20. C. G. Butler and P. N. Patton, *Proc. Roy. Entomol. Soc. London* **A37**, 114 (1962).
21. C. G. Butler, R. K. Callow, N. C. Johnston, *Proc. Roy. Soc. London* **B155**, 417 (1961).
22. M. Barbir and E. Lederer, *Compt. Rend.* **250**, 4467 (1960).
23. C. G. Butler and E. M. Fairey, *J. Apicultural Res.* **2**, 14 (1963).
24. M. Lüscher and I. Walker, *Rev. Suisse Zool.* **70**, 304 (1963).
25. C. G. Butler, *Proc. Roy. Entomol. Soc. London* **A35**, 129 (1960).
26. M. V. Brian and J. Hibble, *J. Insect Physiol.* **9**, 25 (1963).
27. J. B. Free, *Brit. J. Animal Behaviour* **3**, 147 (1955).
28. S. W. T. Batra, *Insectes Sociaux* **11**, 159 (1964).
29. N. C. Johnston, J. H. Law, N. Weaver, *Biochemistry*, in press.
30. R. K. Callow, J. R. Chapman, P. N. Paton, *J. Apicultural Res.* **3**, 77 (1964).
31. C. G. Butler, R. K. Callow, J. R. Chapman, *Nature* **201**, 733 (1964).
32. N. E. Gary, *Science* **136**, 773 (1962); C. G. Butler and E. M. Fairey, *J. Apicultural Res.* **3**, 65 (1964).
33. E. O. Wilson, *Psyche* **65**, 41 (1958).
34. R. A. Morse and N. E. Gary, *Bee World*

42, 197 (1961). The effect was first described by Z. Orösi-Pál in 1955.
35. J. H. Law, E. O. Wilson, J. A. McCloskey, *Science*, in press.
36. D. A. Shearer and R. Boch, *Nature*, in press.
37. D. Otto, *Zool. Anz.* **161**, 216 (1958).
38. J. Simpson, *J. Insect Physiol.* **4**, 107 (1960).
39. M. Renner, *Z. Vergleich. Physiol.* **43**, 411 (1960).
40. R. Boch and D. A. Shearer, *Nature* **194**, 704 (1962); ———, *ibid.* **202**, 320 (1964); N. Weaver, E. C. Weaver, J. H. Law, *Progr. Rep. Texas Agr. Exp. Sta. PR-2324* (1964).
41. R. Boch, D. A. Shearer, B. C. Stone, *Nature* **195**, 1018 (1962); R. L. Ghent and N. E. Gary, *Psyche* **69**, 1 (1962).
42. M. S. Blum, personal communication, May 1965.
43. E. O. Wilson, *Annu. Rev. Entomol.* **8**, 345 (1963).
44. E. R. Lappano, *Insectes Sociaux* **5**, 31 (1958). Lappano related certain suggestive histological findings to the "Schneirla cycle" of the army ant *Eciton burchelli* but offered no direct evidence of the function of the labial glands.
45. M. S. Blum and C. A. Portocarrero, *Ann. Entomol. Soc. Amer.* **57**, 793 (1964).
46. A. Butenandt, B. Linzen, M. Lindauer, *Arch.*

