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Some Bodily and Medical Correlates of Mathematical Giftedness and Commensurate Levels of Socioeconomic Status

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Four groups of 10th-grade students were selected from the upper tails of four distributions based on a stratified random sample of the nation's high schools (N = 95,650): Two groups consisted of mathematically gifted subjects (boys n = 497, girls n = 508); the remaining two groups comprised environmentally privileged students (boys n = 647, girls n = 485). The former represented approximately the top 1% on a standard measure of quantitative ability, whereas the latter represented approximately the upper 1% of a conventional SES index. These four gifted/privileged groups were then compared to one another, by gender, and to their gender equivalent normative cohorts on 43 indices of medical and physical well-being. Although higher levels of physical health are found in both gifted and privileged groups (relative to the norm), medical and physical well-being appears to be more highly associated with mathematical giftedness than extreme levels of socioeconomic privilege. To the extent that these findings may be linked to the construct *general intelligence*, they confirm and extend the view that the nomothetic span (network of correlates) of general intelligence permeates a variety of important and valued nonintellectual domains (cf. Brand, 1987).

In a recent article on sex differences in mathematical giftedness, Benbow (1988) discussed several physiological correlates. Among these are left-handedness and laterality, allergies, hormonal influences, and myopia. In a commentary, Humphreys (1988) made the following statement: "The correlates described are probably only a small sample of the number that could be found" (p. 196). This statement represented an inference from the findings of Humphreys, Davey, and

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Kashima (1986) where small correlations (median = .12) with intelligence were found for 43 different self-report questions concerning health, physical disabilities, and physical well-being. If mathematically gifted students also differ on many physical attributes from appropriate controls, several questions are raised. Are the correlates discussed by Benbow more important than others, or do they represent selective sampling by investigators? Are there correlates of mathematical ability not controlled in the studies reviewed by Benbow that could explain published correlations? Is a separate hypothesis needed to explain each correlate, or are there hypotheses that subsume many correlates?

RELEVANT RESEARCH ON GENERAL INTELLIGENCE AND PHYSICAL WELL-BEING

The 43 items from the student questionnaire administered in Project Talent (Flanagan et al., 1962) were used by Humphreys et al. (1986) to form an "intellectual privilege/deprivation" (P/D) score for the health items. Multiple regression weights for all 43 health items with the intelligence criterion were obtained independently on random samples of about 10,000 students of each sex who were in the 10th grade in 1960, and cross-validated on another random sample of approximately 10,000 cases of each sex. No single weight was large, and a large proportion of the 43 items was represented by significant weights. Cross-validated correlations just below .40 were found with the Talent Intelligence Composite for the male and female keys in both the male and female samples (M = .381). Correlations just above .40 were found between socioeconomic status (SES) and intelligence (M = .414), but the mean correlation between Health P/D and SES was only .222. If the fallible measure of general intelligence is held constant in a partial correlation, the Health and SES measures have only a little variance in common. Control of measurement error as well would reduce the amount of common variance to a trivial amount.

These results show that there are many small physiological correlates of intelligence in the general population and support an extension of the research on those items to a mathematically gifted population. Groups with relevant data representing the upper 1% of each sex's distribution (on a conventional measure of quantitative ability) were available from the research by Lubinski and Humphreys (1990). These groups were a portion of a nationwide sample for which a great deal of information was available (described later).

The extension of this research to the upper 1% of the high-school population on a mathematics measure also requires a control for the SES of the family. Students found at the top 1% of mathematical talent are approximately 1 standard deviation above the norm on SES. Although an a priori hypothesis that high-SES families might be able to reduce the incidence of pathologies among their children was rejected by the earlier data for the general population, a suitable control group is needed for the mathematically gifted. We do not expect greater deviance from the norm for the high-mathematics group on each item in a heterogeneous set, but occasional reversals, if they occur, may suggest hypotheses concerning causation. For the most part, this is hypothesis-generating research. But there are items that can test some of the specific hypotheses in Benbow's (1988) article.

