The Predictive Value of the SAT for Brilliant Seventh- and Eighth-Graders

by Julian C. Stanley

At the January 1978 administration of the Scholastic Aptitude Test there were, for the first time, more than a few 12- and 13-year-olds. They were among the 2,000 gifted students in that age group, who, through the efforts of Julian Stanley, director of the Study of Mathematically Precocious Youth (SMPY) at The Johns Hopkins University, may be able to accelerate in school at a rate that allows them to achieve at their own pace, and study at the undergraduate and graduate levels when they are ready. SMPY's talent searches, of which the primary evaluative tool is the SAT-mathematical score, have broadened beyond the Baltimore area since 1971 to include students from many other States. Maths teachers abroad will welcome this simple procedure for identifying gifted young mathematicians.

In the four talent searches conducted since 1971 by the Study of Mathematically Precocious Youth (SMPY) at The Johns Hopkins University, approximately 3,500 high-ability seventh- and eighth-graders have been administered the mathematical sections of the College Board's Scholastic Aptitude Test. Many of them were also administered the SAT-verbal sections. From the results of these administrations of the SAT, a large number of youths who reason extremely well mathematically have been found, studied further, and have then been offered a smorgasbord of special educationally accelerative opportunities. The effectiveness of various means to improve the pace and level of the schooling of these brilliant youths is being studied by the staff of SMPY. The power of the SAT-mathematical scores for identifying 12- and 13-year-olds who reason splendidly mathematically and for predicting their success when they are accelerated educationally is evident, and there is a need for increased use of the SAT on a national basis by exceptionally able sixth- through ninth-graders. The experience we have had with SMPY has definitely established the SAT as an excellent instrument for initially identifying 10- to 14-year-olds who are already thought to reason well mathematically and can profit from accelerated instruction. We have also found that the SAT-verbal sections and the College Board's Test of Standard Written English are strong supplements to the mathematical sections for this purpose.

The SAT has improved the prediction of success in college. However, relatively little use has been made of SAT below the eleventh grade. The value of the SAT for finding mathematically and verbally talented youths in junior high school or the lower grades of senior high had not been explored much until recently. The SAT is one of the best means that people working with gifted children have for determining which youths are indeed able enough to move ahead fast and well. For this purpose it is a far better instrument than the Stanford-Binet Intelligence Scale or similar individually administered tests that minimize the need for fast responding, good reading ability, and efficient performance under stress. Those three characteristics, required by the SAT, are important for success in most of the educationally accelerative procedures that SMPY employs.

The origin of SMPY

The actual event that led to SMPY's bold, extensive use of the SAT with students in junior high school began in January of 1969 with the discovery of a brilliant Baltimore boy who was an eighth-grader in a public school, three months past his thirteenth birthday. Reports about his intellectual precocity were so glowing that I administered to him several tests designed for older students. The results were so surprising that I suggested he take the SAT and some College Board Achievement Tests at a regular administration. He was tested that March at the age of 13 years, 5 months without the benefit of any practice materials. His scores were as follows: SAT-verbal, 590; SAT-mathematical, 669; Level I (Standard) Mathematics Achievement Test, 642; Level II (Intensive); 772; and Physics Achievement Test, 752. In 1970, I found another eighth-grader remarkably similar psychometrically to the first one.

We were emboldened to look in earnest for more youths who scored well on the SAT. From the start we were especially interested in precocious mathematical reasoning ability, especially as reflected in high scores on the SAT-mathematical sections. Thus it was natural that for our first mathematics talent search, conducted at Johns Hopkins in March of 1972 with seventh- and eighth-graders and a few ninth-graders who were under age, we should use the SAT-mathematical. As a check on achievement in mathematics we also administered the Level I Mathematics Achievement Test. A total of 223 boys and 173 girls took these two tests.

We found even more extreme precocity than we had expected, though mostly among the boys.* The highest score was 790, earned by a 13-year-old accelerated ninth-grader. Forty-nine per cent of the boys scored at least 500, which is above the mean of college-bound male twelfth-graders. The Level II Mathematics scores of those ten boys who scored highest on the combined SAT-mathematical and Level I Tests ranged from 610 to 800, with a median of 690. One seventh-grader just two months beyond his twelfth birthday scored 740 on SAT-mathematical, 620 on SAT-verbal, and 670 on Level II. Another a few months older

* Details are contained in the 1974 book by Stanley, Keating and Fox entitled *Mathematical Talent: Discovery, Description, and Development.* For subsequent reports about SMPY's work, see Keating (1976), Stanley (1976), and Stanley, George, and Solano (1977).

was the top scorer in the science contest and scored 710 on SAT-mathematical, 530 on SAT-verbal, and 800 on Level II. A twelve-year-old eighth-grader who had skipped the second grade scored 670 on SAT-mathematical, 650 on SAT-verbal, and 620 on Level II.