Anat. Microscop. Morphol. Exp. **48**, 13 (1959) [*Atta rubropilosa* Forel].
47. J. C. Moser and M. S. Blum, *Science* **140**, 1228 (1963) [*Atta texana* (Buckley)].
48. M. S. Blum and G. N. Ross, *J. Insect. Physiol.*, in press.
49. M. S. Blum, S. L. Warter, R. S. Monroe, J. C. Chidester, *ibid.* **9**, 881 (1963).
50. R. L. Ghent, thesis, Cornell University (1961).
51. J. D. Carthy, *Nature* **166**, 154 (1950); W. Hangartner and S. Bernstein, *Experientia* **20**, 396 (1964).
52. K. Gösswald and W. Kloft, *Zool. Beitr.* **5**, 519 (1960).
53. R. Ribbands, *The Behaviour and Social Life of Honeybees* (Bee Research Association, London, 1953), p. 57.
54. M. Pavan and G. Ronchetti, *Atti Soc. Ital. Sci. Natur. Museo Civico Storia Natur. Milano* **94**, 379 (1955).
55. M. Lüscher, *Symp. Roy. Entomol. Soc. London* **1**, 57 (1961).
56. The author's personal research discussed here has been supported in part by grants from the National Science Foundation. M. S. Blum, R. Boch, C. G. Butler, J. H. Law, N. Johnston, M. Lüscher, B. P. Moore, and M. Renner rendered valuable assistance and advice during the preparation of the manuscript.

The Financial Status of National Merit Finalists

The proportion of these students from low-income families is related to public support for education.

Robert C. Nichols

A major objective of the education bills considered by the current session of Congress (*1*) is to overcome the educational handicaps of students from low-income families. The recently passed Elementary and Secondary Education Act provides grants to local school systems serving children of low-income families, and the proposed Higher Education Act would provide "opportunity grants" for undergraduate college students from low-income families.

Attempts to determine the need for such programs and to estimate their probable effect on student performance are complicated by the correlation in ability between parents and their children (*2*). Low income is related to low ability, and the children of low-income parents tend to be less able in both test and school performance than children of parents with higher incomes.

The proportion of very able students who need scholarship aid for college is therefore likely to be somewhat less than the proportion of people of college age from low-income families.

The extent to which increased expenditures for primary and secondary education can bring the performance of children from low-income families up to the level of their more affluent contemporaries depends on the relative importance of hereditary and environmental factors in determining their currently lower performance. That part of their lower performance that is attributable to genetic factors or to environmental factors other than formal education is not likely to be remedied by equality of educational opportunity (*3*).

We are thus concerned with two questions: (i) What proportion of able

students of college age are from low-income families? and (ii) What is the relationship between funds expended for primary and secondary education and the achievement of students from low-income families? The first question is a great deal simpler than the second; however, data collected in the operation of the National Merit Scholarship Program may have a bearing on both.

Financial Status of Able Students

The National Merit Scholarship Qualifying Test is a 3-hour test of educational development which is administered in the spring to 11th-grade students in over 17,000 U.S. high schools. The test is optional in most schools, and students who take it tend to be above average in academic ability and to be motivated to attend college; over 800,000 students (about one-third of all 11th-grade students) were tested in 1964. The highest-scoring students in each state are selected as Merit Semifinalists in numbers proportional to the number of students graduated from high schools in the state the previous year; in 1964 the number of semifinalists was 0.056 times the number of graduates. (Boarding schools that enroll over half their students from out of state are considered separately and do not enter into the state figures.)

When the semifinalists complete their applications and obtain a high score

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on a second test (as almost all do), they are named Merit Finalists. As part of the application the student's parents complete a report of the family financial status. However, if the parents are able to pay the full cost of the student's college education, they may request a minimum stipend and not report the financial information. The parents of about one-fourth of Merit Finalists take this option. It is probably safe to assume that those requesting the minimum stipend are in the upper half of Merit Finalists' families in income. This assumption is made in computing the income distributions here reported.

Of 12,418 Finalists who graduated from high school in 1964, 294 (2.4 percent) reported net family incomes of less than $3000; 21 percent of all U.S. families fall into this income bracket, which is officially designated as "poverty" by federal agencies. However, some families have low incomes because of temporary business losses or the death or retirement of a parent, and would not ordinarily be considered poor. If the families with net assets of $20,000 or more are excluded, only 1.8 percent of the 1964 Merit Finalists remain in the under-$3000 category. Comparable data are not available for students of college caliber

other than the Merit Finalists, but one would expect the proportion of students from poor families to increase as the required test score decreases.