METHOD

The Data

Students in more than 900 high schools obtained in a stratified random sample of the nation's schools were tested in Project Talent on a wide range of aptitude, achievement, and information tests, occupational interest tests, and personality questionnaires (Flanagan et al., 1962). Students also completed a comprehensive background questionnaire. The section of that questionnaire labelled "Health," consisting of 43 different items of which 36 were of a *yes–no* format (see Appendix), is the focus of this report. Approximately 100,000 students were tested in each grade so that the normative data for only one cohort, the 10th graders, represent highly stable results for students in 1960.

Selection Composites

Two composites were employed for selecting gifted and privileged students: A Mathematics composite and a conventional SES composite. The former was composed of three of Project Talent's mathematical tests: Mathematical Information (23 items involving the vocabulary of mathematical notation and definitions), Arithmetic Reasoning (16 items, involving the reasoning required to solve arithmetic problems), and Introductory Mathematics (24 items, consisting of all forms of math taught through the 9th grade). To avoid overweighting of formal mathematics, Arithmetic Reasoning was given slightly more weight (raw scores on the three tests were multiplied by the following constants, contained in parentheses): Mathematics composite = Mathematical Information (.55) + Arithmetic Reasoning (1.0) + Introductory Mathematics (.55). Project Talent's SES measure is a weighted composite of nine items, including family income, value of home, education of mother and father, father's occupation, number of books in the home, number of appliances (e.g., TV, radio, etc.). For more detailed descriptions of these measures, the reader is referred to Wise, McLaughlin, and Steel (1979).

Gifted Subjects

Lubinski and Humphreys (1990) selected the upper 1% of each sex (497 boys, 508 girls) on the aforementioned Mathematical composite in their study of the attitudinal, biographical, and cognitive correlates of giftedness. The selection of the upper 1% represented a compromise between opposed objectives. The data reported by Benbow (1988) are from a more highly selected group (defined by a cutting score of approximately 1.5 standard score units more stringent; cf. Lubinski & Humphreys 1990), but to have been more selective would have reduced sample size and increased the instability of statistics for the gifted groups.

Privileged Subjects

For purposes of this research, parallel analyses were also made for the upper 1% of boys and girls using Project Talent's SES composite (647 boys, 485 girls). These "privileged" students are above the mean in ability but not as far above as the mathematically gifted. In standard score units (based on separate male/female distributions), the mathematically gifted boys were 2.66 standard score units above the normative mean on the Mathematics composite and 1.07 standard score units above the norm on SES. Similarly, the gifted girls were 2.74 and 1.09 standard score units above the female norm on the Mathematics composite and SES, respectively. For the privileged groups, the pattern was of course interchanged: For the privileged boys, the standard scores on the Mathematics composite and SES were 1.01 and 2.29, respectively; and comparable standard scores were observed for the girls, namely, 1.04 and 2.46, respectively. Within the data for both genders, there is a small amount of overlap for the members of the gifted and privileged groups. Of the 1,144 (gifted + privileged) boys, 41 were members of both groups. For the 993 (gifted + privileged) girls, 46 were members of both groups. Of course, there is complete overlap of the gifted/privileged groups with the norm. Thus, the size of differences between norm and either math or SES proportions is slightly *under*estimated by the 1% overlap.

Outcomes to Be Observed

As indicated earlier, we knew from the development of the Health P/D keys (Humphreys et al., 1986) that there was only a small amount of common variance between Health and SES total scores, but this small amount cannot be interpreted as extending to each and every item. The Health "test" is very heterogeneous in content, and the causes of the relation to ability may well differ from one item to another. The SES item counts may provide clues concerning causation: If the SES and math groups differ from the norm, but with the difference being larger for SES than for math, the determinants of the difference are primarily associated with the family's status. If the reverse is true, however, the determinants are primarily associated with the ability of the student.

