J. biosoc. Sci. (1973) **5**, 17–30

BIOLOGICAL ASPECTS OF A HIGH SOCIO-ECONOMIC GROUP

II. IQ COMPONENTS AND SOCIAL MOBILITY

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(*Received 2nd June* 1972)

Summary. Data are presented on the verbal and performance (non-verbal) IQs of a sample of university scientists, their surviving fathers and male sibs.

Although mean IQs differ between scientific disciplines the disciplines do not differentially attract scientists from particular socio-economic classes.

The verbal IQs of both the scientists and their fathers are positively correlated with socio-economic class but only in the fathers' sample is the performance IQ/class correlation significant. The variance of both verbal and performance IQs increases from Class I to Class IIIM. The overall estimate of heritability for the verbal IQ is higher than that for the performance IQ.

Verbal and performance IQs are related to the distance the scientists have moved on the socio-economic scale. The effects of social mobility on the genetic and environmental components of the verbal and performance IQ phenotypic variances are discussed.

Introduction

Sir Cyril Burt was not the first to express the idea that 'discrepancies between the general intelligence of the children and the occupational class into which they were born is bound to produce a large and fairly constant amount of "basic mobility"' (Burt, 1961), but he was the first to test the hypothesis in a general population sample by comparing the IQs of fathers and sons and relating the differences to both upward and downward social mobility. Burt & Howard (1956) and Burt (1966) found that a considerable proportion of social mobility was related to IQ. A similar approach but with smaller samples, yielded consonant results (Gibson & Young, 1965; Gibson, 1971).

Gibson (1970) described the IQs and social backgrounds of an age-selected sample of scientists in the University of Cambridge, their male sibs and their surviving fathers. The upward social mobility of the scientists was related to their

IQs. In particular it was found that when siblings who were reared together had moved into different social classes as adults, the sib with the higher IQ was more likely to have moved up and the sib with the lower IQ was more likely to have moved down the socio-economic scale.

Whatever it is that IQ tests attempt to measure, it is certainly not a simple variable. At least two major items, verbal and spatial reasoning abilities, have been identified in many general IQ tests, though it is probable that these two components each consist of complex interacting moieties. Little attention has been given to the possibility that the separate IQ components might be differentially implicated in social mobility. Although the sample of scientists previously investigated is too specialized to be ideal for this purpose it seemed worthwhile to analyse the data from this point of view, pending the completion of more suitable studies now in progress.

The sample

The selection and composition of the initial sample has previously been described in detail (Gibson, 1970). It is sufficient to reiterate here that the probands were a sample of scientists in the University of Cambridge between the ages of 25 and 34. This initial sample provided 157 willing subjects (84·8% of the possible sample) together with fifty-two of their male sibs and eighty of their surviving fathers. Each subject completed a questionnaire about his education and occupational career and undertook an IQ test. Most of the data described in the present paper derive from analyses of the eighty father/son pairs.

The IQ test

The Wechsler Adult Intelligence Scale (Wechsler, 1955) was used to assess the IQs of this sample. The WAIS was chosen because it attempts to measure a spectrum of abilities and is a widely-used general purpose intelligence test. It contains eleven subtests each composed of relatively homogeneous but increasingly difficult items (the one exception is the Digit Symbol subtest). An individual's achievement on each subtest is given a raw score which is then converted to a standardized scaled score. Six of the subtests are primarily concerned with verbal items and five with non-verbal or performance items (Table 1). None of the subtests measures a particular quality. The total of the scaled scores on the verbal and performance items can be used to obtain the age-corrected verbal and performance IQs. The verbal and performance scores are summed to obtain the full-scale score or total IQ. This subdivision of the WAIS into verbal and performance components has been substantiated by factor analysis (Cropley, 1964).

The scientists were in one of the standardized WAIS age groups but the scientists' sibs and their fathers were in a variety of age groups. All of the IQ scaled scores were standardized for age.

Results

Comparison of verbal and performance IQs

The distribution of the verbal and the performance components of the IQs of the scientists and of their fathers is shown in Text-fig. 1. The scientists' mean verbal IQ is significantly higher than their mean performance IQ ($t_{(147)} = 7{\cdot}49$, $P < 0{\cdot}001$), although the variances of the two IQ scores are not significantly different.