The cost of attending college has risen rapidly in recent years, so that even a student from a family with an income as high as the median U.S. family income of something over $6000 might have difficulty attending any but a low-tuition college near his home unless he had some form of financial aid. Of the families of 1964 Merit Finalists, 3.8 percent reported net incomes of less than $4000; 6.7 percent reported less than $5000; 11.1 percent reported less than $6000; 16.8 percent reported less than $7000; and 22.9 percent reported less than $8000. (In these figures all families with assets of $20,000 or more are counted in the over-$8000 category.) Although these percentages are considerably lower than comparable percentages for all U.S. families, they indicate that many of the nation's most able young people need financial aid to attend college.

State Differences

The economic status of able students varies from state to state, and a study of these state differences may offer clues to some of the factors that determine the proportion of able students from low-income families. Table 1 gives state-by-state data on the economic status of 1965 Merit Finalists' families and of all families. The amount of income tax paid is one of the best single indices of the economic status of a family, since it makes allowances for family size and other extenuating factors (4). Tax paid on 1963 income is the index used in Table 1 for Merit Finalists, a tax of less than $500 defining the low category and of more than $1500 the high category. Families that requested the minimum stipend are included with the over-$1500 group. The census figures give the percentages of a state's families with incomes under $5000 and over $10,000.

Of all the finalists' families, 18 percent paid less than $500 income tax and 52 percent paid more than $1500. These percentages varied greatly from state to state. In Arkansas, Florida, North Dakota, South Dakota, and Vermont over 30 percent of the finalists were in the low tax bracket; in Connecticut, Delaware, the District of Columbia, Maryland, New Hampshire,

Table 1. Financial status of families of 1965 Merit Finalists and of all families, by state.

| State | Merit Finalists (No.) | Families of Merit Finalists | | All families * | |
| | | 1963 Tax | | Income | |
		Under $500 (%)	Over $1500 (%)	Under $5000 (%)	Over $10,000 (%)
Alabama	214	13.0	48.5	61.7	8.0
Alaska	9	11.1	55.6	30.3	29.9
Arizona	103	14.7	42.1	42.9	14.4
Arkansas	134	39.0	28.1	70.7	5.5
California	1185	13.8	56.4	30.3	21.8
Colorado	128	16.4	47.5	39.8	14.6
Connecticut	179	6.6	64.3	25.7	22.1
Delaware	29	0	72.4	35.6	19.6
District of Columbia	80	6.6	75.0	39.9	21.7
Florida	321	30.5	36.7	53.3	11.1
Georgia	253	13.1	55.5	58.8	9.2
Hawaii	60	12.3	70.2	34.8	22.0
Idaho	63	17.7	32.3	46.3	10.5
Illinois	757	15.7	51.5	31.5	20.5
Indiana	329	17.1	51.7	39.2	14.1
Iowa	270	27.1	38.7	49.1	10.7
Kansas	211	27.2	37.9	46.1	12.1
Kentucky	183	14.0	41.3	60.8	8.0
Louisiana	242	19.4	49.6	57.9	9.9
Maine	80	29.5	33.3	51.8	7.7
Maryland	234	4.0	66.6	34.4	19.8
Massachusetts	385	15.7	48.1	32.4	17.0
Michigan	593	16.4	49.6	33.4	17.4
Minnesota	307	21.4	46.5	42.6	13.0
Mississippi	153	23.3	41.3	72.1	5.2
Missouri	326	18.1	42.7	48.5	11.8
Montana	61	21.7	33.3	44.3	11.5
Nebraska	115	27.0	36.0	51.9	10.2
Nevada	19	15.8	52.6	29.9	21.9
New Hampshire	41	9.8	26.8	40.3	11.3
New Jersey	408	8.1	61.6	27.7	22.0
New Mexico	64	6.2	57.8	45.7	14.3
New York	1134	10.8	57.1	32.8	19.9
North Carolina	332	23.1	43.2	62.3	6.9
North Dakota	70	31.4	20.0	56.6	8.5
Ohio	687	14.9	47.8	34.1	16.2
Oklahoma	184	19.3	39.8	54.4	10.1
Oregon	148	17.2	44.1	37.3	13.9
Pennsylvania	957	16.0	47.3	39.7	13.9
Rhode Island	60	10.3	51.7	41.0	11.7
South Carolina	175	17.1	43.5	63.2	6.5
South Dakota	58	32.8	25.9	59.6	7.6
Tennessee	271	16.1	50.2	61.7	7.8
Texas	689	19.3	47.9	51.2	11.8
Utah	79	24.7	28.6	36.1	13.8
Vermont	36	33.3	27.8	51.6	8.9
Virginia	240	10.6	64.8	50.4	13.2
Washington	262	14.7	47.1	33.4	16.6
West Virginia	145	24.3	42.1	55.0	8.4
Wisconsin	381	20.3	36.8	37.2	14.3
Wyoming	22	19.0	57.1	38.2	14.6