Statistical Analysis Required

The basic methodology is quite simple. Item counts for the gifted compared with counts for appropriate control groups tell the story. There is, however, a problem that arises in the treatment of frequencies of failure to respond to an item. Humphreys et al. (1986) found that the frequency of failure to respond to a given question was consistently related negatively with intelligence. In order to preserve a constant sample size for the multiple regressions, the Health key was based on items in which the frequency of no response was grouped with the alternative or alternatives negatively related to intelligence. Then a *control key* was formed from the contrast of the no-response category to everything else. Although failure to respond for any one item had in every case a small negative correlation with intelligence, the correlation of the total score on the total key with intelligence was not much larger ($M = -.170$). Individuals who failed to respond tended to be the same item after item. Intercorrelations of healthy responses, on the other hand, were mainly small, positive values as seen in the difference between item validities and aggregate validity.

In the best of all possible worlds the control key would have had a zero regression weight in predicting intelligence in conjunction with the Health P/D key, but the weight is actually a small positive value. This switch from a negative validity to a positive weight for the control key comes about as a function of the higher validity of the primary key ($M = .381$) and the moderately high correlation between primary and control keys ($M = -.547$). The control key is, therefore, a suppressor, but the residual amount of information available in failure to respond is trivial in amount.

Although the control key adds little information in the prediction of intelligence, empirical item counts would be deceiving if norm groups differ from the gifted in frequency of failure to respond. Actually, the lack of significant information furnished by the control key enables us to correct observed item counts for differences in failure to respond with confidence. Corrected proportions to Health item alternatives can be computed by omitting the frequencies of no response. These corrected proportions divide the missing information proportionately between more and less healthy responses and add to 1.00. We shall focus on the corrected proportions, but the observed item proportions are also presented to complete the picture.

The control or norm group to which the gifted and privileged subgroups will be compared is the total 10th-grade sample of each sex from which the subgroups were not excluded. The seven items having multiple options were dichotomized for purposes of computing correlations with Project Talent's Intelligence Composite in the research of Humphreys et al. (1986). The sign of each correlation is based on this earlier research and represents the direction of the healthier response to general intellectual ability.

RESULTS

Table 1 (pp. 104–105) presents the proportions of responses to options for 23 items that can be considered with reasonable confidence to be associated primarily with increases in mathematical ability. Table 2 (pp. 106–107) contains proportions for the 20 remaining items. In both tables the observed proportions of respondents who checked the more healthy (or more normal) option or options appear in the upper row opposite the condensed version of the item and the sign

TABLE 1
Proportions of Responses to Health Items Related to Mathematical Giftedness and SES Privilege

			Boys			Girls		
Health Items	**Answer**	**Sign**	**Norm**	**Math**	**SES**	**Norm**	**Math**	**SES**
241 Times sick in bed past year	0, 1, or 2	+	632	723	645	574	654	505
	> 2		266	267	295	375	340	470
	> 2		293	269	314	396	342	482
242 Longest ever in bed	0 to 1 month	+	784	926	843	855	931	895
	> 1 month		097	062	090	080	065	080
	> 1 month		111	063	096	086	065	082
245 Doctor visits last 6 months	0	+	389	476	389	446	563	441
	> 0		493	511	544	497	431	534
	> 0		559	518	583	527	434	548
246 Hours sleep per night	*8*	+	342	424	372	398	478	429
	< 8 or > 8		537	559	557	542	518	538
	< 8 or > 8		611	569	600	577	520	557
247 Stay up weekends	11	+	245	405	261	260	387	258
	< 11 or > 11		630	578	662	676	605	713
	< 11 or > 11		720	588	717	722	610	734
248 Always wear glasses	No	−	738	680	757	776	688	833
	Yes		143	306	179	164	304	140
	Yes		162	311	191	174	306	144
249 Distance vision problems	No	−	683	605	663	599	528	625
	Yes		201	383	274	341	466	344
	Yes		227	388	292	363	469	355
253 Wear hearing aid	No	+	815	969	889	882	982	938
	Yes		064	019	048	055	010	031
	Yes		073	019	051	059	010	032
254 Always speak clearly	Yes	+	649	834	742	743	846	804
	No		231	154	195	195	150	169
	No		262	156	208	208	151	174
255 Speech easily understood	Yes	+	667	857	753	760	868	827
	No		212	127	182	177	128	140
	No		241	129	195	189	129	145
258 Ever knocked unconscious	No	+	565	742	515	743	870	769
	Yes		309	237	414	191	121	202
	Yes		354	242	446	204	122	208
259 Normal use both legs	Yes	+	772	913	844	835	917	843
	No		101	069	085	099	075	126
	No		116	070	091	106	076	130
260 Normal use both arms	Yes	+	769	921	845	834	919	854
	No		103	060	083	099	075	115
	No		118	061	090	106	075	119
261 Normal use both hands	Yes	+	728	911	819	793	903	825
	No		142	064	110	139	093	140
	No		163	066	118	149	093	145