What has happened to those ten top-scoring young men from the 1972 search during the last five years? Three received baccalaureates from Johns Hopkins recently, two of them at age 17 and the other at 18. All three won National Science Foundation three-year-graduate fellowships, of which only 550 were awarded in the entire country for all fields of science. Those three were half of the NSF fellowships won by all Johns Hopkins students this year. One of the 17-year-olds and the 18-year-old were elected to membership of Phi Beta Kappa, and at graduation all three received both general and departmental honours.

The two 17-year-olds saved four years each, and the 18-year-old saved three. These brilliant, personable, highly effective young men are now graduate students in computer science at Cornell University, electrical engineering at M.I.T and theoretical physics at Princeton University. A fourth young man from the March 1972 talent search also completed his baccalaureate at Johns Hopkins in May of 1977. Nineteen years old and three years accelerated (he skipped grades 11 and 12 and completed B.A. degree requirements in three years), he majored in mathematics and won a teaching assistantship to study applied mathematics at the Virginia Polytechnic Institute and State University, the only graduate school to which he sent an application. He is now working as a data analyst.

The other six boys in the 1972 group are also accelerated in grade placement. All have completed at least a year at one or more of the following colleges or universities: Johns Hopkins (three), Amherst College, Boston University, University of Colorado, and University of Maryland (Baltimore County). Institutions attended by other high scorers from the 1972 talent search include Brown, Cornell, Harvard, Johns Hopkins, Princeton, and Towson State. Obviously, most of these able students choose universities rather than separate colleges, nearly all of them highly selective ones.

Not all major in mathematically related subjects. For example, one of the verbally brightest (SAT-verbal 670 at 13 years of age, SAT-mathematical 670, and Level II 690) has nearly completed a bachelor's degree in creative writing. Another highly able youth is probably going to major in philosophy. One young man plans to become a physician. Most, however, do choose major fields for which high ability in mathematics is extremely helpful, but few major in pure mathematics itself. None thus far has chosen to specialize in chemistry or biology, and a funded study to investigate the apparent lack of interest in college chemistry is now under way, as it would seem that physical chemistry and chemical physics should appeal to some students who at an early age reason extremely well mathematically.

We are well into a systematic follow-up (by questionnaire) of the cohort that in the usual course of events would have been graduated from high school in 1976 or earlier—that is, eighth- and ninth-graders from the March 1972 talent search, ninth-graders from the January 1973 search, and the two tenth-graders from the January 1974 search. From the results of this survey we shall update SMPY's information about

ways in which some of the contestants move along more swiftly than their agemates. It is also apparent from this survey that the baccalaureate can be completed readily in three years.

Emphasis on acceleration

SMPY is not out to set any records for early graduation from college. Instead, we want to remove unnecessary and undesirable barriers to progress of the most talented through school at paces and levels best suited to them. When permitted to learn at full speed, however, several brilliant youths whom we have found and helped do approach the record for achievment though educational acceleration.

The most prodigious student with whom SMPY has been associated thus far is a young man who received his B.S. degree in mathematics from Brooklyn College in June 1977. He became 15 years old on March 24, 1977. After completing the sixth grade at a public school he had gone to college full time and spent four years there. Earning an A in the third semester of college calculus his first term at age 11 and A's in both mathematical analysis and differential equations the next semester, during most of which he was still 11 years old, he maintained an almost perfect academic record in everything for the entire four years. He won an NSF three-year graduate fellowship, which he is using to work toward a PhD degree in mathematics at Princeton University. We had counselled him into college early on the basis of a day of standardized testing at Johns Hopkins when he was barely 11. His high scores on College Board tests then included the top score of 800 in the Level II Mathematics Test.

SMPY has used College Board tests, particularly the SAT, to discover early those persons who would seem likely to benefit from accelerative opportunities. Through our annual talent search some 3,000 students who scored high on the SAT-mathematical sections have been discovered thus far. Helping mathematically apt youths earn a first-rate PhD degree several years earlier than the usual age of 25 or 26 is a major goal of SMPY, but for many students its suggestions lead more to enrichment than to acceleration. However, both early enrichment and subsequent acceleration are often experienced together.

The fourth talent search

In December of 1976 we administered both parts of an early-1970s version of the SAT to 873 contestants brought to the Johns Hopkins campus. Most of these were seventh-graders, but they had to meet an age criterion: not be older than typical seventh-graders. In order to enter the contest, all had to have scored at the 97th, 98th, or 99th percentile of national norms for the mathematics part of an achievement test battery such as the Iowa Tests of Basic Skills.