*Statistical Abstract of the United States: 1964 (U.S. Bureau of the Census, Washington, D.C., 1964)

New Jersey, and New Mexico less than 10 percent were in the low bracket. If we consider a family income of less than $5000 to be roughly comparable to a tax of less than $500, we can see from Table 1 that in every state the poor families are underrepresented among the finalists and the high-income families are overrepresented. But the size of these differences also varies greatly from state to state. There is a relatively high representation of poor families among the Merit Finalists in Utah, Vermont, Maine, Arkansas, Florida, North Dakota, South Dakota, Iowa, Kansas, Nebraska, Nevada, and Wisconsin; there is a relatively low representation in Maryland, New Mexico, the District of Columbia, Rhode Island, Alabama, Kentucky, Georgia, Virginia, and New Hampshire, and no representation at all in Delaware.

Effects of State

Expenditure for Education

Families with above-average incomes can choose to live in neighborhoods with good public schools or to send their children to private schools, or can provide compensatory home instruction if schools are inadequate. The quality of instruction of children from poor families is much more dependent on the minimum level of public education in the state. The Primary and Secondary Education Act of 1965 proposes to remedy this inequity by grants to school systems serving children from poor families. Since states differ in their support of public education, the representation of poor families among Merit Finalists in the various states may offer an indication of the probable effectiveness of this program.

We would expect that poor families would be best represented among the Merit Finalists in states with high expenditures per pupil for education. The correlation between the states' expenditures per pupil for instruction and their representation of children from poor families among Merit Finalists proves to be .31 (5). Alabama, Georgia, Kentucky, Tennessee, South Carolina, and Mississippi have low expenditures for education and also a relatively small representation of their poor families among Merit Finalists; Illinois, California, Minnesota, Wyoming, Wisconsin, Oregon, Washington, Nevada, Michigan, and Massachusetts

have high expenditures for education and a relatively large representation of their poor families among Merit Finalists.

As the size of the correlation indicates, many states do not show this nice correspondence. An examination of the off-quadrant cases proves instructive. Delaware, Maryland, New Mexico, the District of Columbia, Rhode Island, Connecticut, New York, and New Jersey do not have as great a representation of poor families among Merit Finalists as would be expected from their expenditure per pupil for education. On the other hand Utah, Vermont, Maine, Arkansas, West Virginia, Nebraska, Kansas, Florida, Iowa, North Dakota, and South Dakota have a high representation of poor families among Merit Finalists without correspondingly high expenditures for education. Is there some characteristic of these states which obscures the expected relationship? One way in which these two groups of states differ is in the concentration of persons of exceptional ability. Because of special employment opportunities, states in the first group attract scientists and other highly educated persons, whose children tend also to be exceptionally able. These children, all from high-income families, will fill up Merit Finalist positions which might otherwise be available to able children from poor families in the state. Two striking examples of this effect are seen in New Mexico and Delaware, which are small states with large concentrations of scientific and technical personnel. The fathers of 13 of the 28 Merit Finalists in Delaware in 1964 were scientific or high-level-management employees of DuPont; the fathers of 17 of the 62 Merit Finalists in New Mexico were scientists at either Los Alamos or Sandia. Similar situations occur in other states with large groups of scientists, but the effect is less noticeable in larger states. For example, the fathers of ten Merit Finalists from Florida in 1964 were scientific or technical employees in the space program, but this had little effect because the total number of Florida's finalists was large. Moreover, several of Florida's finalists had retired fathers and may therefore have inflated the representation of "poor" families.