(*continued*)

TABLE 1 (Continued)

			Boys			Girls		
Health Items	Answer	Sign	Norm	Math	SES	Norm	Math	SES
263 Stomach trouble	No	+	757	923	847	787	921	882
	Yes		112	058	079	144	071	085
	Yes		129	059	085	155	072	088
266 Had rheumatic fever	No	+	796	938	866	875	964	920
	Yes		067	037	051	050	026	041
	Yes		078	038	056	054	026	043
271 Had infantile paralysis	No	+	816	963	881	889	972	930
	Yes		044	019	039	036	020	035
	Yes		051	019	042	039	020	036
273 Severely aching joints	No	+	714	861	800	741	870	816
	Yes		140	116	121	180	124	144
	Yes		164	119	131	195	125	150
274 Severe headaches	No	+	732	903	832	681	851	812
	Yes		120	072	090	239	134	151
	Yes		141	074	098	260	136	157
279 Special diet from doctor	No	+	784	933	863	844	939	904
	No		059	036	049	068	045	056
	Yes		070	037	054	075	046	058
280 Get more sleep than others	No	+	756	947	869	835	961	902
	Yes		083	021	044	074	022	054
	Yes		100	022	048	081	023	056
282 Take special exercises	No	+	741	945	855	826	963	897
	Yes		095	023	050	081	029	054
	Yes		114	024	055	089	029	057
283 Take prescribed medicine	No	+	741	869	789	745	843	768
	Yes		093	101	115	158	143	190
	Yes		112	104	127	175	145	199

Note. Decimal points omitted.

of the correlation of that option with intelligence in the 10th-grade sample. The observed proportions for the less healthy or pathological option appear in the second row. The difference between the sum of these first two proportions and 1.00 represents the frequency in the failure-to-respond category. The corrected proportions for the same pathological option appear in the third row. Any given corrected proportion for the more healthy option can now be obtained by subtracting the value in the third row from 1.00.

Sampling Errors

Before discussing these data some guidelines to sampling errors are in order. For proportions in the norm groups standard errors vary from .0010 for 95/05 splits to .0022 for 50/50 splits. Sexes in the unselected sample differ significantly in the statistical sense on almost every item. For proportions in the math (gifted) or

TABLE 2
Proportions of Responses to Health Items Marginally or Unrelated to Mathematical Giftedness and SES Privilege

			Boys			Girls		
Health Items	**Answer**	**Sign**	**Norm**	**Math**	**SES**	**Norm**	**Math**	**SES**
243 Health last 3 years	> Good	+	634	776	784	619	814	772
	< Very good		255	212	154	326	180	204
	< Very good		287	215	164	345	181	207
244 Health before 10	> Good	+	543	584	700	563	652	693
	< Very good		345	406	237	382	344	278
	< Very good		389	410	253	404	345	286
250 Wear special purpose glasses	No	−	721	705	699	651	615	608
	Yes		162	281	240	288	379	363
	Yes		184	285	256	307	381	374
251 Problems hearing speech	No	+	822	952	890	877	941	942
	Yes		059	035	043	062	051	029
	Yes		067	035	046	066	051	030
252 Hard of hearing	No	+	817	960	893	882	955	944
	Yes		040	008	020	029	010	008
	Yes		047	009	022	032	010	008
256 More problems with skin	No	+	744	840	835	829	868	887
	Yes		133	146	096	108	126	082
	Yes		152	148	103	115	127	085
257 More problems facial skin	No	+	706	790	799	807	844	885
	Yes		168	189	128	128	152	087
	Yes		192	193	138	137	153	090
262 Back or spine problems	No	+	738	909	808	784	866	837
	Yes		131	073	117	148	130	130
	Yes		151	074	126	159	131	134
264 Body braces, corrective shoes	No	+	749	817	777	826	840	810
	Yes		119	164	148	104	154	157
	Yes		137	167	160	112	155	162
265 Ever had mumps	No	−	283	299	281	331	338	328
	Yes		581	680	637	596	652	637
	Yes		672	695	694	643	658	660
267 Ever had asthma	No	+	769	881	821	852	925	880
	Yes		091	094	102	071	061	080
	Yes		106	096	111	077	062	083
268 Ever had hay fever	No	+	677	775	669	736	751	713
	Yes		185	204	253	190	237	252
	Yes		215	208	274	205	240	261
269 Told allergy by doctor	No	−	697	659	635	706	684	627
	Yes		166	320	289	220	308	338
	Yes		192	327	313	238	310	350
270 Told heart trouble by doctor	No	+	807	948	889	875	949	934
	Yes		055	031	037	051	036	033
	Yes		064	032	040	055	037	034
272 Frequent sore throats	No	+	676	821	793	588	733	746
	Yes		182	160	128	336	255	219