Table 1. The subtest components of the Wechsler Adult Intelligence Scale

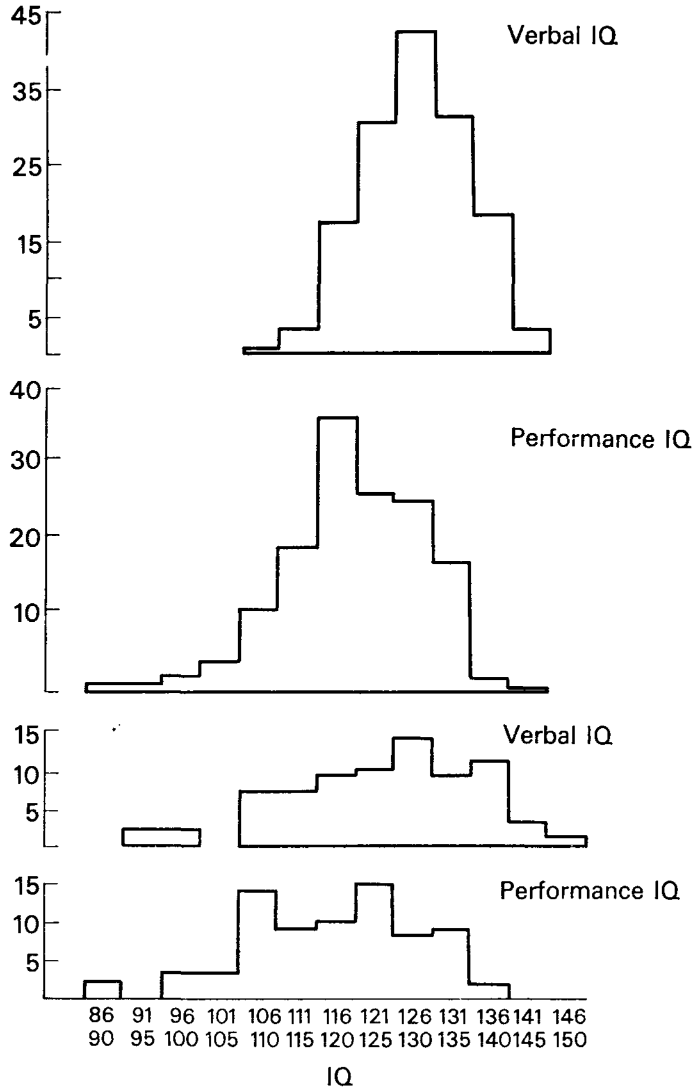
Verbal tests	Performance tests
Information	Digit symbol
Comprehension	Picture completion
Arithmetic	Block design
Similarities	Picture arrangement
Digit span	Object assembly
Vocabulary	

Similarly the mean verbal IQ of the fathers' sample is significantly higher than their mean performance IQ ($t_{(76)} = 3{\cdot}75$, $P < 0{\cdot}001$). The difference between the mean verbal and performance IQs is very similar for both the scientists and their fathers. In a general population sample the mean scores for the two components of the total IQ would not be expected to differ significantly.

Socio-economic class and scientists' discipline

The scientists, by virtue of their professional occupations, were all in Class I of the Registrar General's (1966) classification of occupations. However, they were subdivided on the basis of the socio-economic class into which they were born. For most of the scientists this was their father's main occupational class. It has previously been shown (Gibson, 1970) that the IQ of the scientists was related to the socio-economic class into which they were born. But it was also shown that there were significant differences in mean IQ between scientists in different disciplines and between mean IQs of those who attained different classes of bachelor degree (Gibson & Light, 1967). Therefore it remained possible that the positive correlation between the IQ and class was, at least in part, a consequence of scientists of different disciplines originating in different socio-economic groups, rather than a vestige of the well-known relationship between social background and IQ (Douglas, 1964).

