Development of Superior Mathematical Ability During Adolescence

by

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ABSTRACT

Between 1972 and 1974 the Study of Mathematically Precocious Youth (SMPY) identified over 2000 7th and 8th grade students who scored as well as a national sample of 11th and 12th grade females on the College Board's SAT-Mathematics or SAT-Verbal tests. The academic and social development of these intellectually talented students over the following 5 years was longitudinally investigated. Over 91 percent (1996 out of the 2188 SMPY students) participated.

Five years later the SMPY students reaffirmed their initial academic superiority by scoring on the average 200 points (SAT-M) or 170 points (SAT-V) better than college-bound 12th grade students. Their mean scores on the College Board Achievement Tests for all such tests were 100 points above the average for college-bound seniors. The highest scores were not necessarily in mathematics. On not one test did the SMPY group score lower than the average of college-bound seniors.

The mean number of semesters of mathematics taken by SMPY students was two more than college-bound seniors. SMPY students were ten times more likely to take calculus in high school than high

school students in general. Their achievement in high school science courses was almost as outstanding and compared favorably to that of college-bound seniors.

Mathematics and science were their favorite courses in high school. Mathematics was most preferred but biology, chemistry, and physics were also well liked. SMPY students frequently participated in science fairs and mathematics contests. Within this homogeneous group, however, SAT-M scores could not predict the degree of interest for mathematics or science.

Many SMPY students accelerated their education. These accelerants believed they had benefited in their educational, social, and emotional development, and they achieved similarily in high school to their non-accelerated counterparts who went to college, but in less time.

SMPY students engaged in a wide variety of out-of-school activities. Reading, social, and performing arts activities were the most popular. Most SMPY students received one or more awards or honors. A high percentage of these awards were academic. From the talent search SAT scores the number of academic awards won could not be predicted. Overall, SMPY students did not exhibit a narrow range of interests and participated in a wide range of activities.

By 1980 over 90 percent of the students were attending college, typically at academically and socially prestigious universities, and said they were enjoying it. At least half of the SMPY students intended to major in the mathematical sciences, science, or engineering. Furthermore, since at least 96 percent of the group wanted to receive at least a bachelor's degree, their educational aspirations were high. A doctoral degree was their most frequently named goal. Talent search SAT scores related to their high school achievements.

Sex differences favoring males were found in participation in mathematics and science, performance on the SAT-M, and the taking of and performance on mathematics and science achievement tests. SMPY females received better grades in their mathematics courses, while SMPY boys became slightly more accelerated. Few significant sex differences were found in attitudes toward mathematics and science. A relationship between the sex difference on SAT-M and sex differences in mathematics and science achievement was established.

The influence of SMPY upon these students was perceived as beneficial. Most felt SMPY had helped educationally, while not detracting from their social and emotional development.

To my husband and our family, which grew apace with this work.

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CHAPTER 1

INTRODUCTION

1.1 BACKGROUND AND RATIONALE

Interest in intellectual ability dates back to Socrates. By questioning his students orally, Socrates tried to pick out the best students. It was not, however, until the late nineteenth century that intelligence and its ways of measurement became of interest to Western society. Then Galton (1869) completed his work in human heredity and individual differences, and derived statistical techniques to use in his investigations. In the course of his investigations the need for reliable and valid measurements of characteristics of related and unrelated persons became apparent. Galton (1883) believed that tests of sensory discrimination would be the optimal indicators of intelligence. Cattell (1890) agreed with this philosophy and produced tests similar to Galton's, which he named "mental tests" .

Evaluation of these early mental tests, however, led to disparate results. The individual's performance on one test did not correspond to performance on another test (Sharp, 1898-1899; Wissler, 1901), and it exhibited little or no relationship to independent estimates of intellectual ability (Bolton, 1891-1892; Gilbert, 1894) or academic grades (Wissler, 1901).

Not until 15 years later than Cattell's (1890) article, when Binet and Simon (1905) introduced their mental ability test, did the measurement of intelligence and the philosophy behind it begin to resemble those of the present day. The emphasis of the scale was on judgment, comprehension, and reasoning. This scale was revised twice (Binet & Simon, 1908; Binet, 1911) before Terman revised it and provided standards of intellectual performance for American-born children from 3 to 16 years of age (Terman, 1916). The mental-age score of Binet-Simon was supplanted by the ratio intelligence quotient (IQ), computed by dividing the mental age by the chronological age and then multiplying by 100 to remove the decimal point. This test, originally named the Stanford Revision of the Binet-Simon scale, has become one of the two current standards of measuring intelligence.[1]

In 1916 intelligence was considered to be a general factor as hypothesized by Spearman (1904); the Stanford-Binet gave an overall estimate of this general intelligence factor "g".

1.1.1 Students With High Intelligence

In addition to his contributions towards the measurement of intelligence, Terman, along with Hollingworth, was the pioneer for the field dealing with students of high intellectual ability. In 1921 Terman began his monumental longitudinal study of high-IQ children. His instrument of choice for measuring intelligence was the Stanford Revision of the Binet-Simon Scale. A high IQ score (at least 135) was considered by him to be the standard for giftedness. The findings from this longitudinal study of 1528 children have been reported in the five volumes of Genetic Studies of Genius (Burks, Jensen, & Terman, 1947; Cox, 1926; Oden & Terman, 1947;1959; Terman, 1947) and several more recent publications Oden, 1968; Sears, 1977; 1979; Sears & Barbee, 1977)

1) The other being the scale introduced by Wechsler (1939).

The purpose of the Terman study was to discover the physical, mental, and personality traits that characterize gifted children and ascertain the sorts of adults into which gifted children develop. In general, he found that gifted children were also superior in physique, health, social adjustment, and moral attitudes and were vastly superior in the mastery of school subjects (Terman, 1925). With regard to the second purpose of Terman's study, it was found that the intellectually superior child becomes a superior adult (Oden, 1968).

Hollingworth (1942) studied and facilitated, educationally and otherwise, individual students who on the 1916 Stanford Revision had an IQ of at least 180. Twelve cases were brought to her attention and were presented in her last book (Hollingworth, 1942). Her findings were quite similar to Terman's, except that she saw some social adjustment problems in her intellectually brilliant children. Gallagher (1975), however, saw a wide range in the social development of intellectually talented youths.

Through the two major studies cited above, the mystique associated with gifted children for centuries, which can be characterized by the "sour grapes" feeling that gifted individuals must be miserable and isolated people or by the expression "early ripe, early rot," was dispelled.

1.1.2 Study Of Mathematically Precocious Youth

In 1971 the Study of Mathematially Precocious Youth (SMPY) was founded to continue the pioneering efforts of Terman and Hollingworth. It is longitudinal and studies the characteristics of mathematically talented youths, starting about age 12 and continuing through their adult life. Unlike Terman's study, however, SMPY tries to seek effective ways to facilitate the education of the mathematically talented students it identifies (Stanley, 1977). The philosophy behind SMPY can be succinctly stated in pseudochemical fashion- $MT:D_4P_3$. MT stands for mathematical talent. The four D's are Discovery, Description, Development, and Dissemination. The three P's, which implement D4, are Principles, Practices, and Programs.

SMPY identifies mathematically talented students through its annual talent searches (George & Solano, 1976). Six talent searches were conducted under the direct auspices of SMPY over a seven year period. Although criteria for participation in a talent search have varied somewhat for each search, in essence 7th and 8th-grade students who have scored in the upper 2 to 5 percent in mathematical ability as judged by a standardized in-grade achievement test take part in the voluntary search. As part of the talent search the students take the College Board's Scholastic Aptitude Test (SAT). It now has three parts: mathematics (SAT-M), verbal (SAT-V), and the Test of Standard Written English (TSWE). The test is designed for able 11th and 12th-graders; on the average, these students are four to five years older than the students in the talent searches. The purpose of the test is to measure mathematical and verbal reasoning ability (Angoff, 1971).

Results from the six talent searches have been discussed extensively [but see especially Benbow and Stanley (1980b)]. Benbow and Stanley (1980b) showed that on the average the students in the talent searches performed at a level that was somewhat superior to a national sample of 11th and 12th graders. Furthermore, on the SAT-M a large sex difference favoring boys occurred in every talent search, although no difference was seen on the SAT-V.

The foregoing discussion can be said to describe SMPY's Discovery phase and part of its Description phase. The Description phase occurs when SMPY characterizes its talent search participants' backgrounds and attitudes (Benbow & Stanley, 1980 a,1981a) and tests its students further on a variety of cognitive and affective measures. Specifically, SMPY brings back for further testing those students who score extremely well on the SAT in the talent searches (Benbow, 1978; Cohn, 1977; 1980). As a result of this testing, each student can be characterized carefully. This leads to the prime reason for SMPY, its third D, Development. During that phase the youths who were found and studied are continually helped, facilitated, and encouraged to forge ahead educationally. Each is offered a smorgasbord of educationally accelerative opportunities (see Benbow, 1979; Fox, 1974; Stanley, 1978) from which to choose whatever combination, including nothing, best suits the individual. Finally, the last goal of SMPY is to disseminate its various findings from studying mathematically precocious youths and facilitating their education.

1.1.3 Justification For The Study

Through Terman and Hollingworth's efforts, we know what more-or-less typical high-IQ children in the 1920's were like and what happened to them as they grew up. Nearly 60 years have passed since the inception of this work. Updating the characteristics of gifted children, how they develop, and what happens to the individual (academically and otherwise) in high school is needed for the 1980's. This can be of great assistance to professionals who counsel and facilitate gifted students, as well as to parents and teachers.

One of the best opportunities to provide a present day view of gifted children would be to investigate the longitudinal results obtained by the Study of Mathematically Precocious Youth (SMPY) over the past 10 years of its existence. The significance of this ongoing study is that it provides data from the follow-up at high school graduation of the initial talent search participants who had scored at least as well as a national sample of 11th and 12th-graders do, but as 7th or 8th-graders.

Moreover, results from this study provides the opportunity to evaluate the effectiveness of the various methods devised or utilized by SMPY in facilitating the educational progress of gifted students. Many of the educational options offered by SMPY are accelerative in nature. Although acceleration has received much support from research as an excellent way to provide an appropriate education for the gifted (e.g., George, Cohn, & Stanley, 1979; Pressey, 1949), most persons are suspicious and wary of this method (Gallagher, 1975; Keating, 1979; Robinson, 1981). Findings of this study should help determine what the effects of accelerating a student are and how beneficial acceleration is seen to be by the accelerated students themselves. Thus, principles can be developed for helping decide whether a given student should be accelerated, and how.

Yet another present concern is the sex difference found in mathematics (e.g., Benbow Stanley, 1980; Fox, Brody, & Tobin, 1980) and in science (see Kelly, 1979). Of most interest to these researchers is why highly mathematically able girls do not pursue careers strongly involving mathematics (Ernest, 1976). This investigation provides insights into the potency of certain factors in explaining the higher achievement and greater ability of males than females in mathematics. In addition, sex differences in mathematical ability and achievement in high school can be ascertained. These same questions could be answered for science, also.

A further concern of today is the use of testing. The validity, reliability, and social justification for the use of tests have been questioned. This study assesses the predictive validity of a highly important three-part examination, the Scholastic Aptitude Test (SAT) of the College Board, by ascertaining how scoring high on the SAT as a 7th or 8th grader relates to later achievement and later test scores on the SAT and other tests.

Finally, programs such as SMPY's need to be evaluated continually. This study provides considerable data with which to assess their effectiveness.

1.2 STATEMENT OF THE PROBLEMS

This study was designed to investigate the development of intellectually talented students identified by SMPY in the 7th or 8th grade from that time until they would have begun college. Of particular interest is their academic achievement. Course-taking in mathematics and science, performance on various achievement and aptitude tests, number of awards and honors won, use of accelerative options, and prestige of the colleges attended will be ascertained. Several other variables of a more affective nature will also be studied: the students' favorite courses, their educational aspirations, their favored fields, and their feelings toward acceleration.

The main problems related to this investigation are:

1. Do gifted high school students take more courses in either science or mathematics than other high school students?

2. Do gifted high school students identified in the 7th or 8th grade perform better on either achievement or aptitude tests than other high school students?

3. Do gifted students make more use of accelerative options than other students?

4. Does the number of scholastic awards and honors won in high school covary positively with ability?

5. Do gifted students attend more prestigious colleges than other students?

6. Do gifted students have higher educational aspirations than students in general?

7. What are the favorite courses in high school of gifted students, especially those who reason exceptionally well mathematically?

8. Does mathematical aptitude relate to interest in science and mathematics?

9. How do students who used some of the accelerative options available to them feel that this acceleration affected them educationally, socially, and emotionally?

10. Does the sex difference in favor of males found in mathematical reasoning ability in the 7th or 8th grade persist through the high school years?

11. How does this sex difference in mathematical ability relate to mathematics achievement and interests in high school?

12. Even among this highly select group of students, can aptitude scores in the 7th or 8th grade aid in predicting achievement at the beginning of college?

13. How do the students who participated in the SMPY program feel that this affected them educationally, socially, and emotionally?

14. Is the achievement of accelerated students superior to that of non-accelerated students in high school?

1.3 HYPOTHESES

1. SMPY students will take significantly more semesters of science and, especially, more semesters of mathematics than other high school students.

    1. SMPY students will take significantly more semesters of mathematics than students surveyed by NAEP and the College Board's Admissions Testing Program.

    2. SMPY students will take significantly more semesters of mathematics than science in high school.

3. SMPY students will take significantly more semesters of science than other students.

2. SMPY students will perform significantly better on aptitude and achievement tests taken during high school than will other high school students.

   1. SMPY students will score significantly better on the SAT-M and SAT-V than college-bound seniors in high school.

   2. SMPY students will score on all of the College Board's achievement tests significantly higher than the college-bound seniors who take those tests.

   3. SMPY students will score the highest on the mathematics achievement tests, followed by the science achievement tests, and then the liberal arts tests.

   4. SMPY students will take Advanced Placement Program (APP) examinations significantly more often than students in general.

5. On APP examinations, SMPY students will score significantly better than the mean of the students who take these.

3. Significantly more SMPY participants than other students will be accelerated in school.

4. SAT scores from talent search will rather accurately predict the number of scholastic awards and honors won in high school by the SMPY students.

5. Significantly more SMPY students will attend intellectually highly selective colleges than will students in general.

    1. Intellectualism scores of colleges attended by the SMPY students will be above the mean.

    2. Status scores of the colleges attended by the SMPY students will be above the mean.

    3. Intellectualism scores of the colleges attended by the SMPY students will be higher than those colleges' status

scores.

6. Educational aspirations of SMPY students will be significantly higher than such aspirations of students in general.

7. Mathematics courses followed by science courses will significantly be the favorite subjects of SMPY students.

    1. Significantly more SMPY students will rate mathematics as one of their favorite subjects than will rate science as one of their favorites.

    2. Significantly more SMPY students will rate science as one of their favorite subjects than will rate a liberal arts as one of their favorites.

8. Mathematical aptitude will significantly relate to interest in science and mathematics.

    1. In college more SMPY students will plan to major in mathematics, physical or biological sciences, or engineering than they will in liberal

arts.

2. SAT-M performance from talent search and sex will fairly accurately discriminate between students majoring in mathematics, science, and other fields in college.

3. SAT-M performance from the talent search and high school will fairly accurately predict the degree of liking for mathematics.

4. SAT-M score from talent search and high school will fairly accurately predict the degree of liking for science.

9. Accelerated students will view their acceleration as having affected their social and emotional development positively and will consider they have used educational opportunities available to them significantly better than the non-accelerated students will.

1. SMPY students who have been accelerated will view their acceleration as having benefited their social and em-

otional development positively.

2. Accelerated SMPY students will view their use of educational opportunities as being significantly better than non-accelerated SMPY students.

10. Males will perform significantly better than females on the SAT-M but not the SAT-V in high school.

   1. Males will perform significantly better than females on the SAT-M in high school.

   2. There will be no significant difference between males' and females' performance on the SAT-V in high school.

11. The sex difference in mathematical ability favoring males will exist in mathematics and science achievement and interests of SMPY males and females in high school. Talent search SAT-M scores will be able to account for some of these differences.

1. SMPY males will take significantly more semesters of high school mathematics than SMPY females.

2. SMPY males will take significantly more higher level mathematics courses than SMPY females.

3. Two of the following variables will predict best and accurately the number of semesters of mathematics taken in high school: talent search SAT scores, parental educational level, paternal occupational status, sex, number of siblings, sibling position, mathematics liking at talent search or in high school, rated importance of mathematics for future career, and having rated mathematics as a favorite course in high school. They are talent search SAT scores and parental educational level.

4. There will be no significant difference between males' and females' grades in their mathematics classes.

5. SMPY males will take their mathematics courses in a significantly earlier grade than will SMPY females.

6. SMPY males will have a significantly stronger expressed liking for mathematics in high school than will SMPY females.

7. SMPY males will rank their preference for mathematics significantly higher relative to biology, chemistry, and physics than will SMPY females.

8. Significantly more SMPY males than females will take the College Board's mathematics achievement tests and/or APP mathematics examinations.

9. SMPY males will score significantly higher than SMPY females on the College Board's mathematics achievement tests.

10. SMPY males will score significantly higher than SMPY females on the APP mathematics examinations.

11. Significantly more SMPY males than females will plan to major in the mathematical sciences in college.

12. Significantly more SMPY males than females will have accelerated their educational progress.

13. Significantly more SMPY males than females will take mathematics during the first semester of college.

14. Significantly more SMPY males than females will participate in mathematics contests.

15. There will be no significant difference between SMPY males and females in their participation in science fairs.

16. SMPY males will score significantly higher on the College Board's chemistry achievement test than will SMPY females.

17. SMPY males will score significantly higher on the College Board's physics achievement test than will SMPY females.

18. SMPY males will score significantly higher on the APP chemistry examinations than will SMPY females.

19. SMPY males will score significantly higher on the APP physics examinations than will SMPY females.

20. Significantly more SMPY males than females will take the College Board's chemistry achievement test and/or APP chemistry examinations.