(*continued*)

TABLE 2 (Continued)

Health Items	Answer	Sign	Boys Norm	Boys Math	Boys SES	Girls Norm	Girls Math	Girls SES
	Yes		212	163	139	364	258	227
275 Dizziness, faintness spells	No	+	647	699	736	577	650	682
	Yes		203	280	184	342	340	276
	Yes		239	286	200	372	343	288
276 Frequent aches and pains	No	+	708	844	808	640	811	734
	Yes		140	135	110	277	177	224
	Yes		165	138	120	302	179	234
277 Frequent colds	No	+	660	756	764	652	737	778
	Yes		188	219	154	265	255	184
	Yes		222	225	168	289	257	191
278 Problem getting rid of colds	No	+	626	697	717	614	652	676
	Yes		220	278	200	302	334	285
	Yes		260	285	218	330	339	297
281 Avoid strenuous exercise	No	+	751	916	865	805	945	887
	Yes		086	053	050	101	043	065
	Yes		103	054	055	112	044	068

Note. Decimal points omitted.

SES (privileged) groups, standard errors are large by a factor of 10. Standard errors of differences between a norm group and gifted/privileged groups are only trivially larger than the standard errors for the extreme groups alone. If gender-equivalent gifted/privileged groups are to be compared, the standard error of the difference ranges from .014 for 95/05 splits to .03 for 50/50 splits.

Visual Problems

Let us look first at those items in Table 1 that are related to the physiological correlates discussed by Benbow (1988). Two items concerned with visual problems (248 and 249) show differences among the three groups in both sexes that support the relation of myopia with mathematical giftedness. The SES privileged students are closer to the norm than to the math group, and the differences between norm and math are among the largest in the table. As a matter of fact, the latter differences are surprisingly large relative to the size of the correlations of these options with intelligence obtained in earlier research (Humphreys et al., 1986). Those *r*s were less than .10, and the regression weights were about average in size. Even so, the weights were that large only because the correlations with other predictors were, although generally positive, so close to zero.

It seems reasonable to infer that the determinants of the relation of myopia to mathematical ability are independent of the causes of other Health item correlations. The small, predominantly positive correlations with other predictors in the earlier research were an effect of confounding normal vision with failure to respond in the scoring of the items. Without the confounding the correlations of these two items with the others would have been slightly negative. That is, normal vision would have been positively correlated with health and physical normality in the other items, but normal vision was negatively correlated with intelligence.

Other Items Related to Mathematical Giftedness

The remaining 21 items are quite heterogeneous in content. Some items (241, 242, 245, and 283) are related to the frequency and severity of unspecified illness. Three (246, 247, and 280) represent desirable sleep habits. Others (253, 259, 260, 261, and 280) describe problems of bodily functioning that could be primarily anatomical. Items 254 and 255 are more ambiguous as to whether the problem is anatomical or functional. Serious childhood diseases are represented in 266 and 271, and possibly 273 and 279 as well. One item (258) describes a result of bodily injury. Stomach trouble (263) and severe headaches (274) have many possible causes.