To test this hypothesis we have compared the socio-economic class distribution of scientists in different disciplines (Table 2). These data lend little support to the hypothesis: with the possible exception of mathematicians who originate mainly



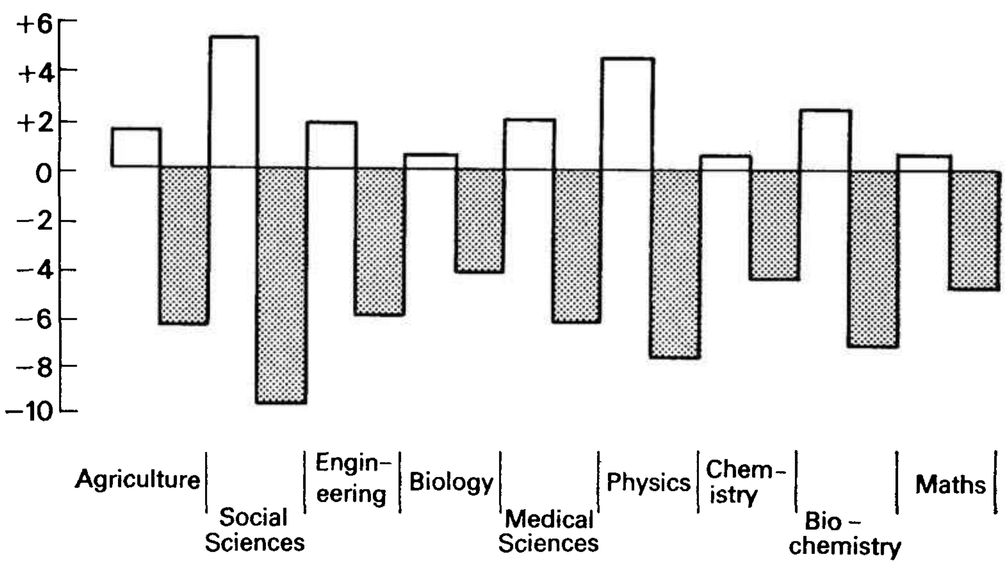
Text-fig. 1. Distributions of verbal and performance IQs in the scientists (upper two figures) and their fathers (lower two figures).

in Class II, there is no obvious relationship between the scientists' socio-economic class origins and their main subjects. There is, however, a suggestion in the data that the disciplines with the lowest mean IQ have relatively few members from the manual socio-economic groups.

Within each discipline the scientists' mean verbal IQ scores were higher than their mean performance IQ scores. This difference between the verbal and performance IQs was similar in each discipline (Text-fig. 2) and the regression of this

Table 2. Scientists' IQ, socio-economic class and main discipline

Main discipline of scientist	Mean IQ	Socio-economic class I	II	IIINM	IIIM	Others
Agriculture	121·6	6	9	2		
Social sciences	121·8	2	6	2		
Engineering	125·0	3	6	4	3	
Biology	126·1	6	8	3	2	1
Medical sciences	127·0	2	6	—	1	1
Physics	127·7	9	7	1	3	
Chemistry	129·6	3	3	3	2	
Biochemistry	130·0	4	3	3	—	
Mathematics	130·4	1	13	—	2	
Mean IQ		129·7	128·6	125·7	123·4	—
n	—	36	61	18	13	2

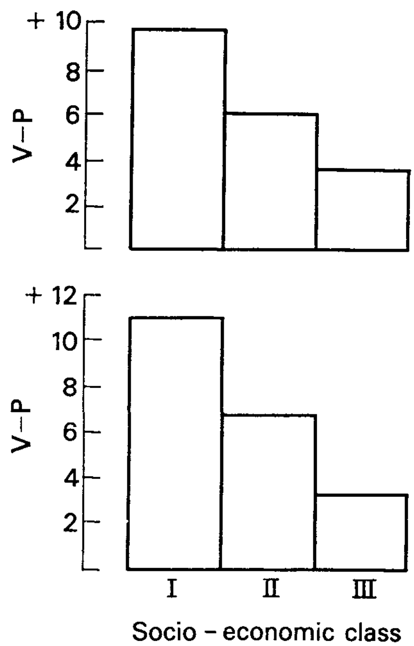


Text-fig. 2. Mean deviation in verbal IQ and performance IQ (shaded) from the mean total IQ in each discipline.

difference on the mean IQ of each discipline was not significant ($t_{(147)} = 1{\cdot}41$, $P > 0{\cdot}05$). These data suggest that the difference between the scores on the verbal and the performance components of the IQ test does not depend upon the total IQ score.

Socio-economic class and the IQ components

The regression coefficient of the scientists' verbal IQ on their initial socio-economic class was positive and significant (Tables 3 and 4). In contrast, the mean performance IQs were very similar for scientists from different socio-economic classes and the regression of their performance IQ on socio-economic class was not significant. The degree of freedom associated with the difference between the two regressions is not significant. However, the difference between the scientists' verbal and performance IQs (Text-fig. 3) increases from Class III to Class I, and the regression of this difference on the class into which the scientist was born is positive and significant ($b = 2{\cdot}86$, $P < 0{\cdot}001$).