21. Significantly more SMPY males than females will take the College Board's physics achievement test and/or APP physics examination.

22. There will be no difference between SMPY males and females in the taking of College Board's biology achievement test and/or APP biology examination.

23. There will be no significant difference between males' and females' performance on the College Board's biology achievement test.

24. There will be no significant difference between SMPY males' and females' performance on the APP biology examination.

25. Talent search SAT will rather accurately predict whether a student takes an achievement or APP examination in one of the sciences or mathematics in high school.

26. SMPY males will like chemistry significantly more than SMPY females will.

27. SMPY males will like physics significantly more than SMPY females will.

28. There will be no significant difference between SMPY males and females in their expressed liking for biology.

12. SAT scores will rather accurately predict achievement at the beginning of college.

1. Among the following variables entered in a stepwise procedure: talent search SAT, paternal occupational

status, parental educational level, number of siblings, sibling position, liking for mathematics, number of semesters of mathematics taken in high school, and rated importance of mathematics for future career, talent search SAT, paternal occupational status and parental educational level will accurately best predict high school SAT-M score.

2. Among the following variables entered in a stepwise procedure: talent search SAT, paternal occupational status, parental educational level, number of siblings, sibling position, liking for mathematics, number of semesters of mathematics taken in high school, and rated importance of mathematics for future career, talent search SAT, paternal occupational status, and parental educational level will accurately and best predict high school math achievement score.

3. Among the following variables entered in a stepwise procedure: talent search SAT , paternal occupational

status and parental educational level, number of siblings, sibling position, and having rated English as favorite subject in high school, talent search SAT, paternal occupational status, and parental educational level will accurately and best predict high school SAT-V .

4. Talent search SAT, paternal occupational status and parental educational level can fairly accurately discriminate between the students having been accelerated and the ones who have not been.

5. When separating the students into three groups by quality of the college attended, the best-weighted composite of the following variables will fairly accurately discriminate between the groups: talent search SAT, paternal occupational status, parental educational level, number of awards and honors won, and degree of acceleration.

6. Quality of college attended by a student will significantly correlate with the student's talent search SAT scores, paternal occupational status, parental educational level, number of awards and honors won, and degree of acceleration.

13. SMPY students will feel that their association with SMPY has benefited them educationally and/or socially and emotionally.

    1. SMPY students will rate their association with SMPY as educationally beneficial, but only slightly more than not at all.

    2. SMPY students will rate their association with SMPY as aiding their social and/or emotional development slightly more than not at all.

14. When separating the students into three groups according to their degree of educational acceleration, the following variables will fairly accurately discrim-

inate between the groups: high school SAT, number of awards and honors won, participation in mathematics contests, intellectualism and status scores of colleges attended, number of semesters of mathematics taken, and number of science courses taken.

1.4 OPERATIONAL DEFINITIONS

Acceleration (academic): Any educational procedure that is vertical. It means moving up into a higher school level of a subject in which the student excels, or into a higher grade than the chronological age of the student would ordinarily warrant (Stanley, 1979).

Accurately predict: 15 percent explained variance based on R. This corresponds to a Pearsonian zero-order, partial, or multiple *r* of approximately .39.

Achievement tests: Designed to measure the effects of a specific program of instruction or training. They measure the effects of learning under partially controlled conditions. They generally represent a terminal evaluation of the individual's status on the completion of training. Intelligence and achievement tests correlate highly, however. The College Board achievement tests were utilized in this study (see College Board Achievement tests) (Anastasi, 1976).

Admissions Testing Program (ATP): Designed to assist students, high schools, colleges, universities, and scholarship agencies with post-secondary educational planning and decision-making (ATP, 1979)

Advanced Placement Program (APP) Examinations (of the College Board): They usually lead to college credit if the person taking them attains a high enough grade. Such grades range from 1 to 5 (and often 3) where 4 and 5 are considered high scores. There are a total of 24 examinations in various areas.

Affective variables in mathematics: The liking of mathematics at the time of the talent search and in high school, having mathematics as a favorite subject in high school, the ranking of preference for mathematics relative to biology, chemistry, and physics, and the rated importance of mathematics to future career

Aptitude tests: Measure the effects of learning under relatively uncontrolled and unknown conditions and significantly more than not at all and serve to predict subsequent performance (Anastasi, 1976) In this study they are the SAT-M and SAT-V (see SAT).

College Board achievement tests: Given by the College Board in its Admissions Testing Program to measure knowledge and ability to apply knowledge in 15 specific subject areas (ATP, 1979)

College-bound seniors (one of the two main norm groups for the SAT): All students in the 1978 graduating class who took the SAT and TSWE

Differences: Statistically significant differences between groups, indicating that these differences are probably beyond or at a 5 percent chance level of occurrence

Educational level: Formal academic, technical, or vocational training completed by the parents of the students by the time of the student's talent search participation, coded in the following manner: 1 = less than high school, 2 = high school graduate, 3 = some college, vocational, or technical training, 4 = college graduate, 5 = some study beyond the Bachelor's degree, 6 = Master's degree, 7 = Doctorate)

Enrichment: "Any educational procedure beyond the usual ones for the subject or grade that does not accelerate or retard the student's placement in the subject or grade" (Stanley, 1979, p. 96).

ETS: Educational Testing Service, Princeton, NJ 08541

Gifted: The conception of giftedness promulgated in Public Law 95-561 suggests the following five categories of exceptionality: intellectual, academic, creative, leadership, and artistic. Students of high special intellectual ability (at least the top 3 percent) are the focus of this study.

Higher level mathematics courses (taken in high school): College algebra, trigonometry, analytic geometry, calculus, probability and statistics, computer science, analysis, matrices, logic, and elementary functions.

Intellectualism score: A college with a high score on this scale will have students of superior academic aptitude who aspire to careers in science and plan to go on for Ph.D. degrees (Astin, 1965). It is a T-score, mean 50 across colleges and standard deviation 10.

Mathematical reasoning ability: Requires numerical judgment, relational thinking and insightful and logical reasoning. Relies on perception of mathematical relationships rather than on past achievement and does not directly include computation or concepts learned by rote or algorithm. Elementary mathematical facts and concepts are required (Angoff, 1971). In the present study SAT-M measures mathematical reasoning ability.

NAEP: National Assessment of Educational Progress.

National high school sample for SAT: "A representative sample of all high school students in the nation who took the test at a special administration in October 1974. Students in the sample were not only those considering college or planning to take the SAT" (ATP, 1979, p.13.).

NLS: National Longitudinal Study of the High

School Class of 1972

<u>Occupational level</u>: Score derived from the NORC (National Opinion Research Center) scale, which was designed to classify the occupational status of occupations in the U.S. The average score is approximately 70,assigned to a cashier. The lowest and highest-scoring occupations obtain status scores of 20 (tobacco farm laborer) and 93 (dentist),respectively.

<u>SAT</u>: Scholastic Aptitude Test of the College Board, administered by the Educatinal Testing Service, Princeton, NJ 08541. It has three parts--mathematical (SAT-M), verbal (SAT-V), and Test of Standard Written English (TSWE). The verbal and mathematical parts measure verbal and mathematical reasoning ability, respectively (Angoff, 1971). It is designed for able high school 11th and 12th-graders. Two norm groups are available, college-bound seniors and a national high school sample.

<u>SAT-M</u>: The mathematics part of the Scholastic Aptitude Test. Scores are permitted to range from 200 to 800, but the chance score is usually about

270. See SAT.

SAT-V: The verbal portion of the Scholastic Aptitude Test. Scores are permitted to range from 200 to 800, but the chance score is usually 230 to 240. See SAT.

Sibling position: Each student's position in the family at time of talent search participation (coded as 1 = first-born, 2 = second-born, etc.)

SMPY: Study of Mathematically Precocious Youth, based at The Johns Hopkins University and founded and directed by Julian C. Stanley, beginning 1 September 1971.

Status score: A college with a high score will have students of high socio-economic status and aspirations for careers in enterprising fields (Astin, 1965). It is a T-score, mean 50 over colleges and standard deviation 10.

Talent Search: A means of identifying intellectually talented students, e.g., as devised by SMPY (George & Solano, 1976). Gifted 7th and 8th-graders participating take the SAT.

TSWE: Test of Standard Written English. It is part of the SAT (see SAT) and measures language mechanics. Scores range from 20 to 60.

Verbal reasoning ability: Stresses basic comprehension and logical reasoning or judgment (Angoff, 1971), and in this study is measured by the SAT-V.

1.5 LIMITATIONS OF STUDY

The results of the study are limited by the population from which the subjects were selected, the instruments utilized, the restriction of range in certain of the variables studied, the lack of appropriate norms for certain variables, and the fact that much of the data were self-report.

1. Initially, the students were selected for the study if they had scored in the upper 2 to 5 percent in mathematical ability on a standardized in-school achievement test (exact cut-off percentile varied for each talent search). Thus, only mathematically able 7th and 8th-graders participated in the talent search. To be included in this longitudinal follow-up of the initial talent search participants, the students had to have scored at least 390 on

the SAT-M or 370 on the SAT-V. This resulted in a rather complete sample of mathematically able students. The sample of verbally talented students, however, is limited to those students who are also mathematically able. (In January of 1980, the talent search, by then conducted by Johns Hopkins' Office of Talent Identification and Development, became a verbal search, too.)

2. Participation in the talent search and in the follow-up was strictly voluntary.

3. Most of the data were self-report.

4. To obtain information on the students at the time of the follow-up an 8-page questionnaire was utilized. A questionnaire was also utilized at the time of talent search participation to assess some background variables. Reliability and validity of these two questionnaires were not assessed.

5. Not all the sample of subjects selected for the study returned their questionnaires. Since over 90% of them did, the possible bias resulting from this would only be minor.

6. Not all students took all the achievement tests administered by the College Board. Thus, the scores obtained come from a self-selected group. This situation is also true for the norms themselves. The norms for a College Board achievement test are based upon performance of college-bound students who took that specific test.

7. Only incomplete data were available for some of the students in the sample.

8. For certain variables studied appropriate norms were not available for comparison purposes.

9. There was considerable restriction of range in most of the variables investigated.

10. The scales used to assess occupational status and the academic difficulty or prestige of the colleges attended are somewhat out of date. John L. Holland (personal communication), however, felt that these two scales were the best available for use today.

11. The part of this investigation dealing with sex differences in mathematics and science are limited in their generalizability by the fact that we are dealing with a gifted sample. Most of the concern about the lack of participation of females in mathematics and related areas expressed by Ernest (1976) and others, however, has been about intellectually able girls, rather than those of average or below average intellectual ability.

1.6 SUMMARY

Especially between 1921 (Terman, 1925) and 1960 (Oden, 1968), work was conducted with highly intellectually able children and adults to discover behavioral, cognitive, and personality concomitants of high IQ scores. More recently, Julian Stanley and his group at Johns Hopkins University's Study of Mathematically Precocious Youth (SMPY) have attempted to identify and understand mathematically gifted preadolescents, while synthesizing many of the early insights and results into a pioneering educational research and development program that provides strong educational facilitation to the students identified.

The early work on the concomitants of high IQ scores, however, is in need of updating. Furthermore, a program such as SMPY needs to be evaluated. The follow-up at high school graduation of the students in the SMPY program caters to these needs and is the focus of this study. The statistical analyses of the results of the follow-up rendered it possible to answer questions pertaining to the development of intellectually talented students in high school, sex differences in mathematics and science, the use of acceleration, and the effectiveness of SMPY. The findings can have important implications for professionals who counsel and facilitate the gifted, as well as for parents and teachers.

CHAPTER 2

REVIEW OF RELATED RESEARCH

The focus of this literature review will be on 6 main topics: a historical perspective to precocity, definitions of intelligence, studies of gifted children, the Study of Mathematically Precocious Youth (SMPY), acceleration, and sex differences.

The present study concerns the characteristics of gifted children. It was thus necessary to show the origins of precocity and how the various stereotypes of gifted children evolved out of them. Then, to better understand what is meant by intelligence, a review of the current state of knowledge is provided. This led into a review of the major studies characterizing individuals who are highly intelligent and how these studies' results were in contradiction to the popular beliefs regarding gifted persons. These works are, however, approximately 50 years old. Updating the characteristics of gifted individuals is needed. The present study attempts to provide this by utilizing the current research advances being conducted by SMPY. In order for the reader to understand SMPY and the uniqueness of the students it identified, a comprehensive review of the rationale behind SMPY and its results is provided.

Many of the techniques utilized by SMPY to help educationally gifted children are accelerative in nature. A controversy spanning decades revolves around the use of acceleration. Some aspects of this controversy are outlined as well as some pro's and con's of acceleration. Its use will be evaluated in the present investigation.

Finally, certain aspects on the literature concerning sex differences in aptitudes and achievement are provided. Sex differences have been noted by SMPY (Benbow and Stanley, 1980b). Their development will be investigated in this work.

2.1 PRECOCITY-A HISTORICAL PERSPECTIVE

In a study dealing with intellectually talented students it would be useful to define what is meant by intellectual talent or precocity. The

Oxford English Dictionary defines "precocity" as "early maturity, premature development" (Stanley, 1974). Thus, an intellectually precocious student is one who shows early maturity in his/her intellectual abilities. Another way of phrasing it would be to say that the precocious youth resembles older students in their way of thinking cognitively (Robinson, 1981).

"Genius" is a concept closely related to or often thought to be equivalent to precocity. Albert (1980) described genius in the following manner:

"Historically, 'genius' has designated persons and/or styles of thinking and performances that clearly break with the past; alter radically the customary means of attack on problems in art, philosophy, politics, science, and welfare; or represent the essence of high performance in these areas. Two key experiential manifestations of genius are (1) the rare but radical disruption of preceding manners, attitudes, customs, or cognitive habits; and (2) the performance of complex tasks in manners and styles very rarely observed....[A]dult-level artistic and scientific works that are extremely precocious are also taken as manifestations...(p. 730). Albert further noted that such persons have been viewed with suspicion and ambivalence.

The stigma associated with being precocious or gifted can be characterized by the "sour grapes" attitude that gifted individuals must be miserable and isolated people or by the expression "early ripe, early rot". These stereotypes have persisted up to present times.

Another definition of talent is an individual's unique pattern of potentials for learning to perform various types of activities important in our culture. In order to be gifted, the person must develop his /or her talent (Flanagan _et al_., 1962).

Giftedness has been in the past and is also currently viewed in terms of scores on intelligence tests. A student scoring highly on an IQ test or some other cognitive ability test is viewed as being gifted. Public Law 95-561, however, describes five different categories of ability: (1) intellecutal, (2) academic, (3) creative, (4) leadership, and (5) artistic. This view, perpetrated from the time of the widely cited Marland Report (1972), has little support from research or any theory of human abilities (Feldhusen, 1981).

Feldhusen (1981) suggests instead the following categories: intellectual, artistic, social, and motor.

2.2 INTELLIGENCE DEFINED

Although precocity and intelligence have interested writers throughout the centuries (Stanley, 1974), empirical work was not begun until over a century ago, when Francis Galton began his studies in human heredity and individual differences. For several cogent reasons Galton's Hereditary Genius (1869) is a landmark. Foremost is the fact that Galton successfully used statistical concepts to study differences between related and unrelated individuals. Secondly, precocity was viewed as an observable and measurable human attribute, not as an act of God. Thus, Galton clarified the concept of genius or intelligence and rendered it amenable to empirical investigation. Finally, the methodology he employed and pioneered Galton contributed greatly to psychometrics

In the course of Galton's investigations of individual differences he realized the need for reliable and valid measurements of human characteristics. With regard to intelligence, Galton (1883) believed that tests of sensory discrimination would be the optimal indicators. Thus, to test for individual differences in intelligence, Galton designed tests such as the Galton bar for visual discrimination of length, the Galton whistle for determining the highest audible pitch, and a graduated series of weights to measure kinesthetic discrimination.

James McKeen Cattell adhered to Galton's philosophy and designed his own tests, which measured such traits as muscular strength, speed of movement, sensitivity to pain, keeness of vision and hearing, weight discrimination, reaction time, and memory. He named them "mental test" (Cattell, 1890).

Evaluation of these early "mental" tests, however, led to disparate results. The individual's performance on one test did not correspond to his performance on another test (Sharp, 1898-1899; Wissler, 1901) and exhibited little or no relationship to independent estimates of intellectual ability (Bolton, 1891-1892; Gilbert, 1894) or academic grades (Wissler, 1901). Thus, Galton and Cattell did not begin mental testing in its modern form.

Not until 15 years later, when Binet and Simon (1905a, b, c) introduced their mental ability tests, did the measurement of intelligence and the philosophy behind it begin to resemble that of present-day technology. Their scales differed radically from the simple sensory measures of Galton and Cattell. They measured a variety of abstract abilities such as reasoning, judgment, comprehension, memory, and vocabulary knowledge. The purpose of the test was to detect which children entering French schools had the mental ability to succeed there. Three years later (Binet & Simon, 1908) this scale had been revised and all of the tests grouped empirically into age levels. The obtained intelligence score was expressed as a mental-age level. The third revision of the scale, which appeared in 1911 (Binet, 1911), the year when Binet died, appeared with virtually no fundamental changes. Between 1910 and 1911 Henry Goddard adapted the Binet-Simon scale for use with English speaking persons and tested thousands of them in the United States (Goddard, 1910a, b; 1911).

In 1916 Terman revised the Binet-Simon scale and attempted to provide standards of intellectual performance for American-born children from 3 to 16 years of age (Terman, 1916). The tests were again arranged in order of difficulty by age levels. Stern had introduced the mental quotient in 1912, computed by dividing the mental age by the chronological age (see Goodenough, 1949). Terman revised this in 1916 by multiplying the mental quotient by 100 to remove the decimal point, and called it the intelligence quotient (IQ). His test, originally named the Stanford Revision of the Binet-Simon scale, has become through its various revisions one of the two current standards of measuring intelligence. The other is the set of scales introduced by Wechsler (1939).