A good index of the concentration of high-level personnel is the percentage of the state's population 25 years old or over with four or more years of

college. This index proves to be negatively correlated ($r = -.24$) with the index of representation of poor families among Merit Finalists, although positively correlated ($r = .54$) with per-pupil expenditure for instruction. When the percentage of people with four or more years of college in the various states is held constant statistically (by partial correlation), the correlation between per-pupil expenditure for instruction and the representation of poor families among Merit Finalists rises from .31 to .54.

The idea of taking the proportion of people with college degrees into account was arrived at in part from inspection of the data (specifically, from the New Mexico and Delaware instances cited above). Thus, although this was the only partial correlation tried, the findings for this index do not represent as clear a confirmation of a prior hypothesis as does the zero-order correlation between expenditure for instruction and representation of poor families among Merit Finalists. Nevertheless, the data support the interpretation that increased expenditure for public education will improve the intellectual performance of children from poor families relative to the performance of children from more affluent families.

An alternative explanation which might be advanced for these findings is that able students from poor families are more likely to participate in the Merit program in states with high expenditures for education. Several lines of evidence (6) suggest, however, that almost all students who are enrolled in school and who can obtain the high test scores required for recognition as a Merit Finalist participate in the Merit program. Thus, in such an alternative explanation it must be assumed that a state's expenditure for education is related to the probability that able students from poor families will reach the 11th grade in school, and that larger expenditures would increase that probability.

The U.S. has embarked on an ambitious program to combat the effects of poverty. A major goal of the program is to raise the minimum level of achievement at least to the point where more young people can function satisfactorily in a demanding society. The data that have been presented here suggest that these efforts may also increase the supply of talent at the very highest level.

References and Notes

1. J. Walsh, *Science* **147**, 382 (1965).
2. The correlation between parents' and childrens' intelligence-test scores has typically been found to be between .40 and .60. See M. P. Honzik, *Child Develop.* **28**, 215 (1957); J. V. Higgins, E. W. Reed, S. C. Reed, *Eugen. Quart.* **9**, 84 (1962).
3. L. Erlenmeyer-Kimling and L. F. Jarvik [*Science* **142**, 1477 (1963)] review evidence which suggests that a substantial proportion of the variance in ability is attributable to differ-ences in heredity. This does not necessarily mean, however, that extreme environmental deprivation cannot result in large decrements in ability, since most studies of the herit-ability of intelligence have used groups of subjects who were relatively homogeneous with respect to environmental opportunity.
4. N. C. Crawford, *J. Assoc. Coll. Admissions Counselors* **8**, 11 (1962), has shown that the income tax paid by a student's family cor-responds closely to the expected family con-tribution to the student's college education as calculated by the College Scholarship Service's system of needs-analysis. These considera-tions led to the use of income tax as the index of family financial status for Merit Finalists in Table 1. Ideally, the figures for all families should also have been based on tax, but these data were not available. Exact comparisons between the figures for Finalists and those for all families are not possible in any event, because the latter are not limited to those families with children graduating from high school. This defect in compar-ability causes relatively little error in the ratio between the two figures as an index of differences between states in representation of poor families among Merit Finalists.
5. Since all existing states are included, this correlation is completely accurate as a de-scriptive statistic; and, since the variables involved do not change greatly from year to year, it can be expected to be reliable over time. However, in drawing inferences from such correlations about the lawful re-lationship between variables, the states must be considered as merely a sample from a universe of possible states, and the usual sampling fluctuation of the correlation must be considered. With a sample of 51 a cor-relation of .31 is significant at the .05 level.
6. For example, in the Presidential Scholars Program all national testing programs con-tribute names of their highest-scoring students. Practically all of these students are also Merit Program participants.
7. This study is part of the research program of the National Merit Scholarship Corpora-tion and was supported by grants from the National Science Foundation, the Carnegie Corporation of New York, and the Ford Foundation.