Text-fig. 3. The mean difference between verbal IQ and performance IQ in each socio-economic class for the scientists (upper figure) and their fathers (lower figure).

The relationship between the verbal IQ and socio-economic class found in the scientists' generation is also evident in the data for the scientists' fathers. However, although both regressions of fathers' verbal IQ and performance IQ on their main socio-economic class are positive and significant, they are not significantly different to the values obtained for these relationships in the scientists' generation (Tables 5 and 6). Again in the fathers' generation the difference between the verbal and performance components of the IQ increases from socio-economic Class III to Class I (Table 3 and Text-fig. 3). It is interesting that the variance of the verbal and performance IQs increases from Class I to Class IIIM (Table 3).

Table 3. The mean verbal and performance IQs of the scientists and their surviving fathers in each socio-economic class

Socio-economic class	Scientists					Fathers				
	n	Verbal IQ	SD	Performance IQ	SD	*n*	Verbal IQ	SD	Performance IQ	SD
I	44	129·52	0·88	120·23	1·10	17	132·71	1·73	121·82	2·57
II	64	128·41	0·88	120·64	1·31	36	124·33	2·13	117·53	1·72
III non-manual	18	124·89	1·43	121·88	2·17	10	119·40	2·87	117·60	3·51
III manual	19	127·21	1·83	120·68	1·67	12	116·50	3·13	111·00	4·35

Table 4. Regression coefficients of the scientists' IQ components on scientists' initial socio-economic class

Verbal IQ	Performance IQ
$b = +2.95$ $t_{(73)} = 3.81$ $P < 0.001$	$b = +0.75$ $t_{(73)} = 0.84$ $P > 0.03$

Analysis of variance of joint regression

Source	df	Mean square	Probability
Joint regression	1	488·1	<0·01, >0·001
Difference between regressions	1	172·16	>0·05, <0·10
Difference between means	1	1492·57	<0·001
Error	146	50·25	

Table 5. Regression coefficients of the fathers' IQ components on socio-economic class

Verbal IQ	Performance IQ
$b = +5.33$ $t_{(73)} = 4.1$ $P < 0.001$	$b = +3.20$ $t_{(73)} = 2.4$ $P > 0.01, < 0.001$

Analysis of variance of joint regression

Source	df	Mean square	Probability
Joint regression	1	2592·42	<0·001
Difference between regressions	1	161·14	>0·02
Difference between means	1	1785·11	<0·001
Error	146	123·09	

Table 6. Comparison of verbal IQ and performance IQ/class correlations in the scientists and their fathers

Analysis of variance of joint regression verbal IQ on class

Source	df	Mean square	Probability
Joint regression	1	2441·93	<0·001
Difference between regressions	1	201·49	>0·1
Difference between means	1	875·67	<0·01, >0·001
Error	146	81·22	

Analysis of variance of joint regression performance IQ on class

Source	df	Mean square	Probability
Joint regression	1	556·61	<0·001
Difference between regressions	1	213·82	>0·1
Difference between means	1	1102·81	<0·001
Error	146	92·12	

These data indicate that the overall relationship found between the IQ and socio-economic class in this sample is largely due to the 'verbal' component of the IQ.

Parent/offspring correlations for the verbal and the performance IQ

The correlation coefficient between the IQs of the scientists and their fathers was 0·30, $P < 0{\cdot}001$. The correlation coefficient for the verbal component of the IQ ($r = 0{\cdot}38$) was significantly higher than the correlation coefficient for the performance IQ ($r = 0{\cdot}21$). For both components of the IQ the correlation coefficients differed between the socio-economic classes (Table 7). They were both highest in Class III and lowest in Class I, where the correlation coefficient between the scientists' verbal IQ and their fathers' verbal IQ was negative and not significant.

Table 7. Correlation coefficients between the scientists' IQ components and the IQ components of their fathers

Component	Socio-economic class I	II	III
Verbal IQ	−0·03*	+0·24	+0·37
Performance IQ	+0·07*	+0·28	+0·28

*$P > 0{\cdot}05$.