At almost the same time that Binet and Simon introduced their radically new concept of mental testing and thus of intelligence, Spearman (1904) published his theory of mental ability or intelligence. He proposed a general intellective factor, _g_, which he believed to be independent of the many special abilities a person may have. Although his theory was too simple and provoked much controversy, it did lead to the search for components of intelligence to supplement the global IQ (Stanley, 1974). For example, Thurstone (1938) postulated that there is a set of primary mental abilities, such as spatial, numerical, and verbal relations. Thorndike (1926) saw as many different types of intelligence as there are different types of tasks. Horn and Cattell (1966) split Spearman's *g* into two components-- g_f, which stands for fluid ability and represents the basic biological capacity of the individual, and g_c, which stands for crystallized ability, represents the type of ability affected by acculturation, and is what is measured by most standardized tests of intelligence (Brody & Brody, 1976).

Vernon (1961) postulated an hierarchial structure of intellectual abilities as generated by successive factor analyses--specific factors are clusters of minor group factors, which become part of major group factors (v:ed and k:m), which finally group into *g*. Guilford's (1967) structure-of-intellect theory, however, claims that intelligence must be viewed in terms of 120 distinct intellectual aptitudes, each representing an independent factor. So far, the existence of all the hypothesized factors has not been verified.

Sternberg (1979; 1980) proposed an alternative to the factor theories of intelligence, which he called a componential theory of intelligence. Components of intelligence can be subdivided by function and generalizability. There are five different function components: metacomponents, performance components, acquisition components, retention components, and transfer components. On the basis of generalizabiltiy there are three different levels of components: general, class, and specific components. Sternberg (1980) claims that the componential theory provides a complementary perspective on the various differential theories generated from factor analytic studies. Carroll (1980) provides a useful critique of Sternberg's theory.

2.3 THE HIGHLY INTELLIGENT

Although Galton was the first person to study "genius", empirically, Terman was the first person to systematically do research in that field. In 1906 Terman published his doctoral dissertation under the title "Genius and Stupidity: A Study of Some Intellectual Processes of Seven 'Bright' and Seven 'Stupid' Boys." This study led him to conclude "that the field was a promising one for experimental investigation" (Terman, 1925). Furthermore, he later conceded that the advances made by Binet and Simon after his initial study made the field even more amenable to scientific investigation (Terman, 1925, p. 1).

Five years after his first (i.e., 1916) revision of the Binet-Simon scale appeared, Terman launched his monumental study entitled "Genetic Studies of Genius." He planned to identify exceptionally bright children early and then to study them throughout their life to see whether or not the popular stereotypes associated with the gifted were true. Terman's instrument of choice for measuring intelligence was his Stanford Revision of the Binet-Simon Scale. A high IQ score was considered by him to be the standard for giftedness.

The search for subjects for the Terman study was limited chiefly to the larger and medium-sized urban areas of California. The sample consisted of 1528 children (857 boys and 671 girls). The children below high school age, who comprised 70 percent of the sample, had to have attained an IQ of at least 140. Their mean was 151. High school age children were given the Terman Group Test of Mental Ability because of the lack of ceiling in the 1916 Stanford Revision. The standard for selection was a score in the top percentile of the general school population. Some siblings of the students identified were later added to the study. The average age of the subjects when they were identified was 11. The ages ranged from 3 to 19 (Oden, 1968). An especially interesting finding when selecting the students for the study was that "nomination as youngest yielded more [qualifying] subjects who would otherwise have been missed than any other kind of nomination, 19.7 per cent of the total nomination group....In other words, if one would identify the brightest child in a class of 30 to 50 pupils it is better to consult the birth records in the class register than to ask the teacher's opinion" (Terman, 1925, pp.32-33).

The findings from this longitudinal study of 1528 children have been reported in the five volumes of Genetic Studies of Genius (Burks, Jensen, & Terman, 1947; Cox, 1926; Oden & Terman, 1947; 1959; Terman, 1925) and several more recent publications (Oden, 1968; Sears, 1977; Sears & Barbee, 1977) Although this life-time longitudinal study is not yet complete (its participants were born, on the average, around 1911), the findings so far will be summarized briefly.

The purpose of the study was to discover the physical, mental, and personality traits that characterize gifted children and ascertain what sorts of adult gifted children become. In the first volume of Genetic Studies of Genius the first purpose was answered (Terman, 1925). Terman found that, in general, intellectually superior children were also superior in physique, health, social adjustment, and moral attitudes and vastly superior in the mastery of school subjects. Furthermore, the typical gifted child appeared to have many and varied interests, with an interest maturity level two or three years beyond his or her chronological age, and appeared to come from families of rather high social and economic status. The children were not one-sided in their abilities. Finally, a wide range of variability was found within this gifted group. Gifted children did not fall into a single pattern but into a variety of patterns (Terman & Oden, 1959).

With regard to the second purpose of Terman's study, it was found that the intellectually superior children become superior adults (Oden, 1968). They maintain their intellectual ability and health, have a lower death rate, and suffer from few serious mental illnesses and personality problems. Crime was virtually non-existent in the group. In educational and vocational achievement the group ranked substantially better than the general population. Approximately 87 percent of the men were professionals or semi-professionals. Furthermore, the list which covers the group's various achievements and honors is extensive. Among the women 42 percent were employed full-time, with teaching being the most frequent occupation. The majority of the women were active in the promotion of community welfare and civic affairs, as was true of the men. In conclusion, Oden (1968) states that "...there can be no doubt that for the overwhelming majority of subjects the promise of youth has been more than fulfilled. The Terman study has shown that the great majority of gifted children do indeed live up to their abilities" (p. 51).

At approximately the same time that Terman began his longitudinal study, Hollingworth started working with gifted children also but on a much smaller scale. Hollingworth studied and facilitated individual students who on the 1916 Stanford Revision obtained an IQ of at least 180. Twelve cases were brought to her attention and presented (Hollingworth, 1942) in a book compiled by her husband after her untimely death. As Terman had found, these students came from above-average home environments. The parents, who had the child when they were fairly old, were for the most part well educated and engaged in prestigious occupations. Several relatives had been eminent. These students were precocious not only mentally but also physically and behaviorally. Above average in size, they talked and read early. The scholastic achievements of Hollingworth's students were also quite advanced, relative to their chronological age. The usual mode for dealing with this precocity was to accelerate the students by several years in grade placement or to group them with quite bright children their own age. Early signs of creativity in these children were noted.

With regard to social adjustment, Hollingworth found that her above-180-IQ children tended to have problems. Terman indicated that he may have discovered this in this top range, also. Because of the social adjustment problem, Hollingworth recommended that, for such students, schools designed specifically to help their personality growth and development and enrich their academic program be created. Hollingworth found that early recognition and appreciation of the child's talent were beneficial and helpful, especially with regard to social adjustment. In her book, Hollingworth concluded that probably the optimal IQ range for normal social development but with the advantage of superior intelligence was 130 to 150. It must be noted, however, that the children studied by Hollingworth were discovered by her on the basis of referral. It is not clear how that may have affected her findings. Gallagher (1975) found a wide range in the social and emotional development of gifted children, for example. Unfortunately, after Hollingworth's 1942 book virtually nothing more has been done with her work.

When Terman died in 1956, most of the systematic concern for the intellectually talented died with him (Stanley, 1974). Three major factors about that time hastened the demise. One was the fear generated when Russia launched its first sputnik. This resulted in designs for special curricula in science and mathematics at the secondary school level. These new curricula were designed for class consumption and thus were not appropriate for the exceptionally gifted, but instead for the above average student.

A second influence was the 1954 Supreme Court ruling that led to the current stress on compensatory education of culturally disadvantaged minority groups. Moreover, various influences, some being derived from the above concern, have produced a wave of egalitarianism that brands as elitist most special provisions for the gifted, that eliminates or dilutes most special schools and curricula for them, and that attacks mental testing itself and urges a return to pre-Binet subjectivism.

The third major factor involved in the demise of the concern for the gifted was that Terman did not produce disciples to continue his work (Stanley, 1974). The decline in concern for the gifted in the 1960's is evident in the contrasting number of professional publications on that subject at the beginning and end of the decade (Tannenbaum, 1979).

The 1970's, however, showed a renewed interest in the gifted. "While as late as 1973 fewer than 4 percent of the nation's gifted children were receiving satisfactory attention at school, and most of the fortunate ones were concentrated in ten states, by 1977 every state in the union demonstrated at least some interest in the ablest" (Tannenbaum, 1979, p. 22). The recent thrust in activity for the gifted, however, has been mostly programmatic and promotional, with little emphasis given to research (Tannenbaum, 1979).

2.3.1 Study Of Mathematically Precocious Youth

The Study of Mathematically Precocious Youth (SMPY), which was founded by Julian C. Stanley with the help of his associates Lynn H. Fox and Daniel P. Keating in September of 1971, is an exception to the current programmatic and promotional trend in the field of gifted children. It is modeled after the great Terman study but with certain differences. It is research-oriented and studies mathematically precocious students on a longitudinal basis. Furthermore, SMPY tries to understand (cognitively and affectively) each mathematically precocious adolescent, so it can facilitate the students educationally (Stanley, 1977). The philosophy behind SMPY can be succinctly stated in pseudo-chemical fashion--$MT:D_4P_3$. MT stands for mathematical talent. The four D's are Discovery, Description, Development, and Dissemination. The three P's, which implement D4, are Principles, Practices, and Programs. Clearly, the above illustrates that discovery, description, and development lead to the ultimate goal of SMPY, research and the dissemination of its findings.

SMPY identified mathematically talented students through its six separate talent searches (George & Solano, 1976). These were conducted in March 1972, January-February 1973, January 1974, December 1976, January 1978, and January 1979. In the first three searches 7th and 8th-graders, as well as a few accelerated 9th and 10th graders, were eligible, while for the last three only 7th graders or accelerated students of 7th grade age were eligible. In addition, in the 1976, 1978, and 1979 searches the students had also to be in the upper 3 percent in mathematical ability as judged by a standardized in-grade achievement test, in 1972 in the upper 5 percent, and in 1973 and 1974 in the upper 2 percent. Thus, both female and male talent search participants were selected by equal criteria for high mathematical ability before entering. Girls comprised 43 percent of the participants in these searches.

In each talent search the students took one or more parts of the College Board's Scholastic Aptitude Test (SAT), i.e., the mathematics (SAT-M) sections every time, the verbal (SAT-V) sections except in 1972 and 1974, and the newly introduced Test of Standard Written English (TSWE) in 1978 and 1979. The SAT is designed for able 11th and 12th-graders; on the average, these students are four to five years older than the students in the talent searches. The test is particularily designed to measure mathematical and verbal <u>reasoning</u> ability (Angoff, 1971).

Results from the six talent searches are shown in Appendix C (Benbow & Stanley, 1980b). Most students scored rather high on both SAT-M and SAT-V. On SAT-V the boys and girls performed equally well, except for accelerated 8th-graders in 1976, where the 12 such boys performed better ($p <$ .05). The overall performance of 7th grade students on SAT-V was at or above the average for a national sample of high school students, whose mean score is 368 (ATP, 1979), or at about the 30th percentile of college-bound seniors. The 8th-graders, regular or accelerated, scored at about the 50th percentile of college-bound seniors.

On the SAT-M, however, a large sex difference favoring boys occurred in every talent search. The smallest mean difference was 32 points in 1979. The largest mean difference (excluding the 22 accelerated 8th-graders in 1976) was 70 points, in 1972. Benbow and Stanley (1980b) discuss this point further. Although a consistent sex difference was found on SAT-M, it can still be concluded that the SMPY students of both sexes were quite able mathematically. The 7th grade girls scored at about the 40 percentile of college-bound senior females on SAT-M and the 8th grade girls at about the 60th percentile. The 7th grade boys scored at about the 36th percentile of college-bound senior males on SAT-M and the 8th grade boys at about the 60th percentile. In conclusion, we can state that SMPY has identified a group of mathematically precocious students. Furthermore, mathematically precocious students also tend to be highly able verbally. The verbal ability is somewhat lower than the mathematical ability of this group, as expected from regression to the mean.

The above discussion can be said to describe SMPY's discovery phase and part of its description phase. The description phase is when SMPY characterizes its talent search participants' backgrounds and attitudes (Benbow & Stanley, 1980a, 1981a) and when it tries to test its students further on other cognitive and affective measures. Specifically, SMPY brings back for further testing those students who score extremely well in the talent searches. In 1976, for example, SMPY brought back the top third of its talent search participants for a day of further testing (Cohn, 1977), followed by another day of more testing for the top 97 males (Cohn, 1980). In 1978 it brought back approximately the top 10 percent (Benbow, 1978). The cognitive tests employed assess specific cognitive abilities, such as mechanical comprehension, abstract reasoning, and spatial relations. The students' science and mathematics knowledge is also determined. By use of the Allport, Vernon, and Lindzey Study of Values, the Holland Occupational Checklist, and the Strong-Campbell Interest Inventory, values and interests are evaluated.

Cohn (1977, 1980) and Benbow (1978) found that the mathematically precocious students are also advanced in their specific abilities and in their knowledge of science and mathematics. Weiss, Haier, and Keating (1974) and Haier and Denham (1976) concluded that students of exceptional mathematical ability are more interpersonally effective and socially mature than their non-gifted peers and thus are more likely to face successfully the social and emotional challenges presented by their unique talents. Furthermore, they were found to be solid, competent individuals who seem to be handling their extraordinary talents in a commendable fashion. These conclusions were based on the testing results obtained from the _California Psychological Inventory_, the _Eysenck Personality Inventory_, the _Study of Values_, _Holland's Vocational Preference Inventory_, and the _Adjective Checklist_. With regard to the mathematically precocious students' values and career interests, it was found that the students had a high theoretical but low religious orientation and preferred investigative careers (Cohn, 1980; Fox & Denham, 1974; Haier & Denham, 1976).

The SMPY students tend to come from larger than average families with well-educated parents of high occupational status (Benbow & Stanley, 1980a; Keating, 1974). The parents tend to have professional careers. Student SAT scores did relate to the parents' educational level and fathers' occupational status (Benbow & Stanley, 1980a) but not to the number of siblings in the family nor the sibling position (Benbow & Stanley, 1980a; Keating, 1974).

The SMPY students' educational attitudes, experiences, interests, and values were remarkably homogeneous in spite of the wide range in SAT scores. In most affective respects a 7th-grader with an SAT-M score of 700 differed little from one with a score of 500. Most participants exhibit a strong liking for and do well in school, mathematics, and science. They perceive science as important for their future careers. Slight differences were seen between the SMPY girls and boys in their liking for mathematics, chemistry, and physics (Benbow & Stanley, 1981a). Keating (1974) found that even though the talent search participants had an overall liking for school, there was a trend in which the students with the highest aptitude liked it less than students with less high aptitude.

Through the further testing of the students' specific cognitive abilities, knowledge of science and mathematics, and their attitudes, values, and interests, and by assessing each student's background, every student can be carefully characterized. This leads to the prime focus of SMPY, the development phase. During this phase the youths who were found and studied are continually helped, facilitated, and encouraged. Each is offered a smorgasbord of educationally accelerative opportunities (Benbow, 1979; Fox, 1974b; Stanley, 1978) from which to choose whatever combination, including nothing, that best suits the individual. Some of the options are: skipping grades, graduating a year early from high school, entering a course a year or more early, completing two or more years of a subject in one year, tutoring following the Diagnostic Testing followed by Prescriptive Instructions approach (Stanley, 1978b; 1979), taking regular college courses on a part-time basis while still enrolled in a secondary school (Benbow & George, 1979; Solano & George, 1976), credit through examination--mostly APP examinations (Benbow & Stanley, 1978), and earning the master's degree concurrently with the bachelor's.

Another educationally accelerative opportunity offered by SMPY is its fast-paced mathematics classes, where several years of mathematics are completed in one year (Fox, 1974a; George & Denham, 1976; Mezynski & Bartkovich, 1981; Mezynski & Stanley, 1980). A special class was even formed to cater to the special social needs of girls (Fox, 1976). The special fast-paced approach was recently adapted to the study of chemistry and physics (Mezynski, McCoart, & Stanley, 1981).

2.4 ACCELERATION

SMPY's educational facilitation of the students it identifies relies heavily on acceleration. Much concern has been and is currently being expressed about the presumed dangers of acceleration, especially with respect to social and emotional development. This myth associated with acceleration persists despite the strong research base that supports its use (Gallagher, 1975). This has led to one of the most unfortunate dichotomies in the field of education--the enrichment versus acceleration conflict (George, Cohn, & Stanley, 1979). The single experimental study that has compared enrichment and acceleration found that a combination of the two provided the best educational benefit for the gifted (Goldberg, Passow, Camm, & Neill, 1966).

Some of the fundamental reasons for an age-graded educational system will be outlined below. The most frequently proposed is that advancing students according to their demonstrated mastery of subject areas fails to take into account the level of their social competencies and their emotional strengths and weaknesses (Hildreth, 1966; Hollingworth, 1929). Social and emotional maturity are thought to correspond rather specifically to chronological age (Gold, 1965; Rothman & Levine, 1963). It is argued that intellectual and academic accomplishments indicate very little about social and emotional development and that to accelerate a student on the basis of progress in one domain may jeopardize healthy progress in the other areas (Congdon, 1979). Another objection is that skipping grades produces gaps in knowledge (Hildreth, 1966). Moreover, it is believed that valuable non-academic experiences will be eliminated through the use of acceleration (Rothman & Levine, 1963).

Robinson (1981) outlined the rationale for acceleration. It is based on the following three premises: (1) "Learning is a sequential, developmental process" (p. 2). (2) "Effective teaching must involve a sensitive assessment of the individual's status in the learning process and the presentation of problems that slightly exceed the level already mastered" (p. 2). (3) "There are very substantial differences in learning status among individuals of any given age" (p. 2). In essence, acceleration means placement according to competence. Although this is not widely accepted in education, it is in many fields such as music, the arts, and sports.