Each prospective examinee was sent a copy of the extensive 1971-72 practice booklet for the SAT. This may have been primarily responsible for the failure of some 200 students who registered for the contest to appear on the designated day for the testing. Still, 873 is a large number of students of one junior high school grade level to take the SAT. Eighty-eight per cent of them came from every county in Maryland and 12 per cent from the District of Columbia, Delaware, Pennsylvania and Virginia.

The two pie charts illustrate some interesting results. Figure 1 is for the 507 boys in the 1976 talent search, and Figure 2 is for the 366 girls who participated in it. Figure 1 shows the percentage of those boys who scored better on the College Board's Scholastic Aptitude Test mathematical sections and/or its verbal sections than did the average college-bound male twelfth-grader. The hatched region at the upper left shows that 16 per cent of the talent-search boys scored higher on SAT-mathematical sections than the select norm group, but not higher on SAT-verbal sections. The dark-coloured area at the top middle shows that nearly 14 per cent scored higher on both, and the smaller wedge indicates that only 7 per cent were above the mean of the seniors on the verbal part but not in mathematical reasoning. The light-coloured area of the circle reveals that 63 per cent of the 507 boys (most of whom were seventh-graders tested three months after school began) exceeded the mean on neither. Overall, 30 per cent of these young students were above the stringent average on mathematical reasoning ability, and 21 per cent were above it on reading comprehension and vocabulary knowledge.

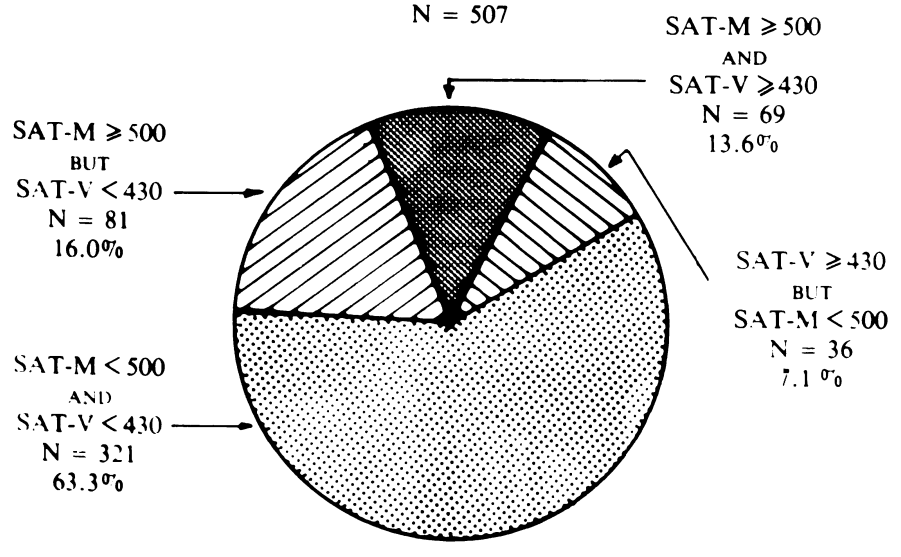

Figure 1. 1976 Talent Search. Boys. Males in the 1976 Talent Search who as seventh-graders (or under-age eighth-graders) scored as well as or better than the average college-bound twelfth-grade male on the SAT-M and as well as or better than the average college-bound twelfth-grader in general on the SAT-V. *Data prepared by Sanford J. Cohn, Johns Hopkins University.*

As depicted in Figure 2, the girls did less well on the mathematical sections (11 per cent instead of 30) and about as well on the verbal sections (20 per cent). They had exactly twice as large a per cent who scored higher than the average college-bound male on the SAT-verbal but not on the SAT-mathematical sections (14.2 vs. 7.1). Yet (not shown in the figures) relative to a random sample of twelfth graders of their own sex the girls scored quite like the boys did relative to their own sex. This comparison seems strong evidence against selection bias.

The girls in the talent search averaged 37 points less on the mathematical scores than the boys did, but only 5 points less on the verbal scores. Five and one-half per cent of the boys scored higher on the SAT-mathematical sections than any girl did (620-780 vs. 610 for the highest-scoring girl). These sex differences are consistent with SMPY's findings in its first three talent searches. Possible reasons why such sizeable discrepancies have occurred each time, consequences of the sex differences, and ways to improve the mathematical aptitude and achievement of girls are being investigated by Professor Lynn H. Fox of The Johns Hopkins University Evening College and Summer Session, who heads the Intellectually Gifted Child Study Group (IGCSG) there. Already she has had some promising results (see Fox, 1976).