Not only was the absence of pathology in each of these items keyed positive for intelligence, but the mathematically gifted show less pathology than the norm. The absence of pathology, furthermore, does not seem to be a function of the above-average socioeconomic privilege of the families of the gifted students. Children of families more privileged than those of the gifted students (*over* 1 *SD* of SES) are merely above average in mathematical ability and intelligence and indicate intermediate levels of pathology between the norm and the math groups!

Items Questionable for Giftedness

Allergy has been related to giftedness in previous reports (Benbow, 1986; Benbow & Benbow, 1984), so we shall look first at those three items in Table 2. Reports of asthma (267) and hay fever (268) were actually negatively related to intelligence in the unselected sample, but when a child reported being told by a physician that he or she had an allergy, the correlation became positive. In Table 2, however, it is seen that answering *yes* to all three items is principally characteristic of students in high-status families. No matter what the sign of the correlation in the unselected sample may be, differences are not associated with mathematical giftedness as such. Data based on medical diagnosis are more valid than self-reports, but sampling from a well-defined population is more valid than sampling opportunistically. An advantage in one cannot compensate for a defect in the other.

The remaining items are again a heterogeneous lot. If one looks at the data for only one sex, or even averages the proportions for the two sexes, several items might be placed in Table 1 (250, 251, 252, 262, 270, and 281). However, we consider them ambiguous in outcome on the basis of SES proportions too close to those for the math group for at least one sex. Some pathologies occur less frequently in the high-SES group for both sexes. Among these are upper respiratory problems (272, 277, and 278) and skin problems (256 and 257). Apparently, the common cold is a more frequent problem among common people, regardless of level of ability, and the mathematically gifted also have as many problems with pimples as the unselected control. Mumps (265) strikes all groups about equally. The norm group has the lowest proportions for body braces, corrective shoes, and so on (264), but the math and SES groups are essentially indistinguishable. The SES groups have the lowest proportions of pathologies of dizziness and faintness (275), whereas the male math group is higher than the norm. The results on the preceding two items are inexplicable. Items 243 and 244 are concerned with health during development and are seemingly contrary to expectations based on the proportions of pathology in items 241 and 242. There is an important difference, however, in the wording of these four items. The latter two require quantitative answers whereas the former two allow respondents to define the qualitative terms as they wish.

Sex Differences

Given male superiority at high levels of mathematical ability (Benbow, 1988), an interesting question concerns the relative size of the differences between the norm and math group in Table 1 for the sexes. Because boys more frequently fail to respond than girls, we shall look again at corrected proportions. Mathematically gifted boys do deviate somewhat more in the healthy direction than girls on 21 items, as well as somewhat more in the pathological direction on the two vision items. There is also a good deal of variability in these differences. Although our gifted samples are relatively large, sampling errors of proportions and of differences between proportions involving these samples are not trivially small.

If we now look at sex differences in corrected proportions among all 43 items for the norm groups, there is no problem about sampling errors. Only one item (257) does not show a statistically significant difference, so we shall concentrate on the large differences. If the sex differences (female minus male) in pathological proportions are distributed without regard to the sign of the correlation with intelligence in the unselected population, 35 of 43 items show differences falling between $-.06$ and $+.08$. The 8 outliers are indeed that, showing differences of .10 or greater. Boys more frequently report being knocked unconscious ($-.15$), but the remaining outliers are all positive in sign (241, 249, 250, 272, 274, 275, and 276). There is an obvious explanation for the male outlier in the differential exposure to bodily injury in play, competitive sports, and work. Girls report more problems with distance vision (249), but there is little difference in the wearing of glasses needed to correct the problem (248). Do girls think of glasses selected for aesthetic reasons as special (250)? This explanation would allow the girls in the SES group to respond *yes* too frequently. An explanation phrased in terms of girls being allowed to be more responsive to minor bodily ailments, whereas boys are discouraged from doing so, can cover the remaining items. Such reports may be a consequence of a pattern of social reinforcement/punishment that encourages acceptance of stereotypic feminine/masculine roles.