Although acceleration has received only minimal acceptance among educational practitioners, it has achieved maximal support from the results of experimental and quasi-experimental studies. Terman and Oden (1947) recommended that students with an IQ greater than 135 be at least accelerated by one year. This was based on their longitudinal findings. Furthermore, they showed that the risk of maladjustment resulting from acceleration is much less than commonly believed and the disadvantages of acceleration mentioned by the Terman gifted group were usually temporary. In contrast, Terman and Oden (1947) pointed out the danger of not accelerating a child. Lack of acceleration resulted in a considerable proportion of the Terman group's languishing in idleness through the elementary grades and high school and thus failing to develop the ambition or work habits necessary to make them successful in college.

Sidney Pressey (1949) also found only advantages in the acceleration of the rate of completing the undergraduate degree. The accelerated students in college were found to have better academic accomplishments, and have participated in more extra-curricular activities. They were also found to have superior all-around development compared to students completing their degrees in normal or longer than normal time.

The Fund for the Advancement of Education (1957) concluded that the results from experiments in allowing bright students to enter college early were impressive at all 12 colleges where it was tested. Again concern was expressed about the dangers of not allowing bright students to accelerate--the ambition and creativity needed for college work might be "educated" out of the bright student unless he is not accelerated.

Hobson (1963) concluded that the "scholastic superiority in elementary school of underage children, originally admitted to school on the basis of physical and psychological examinations, is continued and somewhat increased through high school" (p. 168). Furthermore, the underage students participated in a higher number of extracurricular activities in a variety of areas and won more awards and honors in high school than regular students. Hobson (1963) concluded that early admission to school is an excellent way to provide for individual differences in intellectual ability.

Robinson (1981) reviewed over 200 articles that examined the experiences of accelerated students. His conclusion was that "[n]ot one of these studies lends credence to the notion that such practices lead to major difficulties for the students involved. It is, indeed, much easier from the available evidence to make the case that students who are allowed to move ahead according to their competencies are benefited in their social and emotional development than it is to make the case that they are harmed" (p. 5).

In his review of the literature on the enrichment versus acceleration controversy, Daurio reached the following conclusions: (1) academic enrichment may be worthwhile for all students, and not specifically for the gifted; (2) results have not been found to show that enrichment is superior to acceleration; (3) much of the resistance towards acceleration is based on preconceived notions and irrational grounds, rather than on examinations of the research evidence; (4) accelerated students are shown to perform at least as well as if not better than non-accelerated students on both academic and nonacademic measures; and (5) acceleration appears to be the more feasible method for meeting the needs of gifted students.

Other reviewers who have examined this issue have come to the same conclusions as Robinson (1981) and Daurio (1979) (e.g., Gallagher, 1975; Newland, 1976). Thus, as Keating (1979) concluded, "as for the socio-emotional concerns, it seems time to abandon them unless and until some solid reliable evidence is forthcoming that indicates real dangers in well-run programs" (p. 218). With regard to the concern that grade skipping can cause gaps in knowledge, there is no evidence to support the position that gifted students who do skip grades are afflicted with substantial lacunae in their knowledge base (Keating, 1976; Stanley, Keating, & Fox, 1974).

In summary, the use of acceleration in providing for the special needs of the gifted is well-founded.

2.5 SEX DIFFERENCES IN MATHEMATICS

Huge sex differences have been reported in mathematical aptitude and achievement (e.g., Benbow & Stanley, 1980b; 1981b; Fennema, 1974; Fox, 1976; Fox, Brody, & Tobin, 1980; Fox & Cohn, 1980; NAEP, 1975). In junior high school, this sex difference becomes quite obvious; girls excel in computation, while boys excel on tasks requiring mathematical reasoning ability (Benbow & Stanley, 1980b; Fennema, 1974; NAEP, 1975).

Although the sex difference in mathematical reasoning ability favoring boys is large, the sex difference in mathematics achievement, also favoring boys, is even larger (Fox, Tobin, & Brody, 1979). There is considerable evidence that females and males do not study mathematics at the same rate or to the same extent (Ernest, 1976; Fennema & Sherman, 1977; Fox, 1977; Sells, 1980; Sherman & Fennema, 1977).

The SMPY findings with respect to the sex difference in mathematical aptitude was discussed above (or see Benbow & Stanley, 1980b; Fox, 1976). The longitudinal findings from Project Talent and NLS 1972 will be presented next.

Project Talent was launched in 1960. In the initial phase of Project Talent, a comprehensive battery of tests was administered to over 40,000 high school students in grades 9 through 12. They were considered to be a representative 5 percent sample of all high school students in the United States that year. The test battery consisted of numerous aptitude and achievement tests and three questionnaires concerning background information about the student, his occupational interests, and his personality. The results from this testing were analyzed in terms of 109 variables (64 cognitive and 45 noncognitive) (Flanagan et al., 1962).

The design of Project Talent provided for follow-up of these students by means of questionnaires, one, five, ten, and twenty years after the graduation of their high school classes. The follow-up questionnaires contained a common core of items seeking information concerning education after high school, jobs, and career plans (Flanagan et al., 1962). Relevant findings from the one-year, five-year, and ten-year follow-ups will be presented.

In the follow-up conducted just after high school graduation the following conclusions were derived: the amount of cognitive growth from 9th grade to 12th grade was substantial and important; the two sexes showed different patterns of cognitive growth, the sex with the larger gain being also the one with the higher initial score; the amount known in a subject in 9th grade was a good predictor of what would be known in 12th grade; significant differences were shown to exist among schools with respect to score changes for virtually all of the tests, even after ability had been controlled for; scores on certain tests (Arithmetic Reasoning and Memory for Words, for example) were unaffected by amount of course work in various subjects (mathematics, science, foreign languages); the effect of socioeconomic status (SES) on performance in high school was found to be indirect (operating by affecting other factors); the direct effects of SES had probably had its full force before high school (Shaycoft, 1967).

From the follow-up conducted five years after high school graduation the following two main conclusions were derived: students (girls or boys) with higher academic aptitude and socioeconomic status obtained more education, and there were marked shifts in occupational choices (Flanagan _et al_., 1971).

The published report from the ten-year follow-up concerned itself specifically with factors in mathematics achievement and with the sex difference in mathematics (Wise, Steel, & MacDonald, 1979). The following conclusions were made: small sex differences in mathematical ability existed in the 9th grade but by the 12th grade these differences were large; some of this increase in the sex difference in mathematics could be attributable to the fact that boys took more mathematics courses; interest in mathematics and mathematics-related careers could also explain part of the sex difference in mathematics achievement gains; the most significant predictor of mathematics course-taking in high school was initial 9th grade ability and educational aspiration; the level of interest in mathematics-related careers was the next most significant predictor of mathematics participation after abilities and educational aspiration were controlled; this was followed by a measure of self-confidence and the characteristics of the fathers for the girls; availabiltiy of an accelerated science program was correlated with mathematics achievement for girls after controlling for 9th grade characteristics; and high school mathematics achievement was found to be significantly related to persistence in mathematics-related career plans.

Another relevant investigation recently initiated is the National Longitudinal Study of the High School Class of 1972 (NLS). It aims to gain insights into the educational, social, and economic factors involved in the transition from high school through post-secondary institutions and into the labor market (Malone, 1980). With regard to mathematics and sex differences, the following conclusions were made from the NLS 1972 data: women have lower mathematical competency; women complete fewer high school mathematics courses from a given competency level; women have a lower rate of entry into quantitative fields in college for a given number of mathematics courses completed in high school; women have a lower rate of persistence in quantitative fields; and mathematics course-taking cannot account solely for the sex difference in mathematical aptitude (Malone, 1980).

Fox, Tobin, and Brody (1979) investigated two hypotheses frequently offered to explain the sex difference in achievement and perhaps aptitude. The first, the masculine-identification hypothesis, is based on the belief that it is necessary for one to identify psychologically with a male in order to have interest and ability in mathematics. This hypothesis has been faced with some contradictory results and was thus rejected.

Stronger evidence was found to support the second hypothesis, the social-reinforcement hypothesis, which states that sex-related differences in mathematics achievement, at least in part, are the result of differential social conditioning and expectations for boys and girls. "The evidence shows that male prejudice against girls competing in mathematics does exist and the girls believe it exists. This perception of mathematics as a domain restricted to males may create a conflict for mathematically able girls between academic achievement and popularity, leading to reduced course taking in mathematics" (Fox, Tobin, & Brody, 1979, p. 324). Furthermore, these investigators concluded that "[d]ifferences in mathematics course taking and ability seem to be less a function of biology and identification with a masculine role than of socialization forces (i.e., self-confidence with respect to mathematics, different career interests, and therefore different perceptions of the usefulness of mathematics)" (Fox, Tobin, & Brody, 1979, pp. 324-325).

Fennema and Sherman (1977) proposed that the sex difference in mathematical reasoning ability is simply a function of the fact that boys take more mathematics courses than girls. Differential course-taking is the result of socialization forces. Recently strong data have been presented that contradict this theory (Benbow & Stanley, 1980b). Benbow and Stanley (1980b) found a huge sex difference in mathematical reasoning ability before any differential course-taking had occurred in their sample of 10,000 7th and 8th-graders. Furthermore, they concluded that it "seems likely that putting one's faith in boy-versus-girl socialization processes as the only permissible explanation of the sex difference in mathematics is premature" (p. 1264). They favored instead "the hypothesis that sex differences in achievement in and attitude toward mathematics result from superior male mathematical ability, which may in turn be related to greater male ability in spatial tasks. This male superiority is probably an expression of both endogenous and exogenous variables. We recognize, however, that our data are consistent with numerous alternative hypotheses" (p. 1264). The connection between the sex difference in spatial ability and mathematical reasoning ability has been supported (e.g., Burnett, Lane, & Dratt, 1979; MacFarlane-Smith, 1964; Sherman, 1967).

Considering the extensive publicity aroused by the Benbow and Stanley (1980b) report and the reaction towards it, it is clear that the issue of why girls do not perform as well as boys in the field of mathematics is hotly debated and far from resolved. Much more research is needed in order to elucidate the factors involved in this sex difference.

In this conection, it is fruitful to point out that a similar sex difference in favor of boys is also found for the physical sciences (not biology) (Kelly, 1979). This finding is based on an international study. Sex differences held up in every country studied, regardless of the type of socialization and educational practices dominating that country and the country's wealth.

2.6 SUMMARY

Some of the issues involved in the field of education of the gifted were deliniated. Interest in the gifted was presented in a historical perspective along with the various conceptions of intelligence and giftedness. Then various longitudinal research programs involved with gifted children (e.g., Terman's, Hollingworth's, and Stanley's) were discussed. Finally, the acceleration versus enrichment controversy and the issue of sex differences in mathematics were presented.

Gifted children are seen as functioning mentally at a level several years beyond their chronological age. These children have also been shown to be above average in physical and social development and the mastery of school subjects. As adults, they are highly successful. Thus, it was seen that the popular stereotypes surrounding gifted children are untrue. The works that assessed this, however, are old. Updating is needed, which the present study attempts to provide.

The present investigation's data base evolves out of the research being conducted by SMPY. Its rationale for finding, characterizing, and developing educationally mathematically precocious students was discusssed. Its techniques, however, need to be longitudinally evaluated. The results from the present investigation will yield such an evaluation.

It has been shown that the use of acceleration does result in students of higher academic calibre without harming their social development.

Yet most persons hold adverse attitudes towards acceleration. In the previous studies, however, the students themselves were not asked to evaluate their use of acceleration. This was done here and should provide further validity for its use.

Finally, sex differences in aptitude and achievement have been widely noted by SMPY and others. Certain explanations have been offered for these differences. Most of them relate to boys vs. girl socialization processes, i.e. attitudes and that more boys than girls take mathematics courses. The validity of these hypotheses for the SMPY population and the general population needs to be tested. The present investigation will yield pertinant results for their evaluation.

CHAPTER 3

METHODOLOGY

3.1 SUBJECTS

The subjects in this study consisted of students from SMPY's first three talent searches. In the first three talent searches 7th and 8th grade[2] students in Maryland and Washington, D.C., were eligible to participate if they scored in the upper 5 percent (March 1972) or the upper 2 percent (January-February[3] 1973 or January 1974) nationwide in mathematical ability on a standardized achievement test. As part of the talent search

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2) Some accelerated 9th and 10th-graders were also eligible.

3) In 1973 two somewhat overlapping talent searches were conducted: one by SMPY and the other by the Study of Verbally Gifted Youth, which was directed by Robert Hogan and Catherine Garvey (McGinn, 1976). Students included in this study came from both searches, since criteria for inclusion was based only on SAT scores not which talent search was participated in.

students then took the College Board's Scholastic Aptitude Test--Mathematics (SAT-M) and also, in 1973, SAT-Verbal (Angoff, 1971). A background questionnaire was also completed by the participants in the talent search.

In order to be part of this present study, which followed up the talent search participants at high school graduation, the student had to have scored at least 390 on SAT-M or 370 on SAT-V during the talent search as a 7th or 8th-grader. If in 1972 the student had met the score criterion on a test of scientific information [i.e., 75 points or better out of 150 possible points on the Sequential Test of Educational Progress (STEP) General Science Information Test, Series II, Levels 1A & 1B (first year of college)], he or she was also selected for this study. The above SAT criteria selected students who as 7th or 8th-graders scored as well as the average 11th and 12th-grader does on SAT-V and the average 11th and 12th grade female does on SAT-M (ATP, 1979).

A sample size of 2188 was obtained. Approximately 60 percent of the persons to be followed were male. (In the initial talent searches, approximately 43 percent were females.) When the subjects were contacted (between 1976 and 1980), the subjects would normally have graduated from high school and would be freshmen in college. Keating (1974) found that these students tend to come from homes where the parents had been rather highly educated.

3.2 INSTRUMENTATION

Questionnaires. The initial talent search questionnaire of the students and an eight-page questionnaire assessing their achievements in high school are the two main sources for the results of this study (see Apppendixes A and B). The initial talent search questionnaire was designed to assess the characteristics of the students at the time of talent search participation. Specifically, this questionnaire dealt with the student's family and educational characteristics. The follow-up questionnaire's purpose was to determine the achievement of this group in high school, particularly in the areas of mathematics and science. Acceleration, especially in terms of the use of SMPY's smorgasbord of accelerative options, and college attendance were also studied. Owing to the nature of questionnaires, it is difficult to estimate the validity and reliabilty of these two (Berdie & Anderson, 1974).

Scholastic Aptitude Test (SAT). The SAT was utilized at the time of the talent search. This is a highly reliable and valid test, which has been the subject of continuous refinement since its initial construction by Carl Campbell Brigham (Downey, 1961) in the 1920's. Technical aspects of the test are discussed by Angoff (1971). Estimates of internal-consistency and parallel-form reliabilities approximate .90 for both the SAT-M and SAT-V (Angoff, 1971, pp. 28-29). With regard to validity Angoff (1971, p. 29) concludes that "it is apparent that the SAT provides substantial correlation against grade-point criteria, and at a variety of institutions representing a wide range of ability levels among their undergraduate populations."

Occupational status scale. To assess the occupational status of the parents' occupations the NORC (National Opinion Research Center) long scale was utilized (Reiss, 1961). The reliability of this scale can be judged from a correlation of .99 between prestige scores derived in 1947 and prestige scores derived in 1963 from public opinion surveys (Hodge, Siegel, & Rossi, 1964). Although it appeared to be in need of updating, John L. Holland (personal communication) felt this was the best scale available at present.

<u>Intellectualism and status scale</u>. To determine the quality of the undergraduate institution attended by the students in this group, the Astin (1965) scale was used. This led to two scores, one for intellectualism and one for status, which are T-scores having a mean of 50 and a standard deviation of 10.

Astin (1965, p.54) defined a 4-year college with a high intellectualism score as having a student body that "would be expected to be high in academic aptitude (especially mathematical aptitude) and to have a high percentage of students pursuing careers in science and planning to go on for Ph.D. degrees". A 4-year college with a high status score is defined as having a student body that "would be expected to have a high percentage of students from high socioeconomic backgrounds and who themselves aspire to careers in enterprising fields (lawyers, business executives, politicians)." The initially derived scores for each college were cross-validated and the previous findings were upheld (Astin, 1965). Thus the scale would seem highly reliable and a valid indicator of a college's score on these factors. Since scores were available only for 4-year colleges and universities, and a number of the subjects attended 2-year colleges, it was decided to rate these colleges also by giving them an arbitrary score that was approximately one standard deviation below the lowest score on the scale. This turned out to be a score of 15.

3.3 PROCEDURES

The subjects meeting the criteria as specified in the "subjects" section were mailed an eight-page follow-up questionnaire with an offer of monetary compensation ($5.00, or in some cases $6.00) as an incentive to return the questionnaire. The questionnaires were mailed to students at a time when, normally, they would have been graduated from high school if they had not accelerated their education since their participation in the talent search. The questionnaire was usually completed by the student while they were freshmen in college. Because the students were sampled from the three talent searches held in 1972, 1973, and 1974 and they could have participated in the talent searches as either 7th or 8th-graders, the follow-up questionnaires had to be sent out in four different waves: in December 1976 (N=214, Cohn, 1980),[4] 1977 (N=594), 1978 (N=881), and 1979 (499). After six weeks had passed, the students who still had not completed the questionnaire were sent a reminder letter including an additional questionnaire. Six weeks later a postal card reminder was sent. Finally, to increase the response rate subjects were telephoned (sometimes several times and sometimes with a $10.00 inducement).