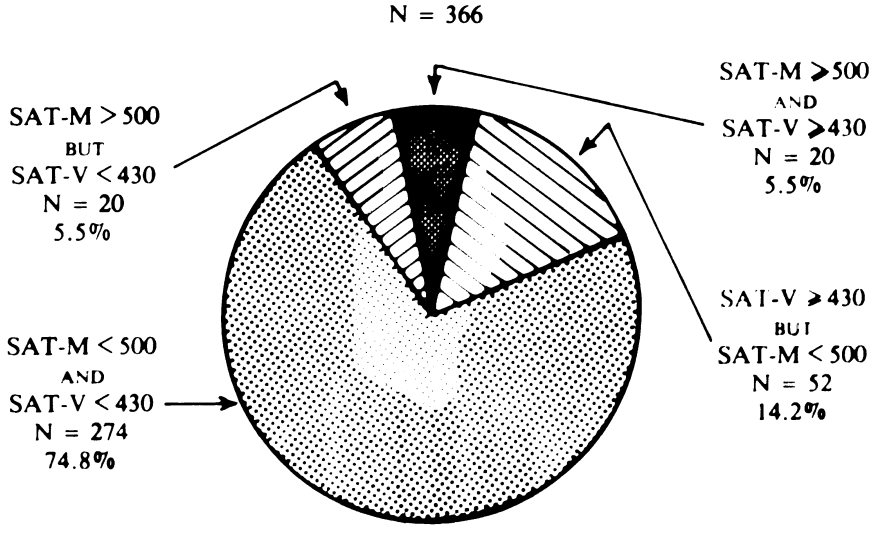

Figure 2. 1976 Talent Search, Girls. Females in the 1976 Talent Search who as seventh graders (or under-age eighth-graders) scored as well as or better than the average college-bound twelfth-grade male on the SAT M and as well as or better than the average college-bound twelfth-grader in general on the SAT V. (The male norms for SAT M were used because they are more stringent.) *Data prepared by Sanford J. Cohn, Johns Hopkins University.*

Results from further testing

Approximately the ablest third of the 873 contestants were brought back in February 1977 for further testing. The criterion used was that twice the examinee's SAT-mathematical score plus one times the SAT-verbal must total at least 1,330. Of the 286 individuals who met that criterion, 278 (i.e. 97 per cent) actually returned—some of them from many miles away—for a full day of taking fairly difficult tests. Besides vocational interest, evaluative attitude, and sex-differences self-report inventories, they took the following six cognitive tests: American College Testing Program Mathematics, ACT-Natural Science Reasoning, Differential Aptitude Test Abstract Reasoning, DAT-Mechanical Reasoning, DAT-Spatial Relationships, and the Co-operative Achievement Test in first-year high school algebra. Their scores were either parallel (ACT-mathematics) to the national norms or decidedly higher (ACT-natural science, all three DAT tests, and the Algebra I test).

On the basis of this kind of information, including a comprehensive background questionnaire and more testing of the ablest students in the fall of 1977, we will be able during the next several years to help many of these mathematically and scientifically brilliant youths forge ahead faster and do better educationally than is usually made possible by schools.

SAT a valuable tool

During the four SMPY talent searches thus far, which have involved a total of 3,500 high-ability seventh- and eighth-graders, we have increasingly learned how powerful an instrument the Scholastic Aptitude Test is for predicting successful educational acceleration in mathematics and other subjects. High scores on both the verbal and mathematical sections of the SAT at an early age, coupled with the youth's eagerness to move ahead faster and better, seem sufficient virtually to guarantee that participation in fast mathematics classes, grade-skipping, college courses taken part-time while still in junior or senior high school, and other radically accelerative procedures, such as being taught privately by an able 'mentor', will work well.

Practical considerations

Administering the SAT does not require nearly the skill that an individual intelligence test does, nor is there much subjectivity in administering and scoring the SAT. And it is considerably more cost-effective than individual intelligence tests. Identification programmes in school systems that require a certain score on an individual intelligence test are almost sure to result in many poorly trained, rushed examiners.

From the cost-effectiveness standpoint too, the extensive use of individual intelligence tests places a considerable burden on the programme. Youths who score much better on the Stanford-Binet than on the SAT because they work slowly, read poorly, or do not perform well under stress need help, but initially they are not nearly as good prospects for educational acceleration as those students who handle the SAT expertly.