Correspondence with Terman's Gifted Group

In several cases there is overlap between the Project Talent Health items and analyses reported by Terman (1925) for his gifted group. Terman's gifted subjects were studied at an earlier age, however, than our 10th graders. Both groups had less frequent headaches, less frequent hearing problems, more defective vision, and less general weakness. Terman's children were characterized as having an excess of sleep, which is not out of line with the 8 hours reported by the high-school students, but many of the high-school controls reported both more and fewer than 8 hours. There was no difference in the frequency of colds in either group. The earlier and younger gifted students had more tonsillectomies than their controls, which suggests that the problem was more governed by the family's status than by the child's intelligence. It appears that the characteristics of gifted children changed little in 35 years.

DISCUSSION AND CONCLUSIONS

Myopia and Giftedness

Our data from a nationwide probability sample of the nation's high schools support an appreciable correlation between mathematical giftedness and myopia. As Lubinski and Humphreys (1990) reported, however, mathematically gifted are also superior in general intelligence. Their superiority on a whole host of information tests, for example, indicates the amount of generality (cf. Benbow, Stanley, Kirk, & Zonderman, 1983). The data we have presented clearly do not relate mathematical giftedness per se to myopia. Also, although our data support the relation, nothing in this report relates to the varying hypotheses concerning causation. We can conclude that the causes of this relation seem to be independent of the causes of the relations of other Health items with mathematical giftedness.

Allergy and Family Status

In contrast, our data do not support a relation between a form of allergy appearing in three questions and mathematical giftedness. In these self-reports the relation is with the family's SES. The relation is also small and confused as a function of the specific question asked. It seems possible that previous claims concerning allergy have been based on data in which SES was not controlled.

BACKGROUND FOR CAUSATIVE CONJECTURES

Humphreys (1979) made a concluding statement about general intelligence that can be used as a starting point for our discussion of the remaining data:

> To the extent that there is a genetic contribution to individual differences in general intelligence, that contribution is polygenic. Environmental contributions are also multiple. To coin a term, we might call these contributions polyenvironmental. Similarly, the biological substrate for general intelligence is polyneural, and the behavioral observations that define the phenotypic construct are polybehavioral. (p. 115)

There is, however, more generality in the phenotype than indicated in this quotation, although at somewhat lower levels of communality than shown by the items in a standard test of intelligence. Terman's (1925) quantitatively systematic study of a large sample of gifted children and of appropriate controls (for many of his observations) showed that they were from birth onwards generally superior physically and medically. They appeared to have more effective respiratory, circulatory, excretory, and reproductive systems. Terman's gifted children tended to be superior organismically, with myopia being a notable exception.

Our conjectures concerning causation for the 21 items in Table 1 that show health to be monotonically related to increases in ability also assume that we are studying, by and large, general intellectual giftedness in our high-mathematics groups. Some of our explanations tilt toward environmental effects, some toward genetic, but these sources are not necessarily mutually exclusive even for a single item, let alone for the set of 21 as a whole.

Possibility of Organismic Superiority

The organismic superiority of gifted youth may well include more effective immune systems, accounting for less time in bed, shorter illnesses, and fewer cases of severe childhood illnesses. Gifted students also may use their high intelligence to take charge of their own lives at an early age. For example, they recognize and attend to bodily needs such as sleep, and they are able to avoid hazardous environmental incidents, both physical and psychological.

Possibility of Effective Parenting

Gifted students also may have more supportive parents who set and enforce reasonable standards, such as hours of sleep, for their children. These parents provide an environment in which many serious accidents and diseases can be avoided. They do not overprotect, however, because they do not rush their children to see a physician or confine them to bed for minor illnesses. Overprotection seems to be characteristic of high-SES parents.

Stochastic Influences

On the other hand, children develop from conception onwards in an environment that is not highly predictable or controllable. A large number of hazardous environmental incidents of all sorts occur in an essentially stochastic manner. Many of these impinge on a child's developing abilities. Individual incidents account for only a small amount of variance, but a large number has a substantial effect. High levels of giftedness depend on genetic endowment, a supportive environment, and luck.