The response rates for each wave of the follow-up were 94 (Cohn, 1980), 90, 93, and 90 percent, respectively, of the total sample. Omitting persons who were unable to be located, the response rates became 98 (Cohn, 1980), 94, 96, and 93 percent, respectively. Across all waves, the overall response rate exceeded 91 percent of the total sample of 2188 students. In the analyses, there were 1996 students, 38 percent of whom were females. Because of the high response rate for the study, it seems likely that the findings derived from data analysis will be an accurate reflection of the talent search participants' status in high school.

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4) The responsibility for conducting the first wave of the follow-ups, with 214 students who had either met the science criterion or had scored greater than 420 on SAT-M as an 8th-grader, was Cohn's. The data collection and analysis for the remaining three waves, with an N=1974, was the responsibility of the author.

The status of the parents' occupations and the quality of the colleges attended by our sample were assessed by trained coders.

3.3.1 Data Analysis

The data were coded, keypunched, and verified. For the first and second wave of the follow-ups they were entered onto the computer by means of the SOS computer package (Shesko, 1975). For the third and fourth waves the data were entered by use of the Filgen and Qgen computer system (Johns Hopkins University's Computing Center). The statistical analyses, performed by using the SPSS program (Nie _et al._, 1975), were done separately for the first wave, second wave, and combined third and fourth waves of the follow-ups.[5] Analyses including talent search SAT scores were also performed separately by grade.[6]

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5) The first and second wave data could not be combined with the third and fourth waves, because the questions on the questionnaire were slightly different in some cases.

6) This was done to reduce confounding from that 8th grade participants received higher scores on the SAT than 7th grade participants in the talent search.

3.4 RESEARCH DESIGN

The design of this study is a longitudinal follow-up of students having been identified as gifted to various degrees, especially mathematically, and told that they are. Furthermore, the students received educational facilitation to various degrees that were usually dependent upon their level of ability. Identification and then initial educational facilitation occurred for the most part in the 7th or 8th grade (the time of the talent search). Thus the research design resembles a type of the time series design, a quasi-experimental design (Campbell & Stanley, 1966). It also somewhat resembles the regression-discontinuity analysis. The rationale is as follows: students were observed at the time of the talent search, when their degree of giftedness was ascertained; this was followed by their being informed of their precocity and subsequently they were offered educational facilitation; and then the students were observed again at high school graduation (and will be at later points in time) through their completion of a questionnaire.

With regard to problems of internal validity, history is the most definite weakness of this design (Campbell & Stanley, 1966). That is, it might not be the identification or the facilitation that caused the shift in behavior but some other event instead. Another problem is "mortality," or in this case not receiving a follow-up questionnaire from the students. If a large enough percentage did not complete the questionnaire, problems of bias might arise. Since over 91 percent of the total sample of subjects returned their completed questionnaires and approximately 4 percent more could not be located, this problem is minimized.

With respect to external validity, the main problem of these types of designs is the interaction of being selected for the study and the treatment. Since for this study the selection is part of the treatment, the problem is minimal.

Participation in the talent searches was voluntary. The findings *might* not generalize to the non-volunteers -- i.e., to those who did not enter the talent search.

3.5 STATISTICAL ANALYSES

Separate sets of analyses were employed for each of the major hypotheses. All of the t-tests were two-tailed at the .05 level and used the customary pooled variances approach. Since the N for all the tests were so large, effect sizes (Cohen, 1977) were also computed to test whether a significant difference was important or useful.

A set of variables was judged to be able to predict the criterion variables accurately if a significance level of .05 and a medium effect size was obtained. On the basis of past experiences, it was expected that to achieve an R^2 greater than 0.15 would be difficult due to the restriction of range in most variables and the inherent crudeness of some (e.g., number of years of education does not include quality of education directly).

As implied above, due to the large sample size the statistical power of the analyses performed was extremely high. Cohen (1977) recommended that the statistical power value exceed or approximate 0.80. The power of the tests employed was at least at that level, and often greater than 0.90.

Hypothesis 1. For the three sub-hypotheses, *t*-tests were used (Glass & Stanley, 1970) to test for significance, and then effect sizes computed. Moreover, to test for significant differences between proportions and to calculate their associated effect sizes, the procedure outlined by Cohen

(1977) was utilized.

Hypothesis 2. For sub-hypothesis 1, a *t*-test was utilized. A sign test (Snedecor & Cochran, 1980) was employed to test sub-hypotheses 2 and 5. Sub-hypothesis 3 required no statistical test since the predicted direction of effect did not hold. Sub-hypothesis 4 was tested by utilizing the procedure of Cohen (1977) to test for differences between proportions. Finally, effect sizes were calculated for each analysis.

Hypothesis 3. The only source with which to compare the SMPY group's degree of acceleration showed that in 1978 about 3 percent of college freshmen entered college a year early (Astin, 1978). In order to support hypothesis 3, a substantially higher percentage of SMPY students had to have entered college early. The significance of the difference between the proportions was assessed by use of the procedure outlined by Cohen (1977).

Hypothesis 4. A stepwise multiple regression analysis was utilized (Kerlinger & Pedhazur, 1973). The associated effect size was also calculated.

Hypothesis 5. For the three sub-hypotheses, *t*-tests were employed and effect sizes were computed.

Hypothesis 6. Again there was a lack of suitable norms to compare the SMPY group with. The Charles Kettering Foundation (1980), however, did report that 51 percent of high school students aspire to a bachelor degree or higher. In order to support this hypothesis, a substantially larger fraction of SMPY students had to have held these educational aspirations. The difference in proportions was tested for significance by use of Cohen's procedure.

Hypothesis 7. For the two sub-hypotheses Cohen's procedure to test for significant differences between proportions was utilized.

Hypothesis 8. Sub-hypotheses 2 was tested by use of a discriminant analysis (Lindeman, Merenda, & Gold, 1980). Sub-hypotheses 3 and 4 were tested by utilizing canonical correlation (Lindeman, Merenda, & Gold, 1980). Sub-hypothesis 1 was tested by employing Cohen's procedure for testing for significant differences between proportions.

<u>Hypothesis</u> <u>9</u>. A Likert scale was utilized to measure the effect of acceleration on social and emotional development as expressed by the students. If the distribution of responses showed significant skewness and kurtosis in the direction of positive effects, the null hypothesis for sub-hypothesis 1 would be rejected. Sub-hypothesis 2 was tested by use of a *t*-test and computation of an effect size.

<u>Hypothesis</u> <u>10</u>. Sub-hypotheses 1 and 2 were investigated by *t*-tests and effect sizes.

<u>Hypothesis</u> <u>11</u>. For most of the sub-hypotheses *t*-tests and effect sizes were computed. In addition, analysis of covariance (ANCOVA) (Myers, 1972) was employed to test certain of the sub-hypotheses in order to control for and discern the effects of ability on certain of the variables.

Sub-hypotheses 4 and 5 were tested by use of a sign test and a chi-square procedure. For sub-hypotheses 3 and 25 multiple regression analyses were utilized. For the sub-hypotheses investigating significant differences between proportions, Cohen's procedure was utilized. Finally, effect sizes for the analyses were computed.

Hypothesis 12. Sub-hypotheses 1 to 3 were tested by use of stepwise multiple regression. Discriminant analysis was used to test sub-hypotheses 4 and 5. Sub-hypothesis 5 analysis was done separately for intellectualism and status scores. Canonical correlation tested sub-hypothesis 6.

Hypothesis 13. The effect of SMPY on the students it identified was assessed by having the students respond to two Likert type questions. The resulting distributions of responses were tested for significant skewness and kurtosis. If the responses were sigificantly skewed or had significant kurtosis in the direction indicating that SMPY had a positive effect on these students, the null hypothesis was rejected.

Hypothesis 14. A discriminant analysis was performed.

3.6 SUMMARY

The development of SMPY students during high school was studied through the use of a questionnaire survey. The 2188 students (chiefly 7th and 8th-graders) from the first three talent searches who had scored as well as a national sample of

11th and 12th grade girls on SAT-M or as well as the national high school sample on SAT-V were followed up after their expected date of high school graduation. Students were mailed an 8-page questionnaire during their freshman year of college, along with an offer of monetary compensation. Over 91 percent of the total sample returned their completed questionnaires to SMPY. In the analyses there were 1996 students, 38 percent of whom were females. All data analyses were performed by computer using the SPSS program. A variety of statistical techniques (i.e., *t*-test, effect size, multiple regression, ANOVA, ANCOVA, canonical correlation, discriminant analysis, sign test, and chi-square) was utilized to test the hypotheses stated in chapter 1.

CHAPTER 4

RESULTS

4.1 HYPOTHESIS 1

SMPY students take significantly more semesters of mathematics than students in general and college-bound seniors do in high school. They do not, however, take significantly more semesters of science than college-bound seniors. Furthermore, their course-taking in science was significantly less frequent than in mathematics.

1. The mean number of semesters of high school mathematics taken in grades 8-12 is shown by follow-up wave and sex in Table 1. Boys took approximately 9.2 semesters, while girls took approximately 8.4. This was significantly different beyond the .001 level (see Table 2). The mean grade for the follow-up group in the mathematics courses was approximately 3.7

Table 1

Reported Mathematics and Science Course Taking in Grades 8-12 by Sex and Follow-up Wave

	First Wave		Second Wave		Third and Fourth Waves	
	Males (133)	Females (69)	Males (310)	Females (221)	Males (785)	Females (478)
Total Mathematics						
Mean No. of Semesters	9.4	9.0	9.3	8.1	9.2	8.5
Standard Deviation	2.3	1.8	2.5	2.6	2.6	2.4
Mean Course Grade	3.6	3.7	3.5	3.6	3.5	3.6
Standard Deviation	0.7	0.5	0.5	0.5	0.5	0.5
Total Science						
Mean No. of Semesters	7.0	6.8	7.0	6.0	8.4	7.6
Standard Deviation	2.4	2.0	2.4	2.4	2.8	2.4
Mean Course Grade	3.6	3.7	3.5	3.6	3.6	3.6
Standard Deviation	0.3	0.4	0.5	0.5	0.5	0.4
Biology	83	97	89	93	89	94
Chemistry	89	93	91	86	89	88
Physics	78	68	77	58	76	57
Percent Total	98	100	98	97	98	99
Calculus						
Percent	62	42	69	34	66	43

Table 2

T-test Results by Follow-up Wave

Variable	Comparison	First Wave *t*	First Wave *df*	Second Wave *t*	Second Wave *df*	Third and Fourth Waves *t*	Third and Fourth Waves *df*
Semesters of high school mathematics	SMPY students vs. college-bound seniors	9.2[c]	201	11.6[c]	530	19.1[c]	1262
Calculus Courses	SMPY Males vs. SMPY Females	2.5[b]	200	8.2[c]	529	8.8[c]	1261
Number of semesters of science	SMPY Students vs. college-bound seniors	1.2	201	-1.0	530	7.3[c]	1262
Number of semesters of Science vs. number of semesters of mathematics	SMPY students vs. SMPY students	13.8[c]	201	18.0[c]	530	10.1[c]	1262
High school SAT-M score	Male SMPY students vs. male college-bound seniors	29.9[c]	128	46.3[c]	280	81.1[c]	730
	Female SMPY students vs. Female college-bound seniors	23.3[c]	64	41.4[c]	199	57.2[c]	433
High school SAT-V score	Male SMPY students vs. male college-bound seniors	19.0[c]	128	35.4[c]	280	49.5[c]	730
	Female SMPY students vs. female college-bound seniors	11.6[c]	64	31.2[c]	199	37.3[c]	433
College Intellectualism Score	SMPY students vs. Norm group	--	--	15.3[c]	436	24.4[c]	1082
College Status Score	SMPY students vs. Norm group	--	--	15.8[c]	436	25.2[c]	1082

Variable	Comparison	First Wave t	First Wave df	Second Wave t	Second Wave df	Third and Fourth Waves t	Third and Fourth Waves df
College Intellectualism vs. status scores	SMPY students vs. SMPY students	—	—	2.6[b]	459	5.8[c]	1165
Use of Educational opportunities	Accelerated SMPY students vs. Non-accelerated SMPY students	2.3[a]	200	.77	520	2.9[b]	1247
High school SAT-M Score	SMPY Males vs. SMPY Females	3.5[c]	192	7.9[c]	479	10.6[c]	1163
High school SAT-V Score	SMPY Males vs. SMPY Females	1.3	192	-1.4	480	-0.6	1163
Semesters of High School Mathematics	SMPY Males vs. SMPY Females	0.6	200	5.3[c]	529	4.3[c]	1261
Higher level Mathematics courses	SMPY Males vs. SMPY Females	2.5[b]	200	6.8[c]	529	7.4[c]	1261
High School Mathematics Liking	SMPY Males vs. SMPY Females	0.7	200	1.8	525	2.2[a]	1242
Mathematics rank relative to 3 sciences	SMPY Males vs. SMPY Females	-0.1	200	1.0	497	.22	1179
Math Level 1 Achievement Test	SMPY Males vs. SMPY Females	1.1	51	3.1[b]	116	5.6[c]	247
Math Level 2 Achievement Test	SMPY Males vs. SMPY Females	2.3[a]	51	2.2[a]	118	5.9[c]	378
APP Calculus AB Examination	SMPY Males vs. SMPY Females	1.9	13	2.1[a]	46	-0.4	139
APP Calculus BC Examination	SMPY Males vs. SMPY Females	1.8	27	-0.5	55	0.9	156
Total No. of APP Examination Taken	SMPY Males vs. SMPY Females	3.4[b]	200	4.0[c]	529	4.7[c]	1261
No.of Advanced Standing Credits	SMPY Males vs. SMPY Females	1.7	83	1.6	166	3.9[c]	515

Variable	Comparison	First Wave t	df	Second Wave t	df	Third and Fourth Waves t	df
No. of Mathematics contests entered	SMPY Males vs. SMPY Females	4.7[b]	200	2.7[b]	529	4.8[c]	1261
Chemistry Achievement Test	SMPY Males vs. SMPY Females	1.8	33	2.1[a]	64	2.0[a]	194
Physics Achievement Test	SMPY Males vs. SMPY Females	2.0[a]	22	2.3[a]	48	2.9	113
APP Chemistry Examination	SMPY Males vs. SMPY Females	--	---	--	---	1.0	79
APP Physics B Examination	SMPY Males vs. SMPY Females	--	--	---	--	2.0	23
Biology Achievement Test	SMPY Males vs. SMPY Females	1.2	11	1.1	48	2.4[a]	194
APP Biology Examination	SMPY Males vs. SMPY Females	--	--	0.7	21	0.7	77
High School Chemistry Liking	SMPY Males vs. SMPY Females	1.9	200	0.8	522	3.2[c]	1213
High School Chemistry Rank	SMPY Males vs. SMPY Females	0.9	200	2.2[a]	499	2.2[a]	1155
High School Physics Liking	SMPY Males vs. SMPY Females	1.4	200	6.1[c]	489	8.3[c]	1134
High School Physics Rank	SMPY Males vs. SMPY Females	1.0	200	6.4[c]	464	8.1[c]	1071
High School Biology Liking	SMPY Males vs. SMPY Females	-1.1	200	-2.2[a]	523	-4.7[c]	1224
High School Biology Rank	SMPY Males vs. SMPY Females	-1.2	200	-5.6[c]	498	-9.7[c]	1158

on a scale where A=4, B=3, etc. (see Table 1). Mainly grades of A's and B's were received.

SMPY students studied mathematics much longer than the number of years of that subject taken by 1979-80 college-bound twelfth graders in the middle states region of the United States (New York, Pennsylvania, New Jersey, Delaware, Maryland, and the District of Columbia).[7] Those college-bound twelfth-graders took 7.4 semesters of mathematics during high school if male and 6.8 semesters if female (ATP, 1980). The differences between the two groups were significant by a t-test (see Table 2) beyond the $p<.001$ level. The effect size, d, varied between .50 and 1.22, which is in the medium to large range. The power of the statistical test was greater than .99.

Overall, SMPY males did not take more courses relative to college-bound senior males in high school mathematics

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7) They were considered to be the appropriate comparison group, since SMPY students resided in that area.

than did the SMPY females relative to college-bound senior females. For the second wave of the follow-up this difference was significant at the $p<.05$ level, however. The effect size was small ($d=.24$). Therefore, the significant difference was disregarded.

Approximately 2/3 of SMPY males took at least one calculus course, compared to 40 percent of the females (see Table 1). For 17-year-olds in 1977-78, calculus was taken by only 4.7 percent of the males and 3.1 percent of the females (NAEP, 1979). At least 10 times that percent of SMPY students took calculus. The difference in proportions between the two groups was significant beyond the $p<.01$ level for both sexes. The effect size equalled 1.45 for the boys and 1.02 for the girls, both of which are considered large. The power of the statistical test exceeded .97.

It can thus be concluded that SMPY students take much more mathematics than students in general. The null hypothesis of no difference was, therefore, rejected.

2. The number of semesters of science taken in high school is shown in Table 1 for the SMPY students by follow-up wave and sex. A *t*-test was utilized to check for significant differences among the SMPY group between the number of semesters of mathematics and science taken in high school. All three analyses were significant beyond the $p<.001$ level (see Table 2). Effect size values spanned the small to large range (i.e., from .38 to 1.5). The power of the tests exceeded .90. Thus, the null hypothesis was rejected. SMPY students do take significantly more semesters of mathematics than science.

3. Essentially all SMPY students took science in grades 8-12 (see Table 1). Biology and chemistry courses were most frequently taken. Fewer students--more boys than girls-- took physics, whereas more girls took biology (see Table 1). The mean number of semesters of science taken was approximately 7.6 and the grades received in those classes were mostly A's and B's (see Table 1).

The difference in the number of semesters of science taken by SMPY students and the number taken by college-bound seniors in high school was not significant when a *t*-test was utilized (see Table 2). College-bound seniors in the Middle States region of the United States had studied the biological sciences for a mean number of 2.8 semesters. The physical sciences were studied on the average for 4.2 semesters by males and 3.4 semesters by females. The total number of semesters studying science was slightly less for college-bound seniors than for SMPY students but not significantly so.