Also important is the differentiation that the SAT provides. Though the Stanford-Binet-type IQ is probably the best single measure of general intellective ability available, it does not suggest specific supplemental

educational action for high scorers. A Stanford-Binet score high IQ does not necessarily mean great mathematical reasoning ability, whereas a high SAT-mathematical score does. In its talent searches, SMPY has regularly found quite a few youths who are far better at mathematical reasoning than in reading comprehension and vocabulary knowledge, and sometimes vice versa. Often we learn more of educational relevance about a particular student in 150 minutes of large-group SAT testing than could be determined by individual administration of the Stanford-Binet, scoring it, reporting the performance of the examinee, and other related activities that take up the whole morning of a school psychologist.

In fact, several special educators worked for days with a brilliant youth we knew and announced at the end of that time that his abilities were mainly verbal and literary. Whereas the SAT showed plainly that the student was far more precocious qualitatively than verbally. He was interested mainly in mathematics and the mathematical and physical sciences, and progressed quickly and eagerly when given appropriate opportunities by SMPY

Another of our protégés, tested by a well-trained, experienced school psychologist, was found weak in reasoning ability. We knew, however, that analytical reasoning ability was probably the area of his greatest strength, and proceeded accordingly. This young man completed his BA degree in quantitative studies at Johns Hopkins the same month he became 17 years old. Now he is a doctoral student at the University of Chicago. As most competent psychometrists have known for many years, single-IQ tests of the Stanford-Binet variety are of little value for differentiating among cognitive abilities. Even the Wechsler tests are not as useful for educational placement and facilitation as are the SAT and, for example, the Differential Aptitude Test battery.

Acceleration: for and against

The range of special educationally accelerative opportunities that SMPY offers its high-scoring talent-search participants and a few other young students is, unfortunately, often more attractive to the youths themselves than to their parents. Prejudice against educational acceleration runs deep in our culture and influences many parents, who worry to vast excess about its presumed deleterious effects on their children's 'social and emotional development' Though our experience and the research literature show clearly that it is advisable to let youths who deeply want to do so move ahead faster than the age-in-grade lockstep, well-meaning parents and teachers (and almost everyone else) will cite a negative example ('I knew a student who ') to justify holding the student back. Often the prolonged 'free ride' with easy A's and the boredom that results render the intellectually brilliant youth unfit for serious academic pursuits. In our opinion, far more academic, social, and emotional harm has been done in the name of promoting 'normal development' than has occurred because suitably able, well-motivated youths were allowed to forge ahead at their own preferred rate (see George, Cohn and Stanley, in preparation).

One need only look at the list of achievements of some individuals who had been successfully accelerated to realize its advantages. The youngest

college graduate in the United States in recent years of whom we are aware was Merrill Kenneth Wolf, who earned his BA degree in music theory under Paul Hindemith at Yale in September 1945 when barely 14 years old. The famous cyberneticist Norbert Wiener received his baccalaureate from Tufts College before he became 15 and a PhD degree in mathematical logic from Harvard before his nineteenth birthday. The most accelerated of the more than 1,000 brilliant participants in Lewis Terman's longterm study of intellectually gifted children entered Columbia at age 12 and received his bachelor's degree at age 16, Phi Beta Kappa.

The youngest graduate of Johns Hopkins prior to SMPY whom we can locate was Shlomo Z. Sternberg, BA in mathematics (Phi Beta Kappa) at age 17 years, 5 months in 1953 and PhD in mathematics three years later. By age 30 he was a full professor at Harvard, where he is still on the faculty. At the May 1971 Johns Hopkins commencement, just before SMPY began officially, the youngest of the 447 recipients of a bachelor's degree was 19 years, 10 months. Only three of the youngest of the graduates were still 20 years old as of the end of the calendar year. Seventy-three per cent were exactly age-in-grade.

The national need

Though we plan to continue our annual talent search involving the SMPY administration of the SAT for at least two more years, it seems to us that increased use of the SAT nationally by *exceptionally able* sixth- through ninth-graders should be encouraged. Many SMPY applicants have in fact taken the test at its most recent regular administration. In communications with parents and students outside our talent-search area (Maryland and adjoining states) we actively encourage the taking of the SAT each year at a regular national testing and the interpretation of scores both in terms of the national norms and of SMPY's norms for its own contestants. We are seeking better ways to make known to the right persons the availability and utility of this remarkable instrument.

Within a few year's SMPY's local talent-searching may go truly national. Meanwhile, all educators should become more alert to the need for further testing of those youths who score in the top few per cent of national norms on in-grade tests of mathematical aptitude. These young people must have opportunities to progress educationally or a precious national resource will be squandered, and individuals who might soar and help society will languish to our loss and their own.

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