Testing the Genetic Hypothesis

In sorting out the importance of some of our speculative causes, a prime source of data is the health history of a close relative. Cohn, Cohn, and Jensen (1988) studied myopia in 60 gifted students paired with the sibling closest in age. They found the expected large difference in intelligence and also found a smaller difference in optometric measures related to myopia. Sibs were less myopic at a probability of less than .05. There was a great deal of variability in the optometric measurements and samples were not large. Thus, standard errors were also large. Such studies should be repeated with larger samples, and our data suggest that controls should be same-sex for many health problems.

CONCLUDING STATEMENT

Finally, although the present research has focused on the relationship between mathematical ability and physical well-being, the former is also a salient marker of general intelligence. To the extent that our finding's generalize to this more globular construct, they broaden the network of (socially desirable and valued) correlates of general intelligence (cf. Brand, 1987; Lubinski & Dawis, in press).

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APPENDIX

The following items (241 through 283) are the health questions used in this study. They were taken from a section of Project Talent's Test Booklet B, Part V, labeled "Health."

Directions: The questions in this part are about your health. Each question has *one answer* and *only one answer*. *Answer every question*. Now, go ahead and answer the questions.

Health

241. How many different times have you been sick in bed (as much as a day) in the past year?

    A. None
    B. One or two
    C. Three of four
    D. Five or six
    E. Seven or eight
    F. Nine or more

242. What is the *longest* period of time that you have ever been in bed for sickness or an accident?

    A. Up to one week
    B. Up to one month
    C. Up to three months
    D. Up to six months
    E. Up to one year
    F. More than one year

243. Which of the following best describes your usual health in the last three years?

    A. Excellent
    B. Very good
    C. Good

D. Average
E. Poor
F. Very poor

244. Which of the following best describes your usual health before you were ten years old?

A. Excellent
B. Very good
C. Good
D. Average
E. Poor
F. Very poor

245. How many times have you been treated by a doctor (outside of school) for illness, injury, or an accident in the past six months?

A. None
B. One
C. Two
D. Three
E. Four
F. Five or more

246. *On the average,* about how many hours do you sleep each night?

A. About six or less
B. About seven
C. About eight
D. About nine
E. About ten
F. About eleven or more

247. How late do you usually stay up on weekends?

A. 9 PM or earlier
B. 10 PM
C. 11 PM
D. 12 Midnight
E. 1 AM
F. 2 AM or later

Items 248–283

For the following questions, mark your answers as follows.

A. Yes
B. No

248. Do you wear glasses all the time?
249. Do you have trouble seeing things from a distance?
250. Do you wear glasses for special purposes (reading, TV, etc.)?
251. Do you have trouble hearing people talk?
252. Are you hard of hearing?
253. Do you wear a hearing aid?
254. Are you able to speak clearly all of the time?
255. Is your speech easily understood?
256. Do you have more trouble with your skin than others your own age?
257. Do you have more trouble with the skin on your face than others your own age?
258. Have you ever been knocked unconscious?
259. Do you have normal use of both your legs?
260. Do you have normal use of both your arms?
261. Do you have normal use of both your hands?
262. Do you have trouble with your back or spine?
263. Do you have frequent stomach trouble or indigestion?
264. Have you ever worn a shoulder brace, corrective shoes, leg brace, or any other appliance?
265. Have you ever had mumps?
266. Have you ever had rheumatic fever?
267. Have you ever had asthma?
268. Have you ever had hay fever?
269. Has a doctor ever told you that you have an allergy?
270. Has a doctor ever told you that you have heart trouble?
271. Have you ever had infantile paralysis (polio)?
272. Have you had frequent sore throats?
273. Have you ever had severely aching joints?
274. Do you often get severe headaches?
275. Have you ever had spells of dizziness and faintness?
276. Do you often get aches and pains even when you are not sick enough to see a doctor?
277. Do you catch colds very often?
278. Do you have trouble getting rid of a cold?
279. Follow a special diet as prescribed by a doctor?
280. Get more sleep than others your age?
281. Avoid too much physical exertion or strenuous exercise?
282. Take special exercises?
283. Take medicine or pills prescribed by a doctor?