Furthermore, SMPY boys did not take more semesters of science relative to college-bound senior males than SMPY girls did relative to college-bound senior females. The one significant sex difference had an effect size equal to .17, which is considered quite small. Thus, that significant difference was ignored.

The null hypothesis of no difference between college-bound seniors and SMPY students in their science course-taking was accepted.

4.2 HYPOTHESIS 2

SMPY students performed significantly better on aptitude and achievement tests taken during high school than other high school students, as judged on the self-reported scores.

1. By the end of high school the boys' and girls' mean score on SAT-M had been raised an average of 155 and 145 points, respectively, from the time of talent search participation (see Table 3). Both boys and girls in the follow-up scored approximately 200 points better than their respective sex norm group of college-bound seniors (see the lower half of Table 3).

   On the SAT-V males improved by 159 points and females by 144 in the second wave of the follow-up (see Table 3). For the third wave males increased by 190

Table 3

SAT Scores at the Time of the Talent Search and in High School of the Participants in Follow-up by Wave (N = 1996), vs. High School Performance of a National Sample of College Bound-Seniors (ATP, 1979)

Talent Search

	First Wave[1] Mean	First Wave[1] Standard Deviation	Second Wave[2] Mean	Second Wave[2] Standard Deviation	Third and Fourth Waves Mean	Third and Fourth Waves Standard Deviation
SAT-M						
Boys	567	91	549	74	526	76
Girls	505	58	510	58	498	61
t of mean difference	5.1 $p < .001$		6.7 $p < .001$		6.9 $p < .001$	
SAT-V[3]						
Boys	—		443	86	400	65
Girls	—		468	86	411	74
t of mean difference			-3.1 $p < .01$		n.s.	

High School

	First Wave[1] Mean	First Wave[1] Standard Deviation	Second Wave[2] Mean	Second Wave[2] Standard Deviation	Third and Fourth Wave Mean	Third and Fourth Wave Standard Deviation	National Sample of College-Bound Seniors (ATP, 1979) Mean	National Sample of College-Bound Seniors (ATP, 1979) Standard Deviation
SAT-M								
Boys	691	75	693	72	695	67	494	121
Girls	652	72	643	68	650	75	444	110
t of mean difference	3.5 $p < .001$		7.9 $p < .001$		10.6 $p < .001$			
SAT-V								
Boys	596	100	602	82	590	88	429	110
Girls	594	115	612	83	592	91	429	110
t of mean difference	n.s.		n.s.		n.s.			

Table 3 (Continued)

[1]Taken from Cohn (1980).

[2]Taken from Benbow & Stanley (1981b).

[3]SAT-V was administered only in the 1973 Talent Search. Thus SAT-V scores were available for the 1973 Talent Search eighth graders, all in the second wave of the follow-ups, and for the 1973 Talent Search 7th graders, all in the third wave of the follow-ups.

points and females by 181. The difference in the amount gained on the SAT-V between these two waves is probably the result of the fact that the SAT-V scores from the second wave of the follow-up were from eighth graders and the SAT-V scores from the third wave were from seventh graders.

Because the students were selected initially on the basis of their high mathematical ability, it was expected that they would score less well on SAT-V than SAT-M because of statistical regression toward the mean. This was true for the talent search and high school results. In high school the students' mean scores on SAT-V were approximately 170 points above the mean for a national sample of college-bound seniors, compared to the 200 point superiority on SAT-M.[8] The above results also indicate that SMPY students maintained their superior mathematical and verbal abilities.

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8) SAT-V scores were lower than SAT-M scores on both the 200 to 800 point scale and in percentile ranks by sex.

With such huge differences between SMPY students and college-bound seniors in SAT scores it seems futile to calculate *t*-tests to check for significant differences. Yet they were performed and shown in Table 2. The differences were significant beyond the $p<.001$ level. The effect size values approximated 2, which is considered extremely large. The power of the analyses exceeded .99. The null hypothesis of no difference between SMPY students and the population (college-bound seniors) on the SAT was rejected.

2. In Table 4 the mean scores of SMPY students and college-bound high school students on the College Board's Achievement Tests are shown. Scores are only presented for those tests where at least 8 percent of SMPY students had reported a score. On every one of these tests, the SMPY students' mean scores were superior to the mean of college-bound high school students. The SMPY males scored on the average 107 points better and the girls 97 points. To test for significant differences between the SMPY group and college-bound seniors a sign test was u-

Table 4

Reported Performance on the College Board's High-School Level Achievement Tests Taken by at Least 8% of the Students in a Group[1]

	First Wave (202)		Second Wave (531)		Third and Fourth Waves (1263)		National Sample of 1978 College-Bound H.S. Students (ATP, 1979)
	Male	Female	Male	Female	Male	Female	
Math Level 1							
Mean Score	692	664	698	656	695	644	541
Standard Deviation	81	99	74	70	65	76	99
N	34	19	60	58	149	100	146,426
Math Level							
Mean Score	742	676	751	724	748	705	665
Standard Deviation	67	93	60	57	59	71	95
N	46	7	91	29	281	99	32,743
English Composition							
Mean Score	653	667	634	656	624	638	512
Standard Deviation	85	55	85	66	84	80	109
N	61	25	145	94	363	199	195,173
Biology							
Mean Score	689	605	667	644	652	613	544
Standard Deviation	86	134	78	68	71	93	111
N	11	2	27	23	58	43	47,291
Chemistry							
Mean Score	670	619	675	634	678	651	577
Standard Deviation	78	66	66	72	85	78	102
N	25	10	50	16	146	50	35,007
Physics							
Mean Score	684	530	683	618	672	607	591
Standard Deviation	74	--	71	84	81	86	106
N	23	1	42	8	100	15	15,408
French							
Mean Score	595	591	616	642	632	646	552
Standard Deviation	121	103	84	93	74	95	109
N	12	8	26	41	45	68	25,673

[1]SMPY students scored significantly higher than college-bound high school seniors on all the achievement tests [$\chi^2 = 5.2$, $p < .05$, $g = .5$ (large effect size), and the power of the test was greater than .43].

tilized. The resulting chi-square equalled 5.2, which was significant beyond the $p<.05$ level. The effect size, g, equalled .5, which is considered large. The power of the analysis exceeded .43. Thus, the null hypothesis of no difference between the groups on the College Board's Achievement tests was rejected.

3. The differences between mean scores of SMPY students and college-bound high school students on the achievement tests studied in sub-hypothesis 2.2 was calculated and are shown in Table 5. (The norm group consists of college-bound high school students.) Clearly, SMPY students do not score most highly on the mathematics achievement tests, followed by the science achievement tests, and then the liberal arts tests. Since the hypothesized order did not hold up, the null hypothesis was accepted without the need to perform any statistical analysis.

4. APP examinations are a means of securing college credit for advanced course work completed in high school if the person scores highly enough. They are taken

Table 5

The Differences Between the Mean Scores of SMPY Students and College-Bound Students on the College Board's Achievement Tests Shown in Table 4

ACHIEVEMENT TEST	MEAN SMPY SCORE	NATIONAL SAMPLE OF COLLEGE-BOUND STUDENTS	MEAN DIFFERENCE
MATH LEVEL 1	676	541	135
MATH LEVEL 2	738	665	73
ENGLISH COMPOSITION	635	512	123
BIOLOGY	645	544	101
CHEMISTRY	668	577	91
PHYSICS	620	591	29
FRENCH	633	552	81

mainly by highly able students. In Table 6 the reported performance of the SMPY students is shown along with the number taking the examinations. Mean scores are presented only for those examinations where at least 10 students reported a score. Across all follow-up waves the total percentage of students taking at least one APP examination was 37. Broken down by sex, the results show that 40 percent of SMPY males and 25 percent of SMPY females took at least one APP examination. This is an outstanding level of participation, since less than 5 percent of high school students take an APP examination (Hanson, 1980). The difference in the proportions taking these examinations (i.e., SMPY vs. students in general) was significant beyond the $p<.01$ level. The effect size equalled .86, which is considered to be large. The power of the analysis was greater than .97. Thus, the null hypothesis was rejected. SMPY students take APP examinations significantly more often than students in general.

Table 6

Reported Performance on the Advanced Placement Program (APP) Examinations by Follow-Up Wave[1, 2, 3]

	First Wave (202)		Second Wave (531)		Third & Fourth Waves (1263)		APP Examination Distribution of Candidate Grades May 1980
	Male	Female	Male	Female	Male	Female	
Calculus AB							
Mean Score	4.1	3.0	3.8	3.0	3.7	3.7	3.0
Standard Deviation	0.8	1.4	1.2	1.3	1.1	1.1	1.2
N	11	4	33	15	98	43	20,096
Calculus BC							
Mean Score	3.6	2.3	3.7	4.0	3.8	3.6	3.2
Standard Deviation	1.2	0.6	1.2	0.9	1.2	1.1	1.3
N	26	3	51	6	132	26	7,783
English							
Mean Score	3.5	3.3	3.4	3.7	3.7	3.7	3.1
Standard Deviation	0.8	1.0	1.0	1.0	1.1	1.0	1.0
N	21	9	43	39	136	99	45,082
American History							
Mean Score	4.2		3.6	3.7	3.8	3.5	3.1
Standard Deviation	0.8		1.1	1.2	0.9	1.1	1.1
N	5	0	40	11	113	38	32,098
European History							
Mean Score	3.9		3.6	3.5	3.4	3.5	3.2
Standard Deviation	0.8		0.8	0.7	1.2	1.2	1.1
N	8	0	11	2	33	12	8,092
Biology							
Mean Score	4.1		4.1	3.8	4.2	4.0	3.3
Standard Deviation	0.9		0.9	0.5	0.8	1.1	1.1
N	10	0	19	4	60	19	13,549

	First Wave (202)		Second Wave (531)		Third & Fourth Waves (1263)		APP Examination Distribution of Candidate Grades May 1980
	Male	Female	Male	Female	Male	Female	
Chemistry							
Mean Score	3.8	3.0	3.5	3.0	3.8	3.5	3.0
Standard Deviation	0.8	-	0.7	-	0.9	1.3	1.2
N	6	1	17	1	68	13	8,209
Physics B							
Mean Score	3.3		4.0		3.8	2.6	2.9
Standard Deviation	0.6		0.7		1.2	1.1	1.2
N	3	0	9	0	20	5	2,411
Physics C - Mechanics							
Mean Score	3.0		3.4	4.0	3.6		3.4
Standard Deviation	1.1		1.1	-	1.2		1.3
N	6	0	10	1	33	0	2,121
Physics C - Electricity and Magnetism							
Mean Score	3.5		3.4	3.0	3.4		3.4
Standard Deviation	1.7		1.1	-	1.0		1.4
N	4	0	8	1	21	0	1,690
French Language							
Mean Score	3.0		3.0	3.8	3.4	4.0	3.1
Standard Deviation	-		0.8	1.3	0.5	1.1	1.2
N	1	0	4	5	7	15	3,379

[1]Scores on APP examinations can range from 1 (the lowest possible) to 5 (the highest possible).

[2]Not more than 10 persons total took any of the following APP examinations: Spanish, German, French Literature, Latin-Classics, Latin-Virgil, Studio Art, History of Art, and Music. Thus, results for these tests were not presented.

[3]SMPY students scored significantly higher than other APP candidates on all APP examinations [$\chi^2 = 9.1$, $p < .005$, $g = .50$ (large effect size), and the power of the test was greater than .70).

5. Mean scores on the APP examinations are also shown in Table 6. On every one of the examinations, mean scores for SMPY students exceeded the mean scores of the students taking the examinations in May 1980. A sign test was utilized to test for a significant difference in performance between SMPY students and the May 1980 examinees. The chi-square equalled 9.1. Thus, the difference in performance was significant beyond the $p<.01$ level. The effect size equalled .50 and is considered to be large. The power of the test equalled .70. Thus, the null hypothesis was rejected. SMPY students perform significantly better on APP examinations than the mean score.

4.3 HYPOTHESIS 3

Significantly more of the SMPY students than of students in general became accelerated in school. Table 7 shows the use by the SMPY group of the various accelerative options available for facilitating a gifted student's education. The most widely known of these options is grade-skip-

Table 7

Reported Use of Accelerative Options by the Beginning of College

	First Wave (202)		Second Wave (531)		Third/Fourth Wave (1263)	
	Male	Female	Male	Female	Male	Female
Grade Skipping						
Mean No.	0.5	0.2	0.2	0.2	0.2	0.2
Standard Deviation (S.D.)	0.8	0.5	0.5	0.5	0.5	0.4
Percent Skipping at least one grade	30	17	13	15	12	14
APP Exams						
Mean No. Taken (S.D.)	0.8(1.2)	0.3(.6)	0.8(1.3)	0.4(.8)	0.9(1.4)	0.6(1.0)
Mean Score	3.7(1.0)	3.1(1.0)	3.6(.9)	3.7(.9)	3.6(.9)	3.6(1.0)
Percent Taking at least one Exam	41	19	40	25	43	32
College Courses as High School Student						
Mean No. Taken	0.8	0.4	0.3	0.2	0.4	0.4
Standard Deviation	2.0	1.2	0.8	0.5	1.3	1.1
Percent Taking at least one course	24	10	19	18	19	19
Early Entrance to College, Percent	29	16	15	17	11	13
Advanced Standing in College, Percent	48	30	35	24	44	37
Mean no. of credits for those students (S.D.)	11.5(8.8)	8.0(5.6)	12.1(10.6)	9.6(8.8)	11.4(10.0)	8.2(6.4)

[1] Scores on the APP exams can range from 1 (the lowest possible) to 5 (the highest possible). Many colleges give credit for a two-semester course for 3's. Most give such credit for 4's and 5's, except that only one-semester credit is usually awarded for 3-5's on the less comprehensive of the mathematics examinations (i.e., Level AB).

ping. Approximately 15 percent of SMPY students skipped at least one grade.[9] The most frequently skipped grade was 12.

APP examinations are a means of securing college credit for advanced course work completed in high school if the person scores highly enough. As noted in hypothesis 2, approximately 40 percent of SMPY males and 25 percent of SMPY females took at least one APP examinations (see Table 7). The mean number of examinations taken was almost 1 for the boys and about 0.5 for girls.

Another accelerative option available to students who want to move ahead in their educational careers is the taking of college courses on a part-time basis while still in high school. Although exact numbers varied for each wave, approximately 20 percent of the SMPY students did so (see Table 7).

Early entrance to college is yet another educationally accelerative option. Of the 1978-79 college freshmen, only 3.4 percent entered college at least one year early (Astin, 1978). Among the SMPY students, 14 percent did (see Table 7). This

9) Included in this computation are students who entered school early.

difference in proportions was significant beyond the $p<.01$ level. The effect size equalled .42, which is considered to be almost a medium effect. The power of the analysis exceeded .97.

Entering college with advanced standing earned through the taking of APP examinations and college courses while a high school student, for example, is the favorite accelerative option of SMPY students (see Table 7). Approximately 38 percent of the SMPY students did this, with a mean number of credits ranging from 8 to 12.

To further study the use of acceleration by SMPY students an acceleration variable was created. Its purpose was to measure the age at which college was begun, while taking into account the amount of advanced standing credits a student may have gathered towards college graduation. A person was considered to be zero months accelerated if he turned 18 years old on July 1 of the year he went off to college and he had garnered no advanced standing credits. If he began college in September of that year, that student would be given an age value of 18.17 years on the acceleration variable. Now if the student had earned 6 to 11 credits of advanced standing in college, three months would be subtractred from his age. If the student had from 12 to 23 college credits, six months would be subtracted. For 24 to 39 college credits, 18 months would be subtracted. Every additional 15 credits of advanced standing took away from the student 6 months of age at college entrance.

An example may make the process clearer. A student born on 3 December and entering college one year early with 12 advanced standing credits would be given a college entrance age of 18.16 - .42 (for December birthdate) - 1.0 (for skipping one grade) - .5 (for the advanced standing credits) = 16.24. In all analyses a student was not considered accelerated if his college entrance age exceeded 17.65. If college was entered in September after high school graduation, that number is the age for a person born on January 1 who later skipped one grade.

The amount of age subtracted because of accumulated advanced standing credits was based on how The Johns Hopkins University gives a student advanced standing. For example, a student with 24 advanced standing credits is considered a sophomore. In the analyses performed in the present work using degree of acceleration as one of its variables, the variable being referred to is this one.

The mean of this variable and its standard deviation are shown in Table 8. Table 8 also includes the percentage of SMPY students who met the criterion for being accelerated. Approximately 20 percent of SMPY students are accelerated by this measure (in the first wave 38% of the males were). The mean age at college entrance is almost 18, which is about 2 months earlier than expected if no acceleration or retardation in educational placement had occurred in the group. Obviously, the group is somewhat accelerated. Taking these findings and the above results on the use of accelerative options into consideration (especially the early entrance to college comparison), it becomes necessary to reject the null hypothesis. SMPY students are significantly more accelerated than students in general.

4.4 HYPOTHESIS 4

SAT scores from SMPY's talent searches could not predict the number of scholastic awards and honors won in high school by SMPY students. Performance in the National Merit Scholarship Competition and the number of awards and honors won as reported by SMPY students are shown in Table 9.

Table 8

Means and Standard Deviations for SMPY Students on the Acceleration Variable[1] and the Percentage of SMPY Students who Met the Criteri for Being Considered Accelerated

	First[2]		Second		Third & Fourth	
	Males (133)	Females (69)	Males (310)	Females (221)	Males (785)	Females (478)
Mean	17.60	17.98	17.91	17.96	17.98	17.99
S.D.	0.95	0.53	0.83	0.60	0.72	0.56
Percent Accelerated	38	20	21	20	20	20

[1]For description on how this variable was derived see hypothesis 3 on page 120.