News and Comment

Defense: McNamara's Comptroller, Charles J. Hitch, Leaves after Four Pioneering Years at DOD

Just down the hall from the offices of the Secretary of Defense on the ex-ecutive "E Ring" of the Pentagon is the office of the Assistant Secretary, Comptroller. The occupant of this post for the past four years has been econ-omist Charles J. Hitch, and his pro-pinquity to the Secretary's office sym-bolizes Hitch's part in what has been called the McNamara revolution.

By common assent, in which even his critics join, McNamara is the first Secretary of Defense to succeed in making civilian control of the govern-ment's biggest department a working reality. Under McNamara, unification of the military services has been achieved through control of the budget. And the comptroller's office has served as the fulcrum for McNamara's lever.

President Johnson gave McNamara's managerial accomplishments the high-est endorsement at his news conference last week when he announced that he had asked Cabinet officers and other heads of federal agencies "to introduce a revolutionary system of planning and budgeting and programming throughout the vast federal system so that through the tools of modern man-

agement the full promise of a finer life can be brought to every American at the lowest possible cost." There was no doubt in anyone's mind that the De-fense Department was the model the President had in mind.

Hitch himself, however, has resigned the comptroller's job and left on Tues-day to assume the post of vice presi-dent for financial affairs at the Univer-sity of California, an institution which has some management problems of its own.

Hitch returns to university life after a break—save for short interludes—of 25 years which began and ended with government service. The middle dozen years were spent in the quasi-academic precincts of the RAND Corporation.

Now 55, Hitch is a first-generation member of a new breed of public servant. Like his boss of the past four years, Robert McNamara, Hitch was part of that small band of bright junior officers and university-based civilians who during the war pioneered the sys-tematic application of mathematics, the sciences, and the social sciences to problems of logistics and strategy and to management of the military estab-lishment.

An early-Depression graduate of the University of Arizona, Hitch spent a year (1931–32) doing graduate work

at Harvard and then went to Oxford as a Rhodes scholar, taking a first in philosophy, politics, and economics. In 1935 he was elected a fellow of Queens College, Oxford, and taught at Oxford for the rest of the decade. Dur-ing those years, Hitch recalls, the great excitement among economists was the theories of J. M. Keynes, and the econ-omists' main concerns were the problem of unemployment and matters of fiscal and monetary policy.

With the coming of the war, Hitch joined Averell Harriman's first lend-lease mission in 1941–42 and later served on the War Production Board. Inducted into the Army in 1943, he was assigned to the Office of Strategic Services and found himself back in Britain working as a member of group analyzing the effects of Allied air raids. At this stage, operations research was a far-from-sophisticated pursuit. The group in which Hitch worked was using a "collection of techniques, many of which had been used before," says Hitch. "What was new was the attempt to apply them to military problems."

Using agents' reports, aerial photo-graphs of bomb holes in factory roofs on the continent, and analyses of Brit-ish experience on the receiving end of German air raids, the group was making estimates of damage done by Allied bombing raids. The group was also able to give the night-raiding RAF clues as to where their bombs were ac-tually landing.

By the end of the war Hitch was working on selection of targets in Japan. Immediately after the war ended he was made chief of the stabilization controls division of the Office of War Mobilization and Conversion.

When Hitch returned to Britain in 1946 he thought he was going back to Oxford for good. He discovered,