Social mobility

Only 29·5% of the scientists were born into, and brought up in, the professional socio-economic class; the majority of the scientists in the sample were upwardly-mobile people. This upward social mobility has previously been shown to be related to differences between the IQ of the scientists and the IQ of their fathers. In the present analysis the verbal and performance components of the IQ were compared, to test whether they contributed equally to the inter-generational mobility of the scientists, for the data described above suggest that they may not.

It is clear (Table 8) that the differences in both the verbal and performance components of the IQ between the scientists and their fathers are similar to each other in each socio-economic class, although the differences are greatest in Class III.

Table 8. Mean differences in verbal IQ and performance IQ between scientists and their fathers in each socio-economic class

Class	*n*	Verbal IQ	Performance IQ
I	17	−0·58	+1·29
II	36	+5·7	+6·0
III	22	+7·1	+7·5

The differences between the IQ components of the scientists' male sibs and their fathers were also compared. The number of male sibs available in any particular class was small, so comparisons were made between downwardly-mobile sibs, upwardly-mobile sibs and sibs who remained in their original socio-economic class. These data (Table 9) also show that both the verbal and performance components of the IQ are higher, and to the same extent, in male sibs who were upwardly mobile than their fathers' scores. The downwardly-mobile male sibs had lower verbal and performance IQs than their fathers, as did the non-mobile sibs. However, these data are concerned with the male sibs' current occupational class and, unlike the scientists, their social mobility may not be complete. Overall, the data do not

Table 9. Mean differences in verbal and performance IQ between the scientists' brothers and their fathers

Mobility	*n*	Verbal IQ	Performance IQ
Upwardly mobile	11	+6·12	+6·25
No change in class	8	−1·12	−0·51
Downwardly mobile	11	−1·8	−2·8

provide evidence for either component of the IQ being more relevant to social mobility.

Discussion

The present results are complementary to those described in the previous paper, which was concerned with the total IQ in this sample of university scientists. In particular, the present data show that the overall correlation previously found between the IQ of the scientists and their fathers' main socio-economic class does not appear to be a consequence of different disciplines attracting people from particular socio-economic classes. There is, however, an intriguing, but unexplained, exception as a substantial proportion of the fathers of mathematicians were in occupations in Class II. As the sample size in any particular discipline was small this result must be interpreted with caution.

It thus seems likely that the positive correlation between the scientists' IQ and their original socio-economic class is a vestige of the well-documented relationship found in general populations between the IQ and social class background (Douglas, 1964).

There is now a considerable body of evidence showing that differences in IQ between fathers and their sons are correlated with the son's mobility on the socio-economic scale relative to their father's occupation. The studies of Burt (1966), Gibson & Young (1965), Gibson (1970) and Waller (1971) permit of no other conclusion. It has been argued, for example by Thoday & Gibson (1970), that if IQ is correlated with social mobility and has significant heritability, as IQ has (Erlenmeyer-Kimling & Jarvik, 1963), then 'social mobility will lead to non-random transfer of genes from class to class' and thus we have a theoretical expectation that 'social classes will therefore be expected to come to differ genetically to some extent . . . [and] . . . will also differ for immediate environmental (including cultural) reasons'. This hypothesis depends on the assumption that the relationship between IQ phenotypes and social mobility implies some significant relationship between IQ genotype and social mobility.

At the present we have no means of testing this hypothesis in human populations, although work with an experimentally more amenable organism suggests that it is tenable (Thoday & Gibson, 1970).

It is interesting that the correlation with socio-economic class of origin was higher for the verbal component of IQ than for the performance component of IQ, both in the scientists' and in their fathers' generation. Superficially this indicates a more important role for the verbal IQ in social mobility. However, the data for father/son pairs suggest that both components contributed to a similar extent. Both components were higher in the upwardly-mobile sons than in their fathers, and both were lower in downwardly-mobile sons. This result is intriguing in view of the overall higher correlation between verbal IQ and socio-economic class that has been described.