[2]The difference between males and females was significant ($p < .01$) for the first wave of the follow-up ($t = 2.96$) effect size = .5 (medium), and power of analysis = .92)

Table 9

Reported Performance in the National Merit Scholarship Competition and Number of Awards and Honors Won in High School

National Merit[1] (Percent)	First Wave (202)	Second Wave (531)	Third and Fourth Waves (1263)
Letter of Commendation Only	27	41	38
Semi-finalist	5	19	17
Finalist	13	15	14
Scholarship Winner	4	4	5
Academic Awards			
Mean No.	2.7	2.4	2.5
Standard Deviation	2.4	2.8	3.1
Other Awards			
Mean No.	0.7	2.2	2.5
Standard Deviation	1.2	3.0	3.2

[1] Except for a Letter of Commendation, every student in successive echelons of the National Merit Competition had satisfied the requirement for the previous level.

Performance in the former is judged on the basis of students' Preliminary Scholastic Aptitude Test (PSAT) scores, typically taken in October of the 11th grade. SMPY students did well on the PSAT. More than 50 percent of them satisfied the criteria for receiving at least a Letter of Commendation. Any student in the competition who goes further has to satisfy the criterion for the previous level. For example, students who satisfy the criterion for a National Merit Finalist has also satisfied the criterion for semi-finalist and for Letter of Commendation. Approximately 5 percent of SMPY students reached the highest level of the competition, National Merit Scholarship winner. This finding attests to the fact that SMPY students are extremely able.

With respect to academic awards and honors won in high school, approximately 67 percent reported receiving at least one. The mean number won per student was about 2.5 (see Table 9). The mean number of other awards won is also shown in Table 9. They average two. These were won by approximately 59 percent of the students. Clearly, the group won a large number of awards and honors.

To determine whether ability at the time of the talent search could predict the number of academic awards[10] won in high school, a step-wise multiple regression analysis was performed (see Table 10). The multiple regressions analyses were calculated separately by grade and by follow-up wave. This was done because 8th-graders tended to perform better on the SAT at the time of the talent search than did the 7th-graders. Confounding because of grade at talent search participation was thus diminished. Although some of the analyses in Table 10 were significant, the effect sizes were small. The amount of variance accounted for by ability at the time of the talent search ranged from virtually nothing to 8 percent.

For the two analyses that were multiple regressions rather than Pearson *r*'s, the R^2 change for each predictor variable was tested for significance at the .05 level. The resulting equations are shown in Table 11. For one of the equations, talent search SAT-M was the only variable meeting the above specification for inclusion in the

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10) National Merit Competition performance was not included in this measure, since performance is entirely judged on PSAT scores. The number of academic awards won is a rather weak variable, because quality is not taken into account.

Table 10

Stepwise Multiple Regression Analyses
Predicting the Reported Number of Scholastic Awards
and Honors Won in High School by Grade and
Follow-up Wave

Order of Entering Predictor Variables	Predictor Variables	R	R^2	R^2 Change	F	β
	Follow-up: Wave 1 - 8th Graders ($N = 184$, $f^2 = .01$, powers = > .99)[1]					
1	T.S. SAT-M	.07	.005		.92	.07
	Follow-up: Wave 2 - 8th Graders ($N = 451$, $f^2 = 0$)					
1	T.S. SAT-V	.03	.00		.44	-.03
2	T.S. SAT-M	.03	.00	.000	.08	.01
	Follow-up: Wave 2 - 7th Graders ($N = 56$, $f^2 = .051$, power = .39)[1]					
1	T.S. SAT-M	.23	.05		2.9	.23
	Follow-up: Waves 3 & 4 - 8th Graders ($N = 736$, $f^2 = .042$, power > .99)[1]					
1	T.S. SAT-M	.20	.04		32.04	.20
	Follow-up: Waves 3 & 4 - 7th Graders ($N = 500$, $f^2 = .01$, power = .60)[1]					
1	T.S. SAT-M	.12	.01		6.8	.12
	Follow-up: Waves 3 & 4 - 7th & 8th Graders ($N = 148$, $f^2 = .04$, power .58)					
1	T.S. SAT-M	.17	.03		2.8	.14
2	T.S. SAT-V	.20	.04	.011	1.7	.11

[1]Talent Search SAT-V scores were unavailable.

Table 11

The Resulting Prediction Equations for the Multiple Regression Analyses After the R^2 Change of the Entering Predictor Variables Were Tested for Significance

Dependent Variable	Follow-up Wave and Grade	Prediction Equation	Standard Error of Estimate	Standard Deviation of Dependent Variable	R^2
No. of Academic Awards Won	2 - 8th	--	2.9	2.9	0
	3&4 - 7th & 8th	.17(T.S.SAT-M)	2.6	2.7	0.3
No. of Semesters of Mathematics	1 - 8th	.28(Math Favorite Course) + .13 (Father's education) + .12 (sex)	2.1	2.2	.10
	2 - 8th	.19(T.S.SAT-M) + .18 (Math Favorite Subject) +.13(Math Imp.) .13(Sex) - .09(no.siblings)	2.5	2.7	.14
	2 - 7th	.29(T.S.Math Liking)	1.9	1.9	.09
	3&4 - 8th	.20(Math Favorite Course) + .10 (T.S.SAT-M) + .12(Sex) + .09(Father's education)	2.3	2.4	.08
	3&4 - 7th	.22(Math Favorite Course) + .10(Sex) + .09(T.S.SAT-M) + .08(T.S.Math Liking) + .07(Father's Occupational Status)	2.6	2.7	.09
	3&4 - 7th & 8th	.16(Sex)	2.5	2.7	.02
No. of Math and Science Tests Taken	1 - 8th	.29(T.S.SAT-M) + .16(Sex)	1.0	1.5	.18
	2 - 8th	.35(T.S.SAT-M) + .14(Sex) + .12(T.S.SAT-V)	1.3	1.4	.21
	2 - 7th	.39(T.S.SAT-M)	1.2	1.4	.15
	3&4 - 8th	.39(T.S.SAT-M) + .14(Sex)	1.3	1.5	.19
	3&4 - 7th	.42(T.S.SAT-M) + .08(Sex)	1.4	1.6	.19
	3&4 - 7th & 8th	.42(T.S.SAT-M) + .15(Sex)	1.5	1.6	.23

Table 11 (Cont.)

Dependent Variable	Follow-up Wave and Grade	Prediction Equation	Standard Error of Estimate	Standard Deviation of Dependent Variable	R^2
High School SAT-M	1 - 8th	.42(T.S.SAT-M) + .11(Mother's Education) + .15 (Semesters of Math) + .14 (Father's Education)	71	87	.37
	2 - 8th	.56(T.S.SAT-M) + .23(Semesters of Math) + .09 (T.S.Math Liking) + .08(Sibling Position)	57	76	.45
	2 - 7th	.50(T.S.SAT-M) + .34(Sibling Position) + .21 (Father's Occupational Status)	49	64	.38
	3&4 - 8th	.60(T.S. SAT-M) + .23 (Semesters of Math) + .13 (T.S.Math Liking)+.09 (Father's Education)	51	73	.52
	3&4 - 7th	.55(T.S.SAT-M) +.17(Semesters of Math) + .10(Father's Occupational Status) -.09(Sibling Position) + .08 (Father's Education) + .06(T.S.Math Liking)	52	67	.42
	3&4 - 7th & 8th	.63(T.S.SAT-M) + .26(Semesters of Math)	44	66	.50
Math Level 1 Achievement Test	1 - 8th	.61(Semesters of Math) + .41(T.S.SAT-M) + .25(Mother's Education)	67	88	.48
	2 - 8th	.57(T.S.SAT-M) + .27(T.S.Math Liking) + .21 (Semesters of Math) + .17(Father's Occupational Status)	52	76	.52
	3&4 - 8th	.37(T.S.SAT-M) + .32(Semesters of Math) + .28(T.S. Math Liking)	60	77	.41
	3&4 - 7th	.50(T.S.SAT-M) -.29(Sibling Position) + .14(T.S.Math Liking) + .16 (Mother's Education) + .14(Semesters of Math)	56	71	.41
High School SAT-V	1 - 8th	.35(T.S.SAT-M) + .22(English Rating) + .17(Mother's Ed)	95	105	.21
	2 - 8th	.66(T.S.SAT-V) + .11(Father's Education) + .08(English Rating) + .08(T.S.SAT-M)	54	84	.56
	2 - 7th	.49(English Rating) - .28(Sibling Position)	72	78	.25
	3&4 - 8th	.37(T.S.SAT-M) + .23 (English Rating) + .11(Mother's Education) + .07(Father's Education) -.04(Sibling Position)	75	86	.25
	3&4 - 7th	.41(T.S.SAT-M) + .19(English Rating) + .15(Father's Occupational Status) + .12(Mother's Ed.)-.10(Sibling Pos)	76	90	.28
	3&4 - 7th & 8th	.62(TS.SAT-V) + .30(Father's Occupational Status)	50	77	.34

regression equation. For the other equation, not one variable met the criterion. Comparing the standard error of estimate with the standard deviation of the criterion variable revealed that the two numbers were essentially identical. This indicates that the equation would result in a substantial number of errors in predicting number of academic awards won. Thus, the null hypothesis was accepted. It was concluded that ability at the time of talent search can not predict the number of awards and honors won in high school.

4.5 HYPOTHESIS 5

Significantly more SMPY students attend intellectually highly selective colleges than students in general. Furthermore, over 90 percent of SMPY students were attending college at the time of their completion of the questionnaire (see Table 12). They also had a strong liking for their colleges (see Table 12).

The intended college majors of the SMPY students as college freshmen are shown in Table 15. Approximately 61 percent of the males and 50 percent of the females are planning to major in science, mathematics, or engineering. Compared to college-bound high school seniors, of whom 45 per-

Table 12

Percent of Students Attending College, Their Colleges' Ratings on Intellectualism and Status (Astin, 1965), and Their Liking for College

	First Wave (202)	Second Wave (531)	Third/Fourth Waves (1263)
Percent Attending College	95	92	92
College Intellectualism Score			
Mean (S.D.)[1]		58.4 (11.5)	58.8 (11.8)
Mean for Colleges, including Community Colleges (S.D.)[2]		56.1 (14.5)	55.7 (16.0)
College Status Score			
Mean (S.D.)[1]		57.1 (9.4)	57.3 (9.4)
Mean for Colleges, including Community Colleges (S.D.)[2]		55.1 (13.0)	54.3 (14.1)
Liking for College			
Mean[3]	4.4	4.4	4.4
S.D.	0.8	0.9	0.8

[1] College intellectualism and status scores are T-scores, mean 50 and standard deviation of 10.

[2] An arbitrary value of 15 was given to a community college.

[3] Liking for college was coded as follows: 5 = strong like, 4 = moderate like, 3 = neutral or mixed feelings, 2 = moderate dislike, 1 = strong dislike.

cent of males and 33 percent of females intend to major in science, mathematics, or engineering (ATP, 1979), this mathematically talented group show a strong interest in these fields.

1. The intellectualism scores of colleges attended by SMPY students are shown in Table 12. Intellectualism and Status scores were not available for the first wave of the follow-up. For the second and combined third and fourth wave two intellectualism and status mean scores are presented (see Table 12). The first is the mean of ratings for colleges included by Astin (1965). The second is the mean of the ratings for colleges included by Astin and for community colleges, which were given a rating of 15 by the present investigator (approximately one standard deviation below the lowest rating for a 4-year college). For both sets of ratings the colleges attended by SMPY students were significantly above the mean of 50 ($\underline{p}<.001$) (see Table 2). The effect size was large for the analysis excluding the students who attended community colleges ($\underline{d}=.84$ and .88, respectively for the second and combined

third and fourth wave of the follow-ups). The effect sizes were medium for the other analysis. Thus, the null hypothesis was rejected.

2. Status scores of the colleges attended by the SMPY students are shown in Table 12. Status scores were not available for the first follow-up wave, and two sets of ratings were presented for the other waves of the follow-up, as explained in the previous sub-hypothesis (see Table 12). The mean status scores for the SMPY students (i.e., 57) were significantly above the mean of 50 ($p<.001$) (see Tables 12 and 2). The effect size was a high medium ($d=.71$ and .73, respectively for the second and combined third and fourth waves). These calculations were based on the distributions where community colleges were excluded. Similar results, however, were found if you included the students who were attending community colleges in the analyses. Thus, SMPY students attended socially selective colleges and universities; the null hypothesis was rejected.

3. Although the intellectualism scores of the colleges attended by the SMPY students were significantly ($p < .01$) higher than their status scores (see Table 2), the effect sizes equalled less than .10, which does not reach the criterion for being considered even small. Thus, the null hypothesis of no difference between the means was accepted.

4.6 HYPOTHESIS 6

Educational aspirations of SMPY students were significantly higher than aspirations of students in general (see Table 13). Fewer than 4 percent of the students hoped to obtain less than a bachelor's degree. The most frequently aspired-to educational level was a doctorate (39%). These figures were compared to the educational aspirations of high school students in general, where only 51 percent aspire to obtain a bachelor's degree or more (Charles Kettering Foundation, 1980). The differences between the proportions aspiring to at least a bachelor's degree was significant beyond the $p < .01$ level and the effect size, h, equaled 1.15, which is considered large. The power of the

Table 13

Educational Aspirations of SMPY Students

Highest Degree	Percent
Less than Bachelor's	4
Bachelor's	18
Master's	34
Doctorate	39

test was at least .97. Therefore, the null hypothesis of no difference between groups was rejected. SMPY students have higher educational aspirations than students in general.

4.7 HYPOTHESIS 7

The favorite courses of SMPY students in high school were mathematics and science. Their favorite courses were grouped into 5 categories and the percentage naming a course in each category was compared to that of 17-year-olds in general (NAEP, 1979). The results are shown in Table 14. Clearly, SMPY students preferred mathematics or science in high school (64% reported them as their favorite high school course). The difference between percentages of SMPY students and students in general reporting mathematics and science as their favorite course was significant at the $p<.01$ level. The effect size equalled .70, which is considered to be a medium effect size. The power of the test was greater than .97. Thus, SMPY students do show a significantly greater interest in science and mathematics than students in general, and hence the null hypothesis was rejected.

Table 14

The Reported Favorite Courses of SMPY Students in High School by Sex and for 17-Year-Olds

	Percent			
Favorite Course	Males (1228)	Females (768)	Total	17-Year-Olds (NAEP, 1979)
Mathematics	36	31	34	18
Science	34	25	30	12
Social Studies	11	9	11	13
English	7	17	11	16
Other	13	17	15	41

1. SMPY students did not, however, prefer mathematics significantly more than science in high school (see Table 14). The difference in proportions reporting these courses as their favorites was not significant.

2. SMPY students did report a mathematics or science course as their favorite much more frequently than they reported a liberal arts course (see Table 14). The difference was significant at the $p<.01$ level, $h=.88$ (a medium to large effect size), and the power of the test was greater than .97. The difference between the percentage of students reporting science as their favorite course and a liberal arts course as a favorite was significant at the $p<.01$ level, $h=.48$ (a medium effect size). The power of the test exceeded .97.

As a result of the above analyses, the null hypothesis was accepted for sub-hypothesis 7.1 but was rejected for sub-hypothesis 7.2. Thus, in high school SMPY students were not more interested in mathematics courses than science courses but they were significantly more interested in mathematics and science courses than liberal arts courses or any other course ($p<.01$, $h=.57$, and power greater than .97) in high school.

4.8 HYPOTHESIS 8

High mathematical aptitude relates to interest in mathematics or science, but the degree of high mathematical aptitude can not accurately predict the degree of liking for science or mathematics nor whether a student intends to major in a physical, biological, or mathematical science in college. Furthermore, sex can not discriminate between students majoring in mathematics or science and the ones who are not.

1. More SMPY students were planning to major in mathematics, engineering, or the physical sciences (58%) than in the liberal arts (9%) in college (see Table 15). The difference between these two proportions was significant at the $p<.01$ level. The effect size equalled 1.12, which is considered large, and the power of the test was greater than .97. Thus, the null hypothesis of no difference was rejected.

Table 15

Intended College Majors Reported by the

Students in the Follow-up

Majors	Percent		
	Male	Female	Total
Mathematical sciences/ Engineering	36	25	32
Science	26	25	26
Social Science	10	13	11
Liberal Arts	8	11	9
Other	11	12	11
Undecided	10	14	12

2. SAT-M performance in SMPY's talent search and sex can not accurately discriminate between students majoring in mathematics or the physical sciences and students majoring in other fields in college (see Table 16). Discriminant analyses were performed for each wave of the follow-up and by grade. Although some of the discriminant analyses were significant because of the large N, less than 5 percent of the variance in student college majors could be accounted for by talent search SAT-M and sex (see Table 16). Between 51 and 60 percent of the cases were correctly classified when using the discriminant function (see Table 16). This is almost at the level expected by chance, i.e., 50 percent. Therefore, considerable overlap between the groups is apparent. They are not clearly separated even though the discrimination was significant in some of the analyses. Thus, the null hypothesis was accepted.

3. SAT-M performance in talent search and later in high school does not relate to degree of liking for mathematics at talent search participation and later in

Table 16

Discriminant Analyses on the Basis of Talent Search SAT-M and Sex of SMPY Students Classified into Mathematics or Science Majors or Other Majors in College Performed by Grade and Follow-up Wave.[1]

Follow-up Wave And Grade		Discriminant Function	Eigen value	Relative Percentage	Canonical Correlation	Functions Derived	Wilks' Lambda	Chi-Square	df	Sig
2 - 8th	(N = 421)					0	.99	5.2	2	n.s.
		1	.01	100	.11					
2 - 7th	(N = 47)					0	.99	.03	2	n.s.
		1	.00	100	.03					
3&4 - 8th	(N = 649)					0	.98	15.9	2	.001
		1	.02	100	.16					
3&4 - 7th	(N = 445)					0	.97	11.5	2	.01
		1	.03	100	.16					

Standardized Discriminant Function Coefficients

Follow-up Wave And Grade	2 - 8th	2 - 7th	3&4 - 8th	3&4 - 7th
T.S. SAT-M	1.00	.83	.38	.59
Sex	0	-.79	.84	.70

Prediction Results

Follow-up Wave and Grade	2 - 8th	2 - 7th	3&4 - 8th	3&4 - 7th
Percent False Positives	19	13	18	18
Percent False Negatives	29	36	22	25
Percent Correctly Classified	52	51	60	57

[1] This analysis could not be performed for the first wave of the follow-up.

high school (see Table 17). For the first wave of the follow-up this analysis was combined with the analysis for sub-hypothesis 8.4 because only the reported degree of liking for mathematics in high school was available. The other analyses were performed by grade for each wave of the follow-up (see Table 17). Although the canonical correlations thus derived were significant, they were small; less than 11 percent of the variance could be accounted for. Thus, the null hypothesis of no relationship between these two sets of variables was accepted.

