage of Bartlett's method is that it maximizes the correlation between the factor scores and the particular latent trait they are intended to measure (in this case the g factor), at the same time minimizing any unique variance in the factor scores. The factor scores are standardized (i.e., z scores). The mean standardized difference in g factor scores for the postnatal environmental effect (i.e., contrasting A+ and A- in Table 1) is 0.129, $t = 0.41$, $p = .68$ (2- tail). The mean standardized difference in g factor scores for the *biological* effect (i.e., contrasting B+ and B- in Table 1) is 0.861, $t = 3.08$, $p = .004$ (2-tail). In other words, the effect on the level of g of an extreme difference in SES environmental background is small and, in this study, even nonsignificant. In contrast, the effect on g of a difference in the SES level of the adoptees' biological parents is relatively large and highly significant.

It should be noted that the average difference in IQ between the high SES parents and the low SES parents (whether the biological or the adoptive parents) are less extreme than their difference in SES, because of regression due to the less than perfect correlation between IQ and SES. The typical correlation in adults between IQ and attained SES is about +.70.

Black-White differences related to g. In light of recent behavior-genetic studies of the sources of influence on the average W-B differences in IQ and scholastic achievement (Rowe & Cleveland, 1996; Waldman et al., 1994), it should be noted that W-B differences in the WISC-R U.S. standardization samples are more highly correlated ($r = .514$) with the biological effects (*Bio* in Table 3) than with SES differences in the adoptive (*Adp*) environment ($r = .039$).

This finding is consistent with the actual results of the above cited studies (if not always with their authors' disclaimers). These consistencies seem worth pointing out, because science, in its continuing battle against ad hoc explanations, advances through the discovery of consistencies (and inconsistencies) across various studies and lines of evidence that have certain phenomena, constructs, or variables in common.

NOTE

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