The overall father/son correlation was significantly higher for verbal IQ than for performance IQ. Using the formula $rpo = \frac{1}{2}[h^2 (1 + \mu)]$, where μ = the degree of assortative mating (Fisher, 1918), it is possible to obtain estimates of the heritabilities of the two components (see also Jinks & Fulker, 1970). Although in the present sample we have evidence for a high correlation in the level of education between the scientists' parents and between the scientists and their wives (Gibson, unpublished), we have no data on assortative mating for IQ. But Burt & Howard (1956) found a marital correlation of $\mu = 0{\cdot}3875$ in their sample using the London Revision of the Terman-Binet Intelligence Scale to assess IQ. This value suggests a considerable amount of assortative mating at the phenotypic level. But it is possible that the degree of assortative mating for verbal and performance IQs is not the same. We are at the present time collecting data of this kind in a large general population sample using the WAIS test. Data on assortative mating are available for forty-seven husband/wife pairs and the correlation coefficient for verbal IQ is 0·35 and significant ($0{\cdot}01 < P < 0{\cdot}05$), whereas that for performance IQ is 0·24 and not significant ($P > 0{\cdot}05$). The marital correlation coefficient for total IQ is 0·46 ($P < 0{\cdot}001$) in this sample. Although these estimates are from a different sample with a different socio-economic class composition, it seems worth using these values rather than assuming that $\mu = 0$. This will of course lower the heritability estimates, especially for verbal IQ.

Using these values for the marital correlation, the overall heritability estimates of 0·34 for performance IQ and 0·56 for verbal IQ can be used to partition the total phenotypic variance in the fathers' generation into its genetic and environmental components. (Such estimates of heritability are of course confounded with cultural inheritance, which might be expected to be more significant for verbal IQ than for performance IQ). These calculations indicate that there is more genetic variance and less environmental variance in verbal IQ than in performance IQ (Table 10), a result in agreement with data obtained in twin studies by other workers (Shields, 1962; Scarr-Salapatek, 1971).

The parent/offspring correlations for both IQ components differed between the socio-economic classes (Table 7) and it seems that both components of IQ have lower heritabilities in Class I than in other socio-economic groups. This result is in marked contrast to the findings of Scarr-Salapatek (1971) which suggested that IQ heritabilities might be positively correlated with socio-economic status.

Table 10. Heritability estimates and components of variation in the fathers' generation

Component	h^2	VP	VA	VE
Verbal IQ	0·56	146·2	81·9	64·3
Performance IQ	0·34	135·1	45·9	89·2

As one of the effects of social mobility is to reduce the phenotypic variance of the IQ of the sample remaining in a class after social mobility (Gibson, 1970), it might be argued that genetic variance would also be reduced, on the assumption that there is a significant relationship between IQ phenotypes and genotypes. Thus it might be informative to compare the separate heritability estimates obtainable for the socially mobile and non-mobile individuals in the sample. For this purpose the father/son pairs were divided into two groups depending on whether or not the scientist's father was born in the same class as his son or was himself mobile relative to the scientist's grandfather. It was also assumed that $\mu = 0$, as our data for assortative mating are too few to subdivide into separate socio-economic classes.

Table 11. Heritability estimates in the socially mobile and the non-mobile groups

Component	Social mobility	h^2	VP	VA	VE
Verbal IQ	Mobile	0·42	42·9	18·1	24·8
	Non-mobile	0·74	36·2	26·8	9·4
Performance IQ	Mobile	0·61	47·1	28·7	18·4
	Non-mobile	0·02	85·6	1·7	83·9

These data (Table 11) show that the genetic variance of performance IQ is considerably less in the non-mobile group than in the mobile group, whereas its environmental variance is highest in the non-mobile group. In contrast the genetic variance of verbal IQ is higher and the environmental variance lower in the non-mobile group than in the socially mobile. The most striking feature of these data is the high phenotypic variance and the very low parent/offspring correlation for performance IQ in the non-mobile group. It is difficult to suggest a simple explanation for this observation. However, attention has often been drawn to the lower heritability estimates obtained for non-verbal IQs compared to those for verbal IQs. Heritability estimates of IQ based on general purpose IQ tests might be disproportionately affected by 'verbal' components of IQ.

The present results emphasize the relationship between social mobility and IQ and suggest that it would be profitable to investigate in more detail separate IQ components in relation to assortative mating, social mobility, and social class structure in a general population sample.

Acknowledgments

We are grateful to Dr P. O'Donald and Professor J. M. Thoday for critically reading the manuscript.

One of us (J.B.G.) acknowledges the financial support of the Eugenics Society and the John Prynce Hopkins Donation Funds, USA. C.G.N.M.-T. is in receipt of a Medical Research Council Post-graduate Scholarship.

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