4. SAT-M performance in talent search and later in high school does not relate to reported degree of liking for science in high school (see Table 18). For the first wave of the follow-up, this analysis was combined with sub-hypothesis 8.3 (see Table 17). Although the canonical correlation between the two sets of variables-SAT-M from talent search and from high school and degree of reported liking for biology, chemistry, and physics-was for the most part significant because of the large N, less than 11 percent of the

Table 17

Canonical Correlation Analyses Between SMPY Students' Liking for Mathematics at Talent Search and in High School and Talent Search and High School SAT-M Performed Separately by Grade and Follow-up Wave

Follow-up Wave and Grade	Number	Eigen Value	Canonical Correlation	Wilks' Lambda	Chi-Square	d.f.	Sig
1 - 8th[1]	1	.11	.34	.88	21.2	4	.01
2 - 8th[2]	1	.11	.34	.89	39.0	4	.001
3 & 4 - 8th	1	.10	.31	.90	71.9	4	.001
3 & 4 - 7th	1	.03	.16	.97	13.2	4	.01

Coefficients for Canonical Variables

Follow-up Wave and Grade	1 - 8th	2 - 8th	3 & 4 - 8th	3 & 4 - 7th
Second Set				
Talent Search SAT-M	.63	.16	-.29	.08
High School SAT-M	.51	.89	1.16	.95
First Set				
Talent Search Math Liking	--	.40	.52	.59
High School Math Liking	.07	.82	.70	.63
High School Biology Liking	-.42	--	--	--
High School Chemistry Liking	.48	--	--	--
High School Physics Liking	.66	--	--	--

[1]This analysis was different from the others because it included rated likings in high school for biology, chemistry, and physics in addition to the high school matnematics liking. Talent Search ratings of liking for mathematics was not available.

[2]The analysis for the 7th graders in the second wave of the follow-up could not be performed, because talent search ratings of liking for mathematics were unavailable.

Table 18

Canonical Correlation Analyses Between SMPY Students' Liking for Biology, Chemistry, and Physics in High School and Talent Search and High School SAT-M Performed Separately by Follow-up Wave and Grade

Follow-up Wave and Grade	Number	Eigen value	Canonical Correlation	Wilks' Lambda	Chi-Square	d.f.	Sig.
2 - 8th	1	.13	.36	.87	55.9	6	.001
2 - 7th	1	.05	.21	.95	2.1	6	n.s.
3 & 4 - 8th	1	.08	.28	.92	52.3	6	.001
3 & 4 - 7th	1	.06	.25	.94	28.4	6	.001

Coefficients for Canonical Variables

Follow-up Wave and Grade	2 - 8th	2 - 7th	3 & 4 - 8th	3 & 4 - 7th
Second Set				
Liking for Biology in High School	-.46	.03	-.45	-.22
Liking for Chemistry in High School	.48	-.91	.51	.35
Liking for Physics in High School	.64	.82	.68	.82
First Set				
Talent Search SAT-M	.67	.84	.10	.25
High School SAT-M	.42	.27	.93	.83

variance could be accounted for (see Table 17 and 18). Thus, the null hypothesis of no relationship between these two sets of variables was accepted.

4.9 HYPOTHESIS 9

A fairly high percentage of SMPY students used at least one of the educationally accelerative options for facilitating their education (see Hypothesis 3). The students who considered themselves to be somewhat accelerated felt that their acceleration had affected their social and/or emotional development somewhat positively and, that they had made significantly better use of their educational opportunities available to them than had their non-accelerated counterparts.

1. Accelerated SMPY students reported that their acceleration had affected their social and/or emotional development somewhat positively (see Table 19). Only 5 out of 1104 (0.5%) students in the 2nd, 3rd, and 4th follow-ups who considered themselves to have been accelerated felt that their acceleration had affected their social and/or emotional development

Table 19

Mean of the Ratings of How Accelerated Students Felt Their Social and/or Emotional Development Had Been Affected by Their Acceleration and the Difference Between Accelerated and Non-Accelerated Students (by the College Entrance Age Criterion) in How Well They Felt That They Had Made Use of All Available Educational Opportunities

Acceleration Affect Social and Emotional Development

Follow-up Wave	First (161)	Second (310)	Third & Fourth (794)
Mean[1]	1.60	3.81	3.72
S.D.	0.49	0.83	0.86

Use of Available Educational Opportunities

Follow-up Wave	First		Second		Third & Fourth	
	Accel-erated (65)	Non-Accel-erated (137)	Accel-erated (108)	Non-Accel-erated (414)	Accel-erated (245)	Non-Accel-erated (1004)
Mean[2]	3.94	3.61	3.57	3.50	3.74	3.54
S.D.	0.90	0.95	0.93	0.92	0.91	0.95
t of mean difference between accelerated and non-accelerated students	2.31, $p < .05$		n.s.		2.92, $p < .01$	

[1]How accelerated students viewed the effect of their acceleration on their social and/or emotional development was coded as follows for the second and combined third and fourth waves of the follow-up: 1 = much for the worse, 2 = negatively, 3 = no influence, 4 = positively, and 5 = much for the better. For the first wave it was simply: 1 = negatively and 2 = positively.

[2]Use of available educational opportunities was coded as follows: 1 = extremely poorly, 2 = rather poorly, 3 = about average, 4 = rather well, and 5 = extremely well.

much to the worse. In contrast, 203 (18%) of the students felt the opposite (see Table 19). The difference between these two proportions was significant at the $p<.01$ level by a two-tailed test of significance. The effect size equalled .78 (a medium effect size) and the power of the test was greater than .97.

2. SMPY students felt that on the average they had made rather good use of the educational opportunities available to them (see Table 19). In this analysis, whether a person was considered accelerated was judged on the basis of age at college entrance. This variable was the same one discussed in hypothesis 3. A person was judged as accelerated if at the time of college entrance he/she would have been or was less than the equivalent 17.65 years old, taking advanced standing credits into account.

The accelerated students (by this criterion) felt that they had made better use of their available educational opportunities than their non-accelerated counterparts. The difference was significant for the first and combined third and fourth waves of the follow-up (see Table 2) but not the second wave.[11] The effect sizes were small (.35 for the first wave and .21 for the combined third and fourth waves). Yet the null hypothesis of no difference between accelerated and non-accelerated students on their perceived use of educational opportunities available to them was rejected.

4.10 HYPOTHESIS 10

Males performed significantly better than females on the SAT-M but not the SAT-V in high school.

1. SMPY males scored significantly better than their female counterparts on the SAT-M (see Table 3). The *t*'s, computed separately by follow-up wave, ranged from 3.5 (for the first wave) to 10.6 (for the combined 3rd and 4th waves). The significance was at the $p<.001$ level (see Table

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11) The power of the test for the second wave of the follow-up was only .35.

2). The effect sizes ranged from .52 to .71, which are all in the medium range. Thus, the null hypothesis of no difference between the sexes on the SAT-M was rejected.

2. The difference between male and female reported performance on the SAT-V in high school was not statistically significant (see Table 3). Thus, the null hypothesis of no difference between the sexes on the SAT-V was accepted.

It can be seen in Table 3 that the initial sex difference on SAT-V at talent search participation favoring girls diminished in high school, and for the second wave was no longer statistically significant. Both on the SAT-M and SAT-V SMPY males improved more than SMPY females.

4.11 HYPOTHESIS 11

Significant sex differences were found in mathematics and science achievement during high school among SMPY students. Males took more science and mathematics courses, took more mathematics and science achievement tests or APP examinations, and scored better on them than SMPY females. There appeared to be a relationship between the sex difference on the SAT-M and these differences.

Few significant sex differences were found, however, in the attitudes toward mathematics and science. Surprisingly, slightly more females than males were planning to major in the mathematical sciences in college and SMPY females reported receiving better grades in their mathematics courses than SMPY males reported for themselves.

1. SMPY males took significantly more semesters of high school mathematics than SMPY females (see Tables 1 and 2). Table 1 shows that boys took approximately 9.2 semesters of mathematics, while girls took approximately 8.4. The difference was statistically different beyond the .001 level by a t-test (see Table 2). The effect sizes, d, equalled .19, .47, and .28, respectively for each wave or group of the follow-up. Thus, the effect was considered to be only small. Even though the difference was small, the null hypothesis was rejected.

2. SMPY males took significantly more higher level mathematics courses than SMPY females (see Tables 20 and 2). The boys took an average of 3.7 such courses, while girls took an average of 2.8, significantly different beyond the $p<.01$ level. The effect size values were in the range of .38 to .60. This is in the small to medium range.

Approximately 2/3 of SMPY boys took at least one calculus course, compared to 40 percent of the girls (see Table 1). The difference in proportions was significant ($p<.01$), with a medium effect size ($h=.53$). Furthermore, many more boys than girls took two courses in calculus (see Table 20). The differences were significant beyond the $p<.001$ level (see Table 2). No significant sex difference was found in the grades received in calculus, which were mostly A's and B's (see Table 20).

The null hypothesis of no difference between SMPY males and females in the taking of higher level mathematics courses was rejected.

Table 20

The Mean Number of Higher Level Mathematics Courses and Calculus Courses Taken by SMPY Students by Follow-up Wave and Sex[1]

	First Wave		Second Wave		Third & Fourth Waves	
	Males (133)	Females (69)	Males (310)	Females (221)	Males (785)	Females (478)
Higher Level Mathematics						
Mean	3.7	3.0	3.7	2.6	3.7	2.9
S.D.	1.9	1.8	1.9	1.8	1.9	1.7
Calculus						
Mean No. of Courses	1.2	0.8	1.3	0.6	1.2	0.7
S.D.	1.0	1.0	0.9	0.9	0.9	0.9
Mean Course Grade	3.5	3.6	3.4	3.6	3.4	3.6
S.D.	0.8	0.6	0.8	0.7	0.8	0.6

[1] The following courses were considered to be higher level: college algebra, trigonometry, analytic geometry, calculus, probability and statistics, computer science, analysis, matrices, logic, and elementary functions.

3. In stepwise multiple regression analyses performed separately by follow-up wave and grade the following variables can not accurately predict the number of semesters of high school mathematics taken in high school by SMPY students: talent search SAT scores, parental educational level, paternal occupational status, sex, number of siblings, sibling position, mathematics liking at talent search or in high school, rated importance of mathematics for future career, and having rated mathematics as a favorite course in high school (see Table 21).

In the stepwise multiple regression analyses performed on the large samples (N>300), relatively small amounts of variance in mathematics course-taking could be accounted for by the predictor variables (between 9 and 16 percent). For two of the analyses with a small N, 23 and 24 percent of the variance could be accounted for. In the other remaining analysis only 11 percent of the variance was accounted for. The effect size values ranged from .10 to .32 (see Table 21). Three of them were in the medium

Table 21

Stepwise Multiple Regression Analyses
Predicting the Number of Semesters of
High School Mathematics Taken by
Follow-up Wave and Grade

Follow-up Wave 1 - 8th graders (N=177, f^2 = .30, power > .99)[1,2]

Order of Entering Predictor Variables	Predictor Variables	R	R^2	R^2 Change	F	β
1	Math Favorite Subject in high school	.35	.12		11.9	.27
2	T.S. SAT-M	.45	.20	.080	12.7	.28
3	No. of siblings	.46	.21	.011	3.4	-.15
4	Mother's education	.48	.23	.013	2.8	.12
5	Sex (Males=1,Females=0)	.48	.23	.005	1.4	.09
6	Sibling position	.48	.23	.002	0.4	.05
7	Math Liking in high school	.48	.23	.002	0.4	.05

F-level or tolerance was insufficient to include father's education in analysis.

Follow-up: Wave 2 - 8th graders (N = 329, f^2 = .19, power > .99)

Order of Entering Predictor Variables	Predictor Variables	R	R^2	R^2 Change	F	β
1	T.S. SAT-M	.24	.06		11.2	.22
2	Math Favorite Subject in high school	.31	.10	.037	8.4	.16
3	Importance of math for job at T.S.	.34	.12	.023	4.2	.11
4	Sex	.36	.13	.014	3.2	.10
5	No. of siblings	.38	.14	.008	3.1	-.12
6	Liking for math at T.S.	.38	.15	.005	2.1	.08
7	Father's education	.39	.15	.005	2.1	.09
8	T.S. SAT-V	.39	.15	.005	1.9	-.09
9	Sibling position	.39	.16	.001	0.2	.03
10	Mother's education	.39	.16	.000	0.1	-.02

F-level or tolerance was insufficient to include father's occupational status in analysis.

Table 21 (Cont.)

Follow-up: Wave 2 - 7th graders (N = 50, f^2 = .32, power = .73)[1]

Order of Entering Predictor Variables	Predictor Variables	R	R^2	R^2 Change	F	β
1	Math liking in high school	.29	.09		5.8	.41
2	No. of siblings	.32	.10	.018	3.8	-.34
3	Sibling position	.37	.14	.034	3.0	.33
4	Mother's education	.40	.16	.025	4.3	-.36
5	Father's Occupational status	.48	.23	.065	1.5	.23
6	Father's education	.48	.23	.007	0.5	.14
7	Sex	.49	.24	.003	0.2	.06
8	Math favorite course in high school	.49	.24	.003	0.2	-.07

F-level or tolerance was insufficient to include T.S. SAT-M in analysis.

Follow-up: Waves 3 & 4 - 8th graders (N = 682, f^2 = .10, power > .99)[1]

Order of Entering Predictor Variables	Predictor Variables	R	R^2	R^2 Change	F	β
1	Math favorite course in high school	.20	.04		27.5	.19
2	T.S. SAT-M	.25	.06	.021	6.2	.10
3	Sex	.27	.07	.013	9.0	.11
4	Father's education	.28	.08	.008	0.9	.06
5	Sibling position	.29	.08	.003	0.5	-.03
6	Father's Occupational status	.29	.08	.001	0.7	.04
7	No. of siblings	.29	.08	.000	0.2	-.02
8	Importance of math for job at T.S.	.29	.08	.000	0.1	.01
9	Mother's education	.29	.09	.000	0.0	-.01

F-level or tolerance was insufficient to include liking for math at Talent Search in analysis.

Table 21 (Cont.)

Follow-up: Waves 3 & 4 - 7th graders (N = 448, f^2 = .11, power > .99)[1]

Order of Entering Predictor Variables	Predictor Variables	R	R^2	R^2 Change	F	β
1	Math favorite course in high school	.24	.06		22.8	.22
2	Sex	.27	.07	.016	4.0	.10
3	T.S. SAT-M	.29	.08	.010	3.4	.09
4	Liking for math at T.S.	.30	.09	.006	1.8	.06
5	Father's Occupational status	.30	.09	.005	1.6	.08
6	Sibling position	.31	.10	.003	1.9	.09
7	Importance of Math for job at T.S.	.31	.10	.003	1.4	.06
8	No. of siblings	.32	.10	.001	0.4	-.04
9	Mother's education	.32	.10	.001	0.4	.04
10	Father's education	.32	.10	.000	0.1	-.02

Follow-up: Waves 3&4 -7th & 8th graders (N = 123, f^2 = .12, power > .98)

Order Entering Predictor Variables	Predictor Variables	R	R^2	R^2 Change	F	β
1	Sex	.16	.02		3.6	.19
2	T.S. SAT-V	.20	.04	.016	3.4	-.18
3	Sibling position	.24	.06	.015	2.4	.19
4	Mother's education	.25	.06	.010	1.2	.11
5	T.S. Math Liking	.27	.07	.008	2.0	-.14
6	Math favorite course in high school	.29	.09	.012	1.7	.12
7	Father's Occupational status	.30	.10	.007	1.8	.18
8	No. of siblings	.32	.11	.007	0.9	-.11
9	Father's education	.32	.11	.005	0.9	-.14
10	Importance of Math for job at T.S.	.33	.11	.002	0.3	-.05
11	T.S. SAT-M	.33	.11	.002	0.2	.05

[1]Talent Search SAT-V scores were unavailable.

[2]Paternal occupational status ratings were unavailable.

range, while the other 3 effect sizes were in the small range.

For the criterion variable, the R^2 change for each predictor variable was tested for significance at the .05 level. The resulting equations and their standard error of estimate are shown in Table 11. The six separate analyses did not reveal a predictor variable that was overall best among the set.

Comparing the standard error of estimate with the standard deviation of the criterion variable revealed the numbers to be almost identical. This indicates that the equations would probably result in a substantial number of errors in predicting the number of semesters of mathematics taken. Therefore, the null hypothesis was accepted.

4. There was a significant difference between máles' and females' grades in their mathematics classes. The girls received better grades. The mathematics courses taken by the group is shown and contrasted by sex in Table 22. The course grades of boys and girls are rather sim-

Table 22

Reported Mathematics Course-taking in High School by SMPY Students, Their Mean Course Grades, and Their Mean School Grades When Enrolled, Shown by Sex and Follow-up Wave for Those Courses Where at Least 5% Had Been Enrolled[1]

Follow-up Wave	First		Second		Third & Fourth	
	Male (133)	Female (69)	Male (310)	Female (221)	Male (785)	Female(478)
Algebra I						
Mean course grade	3.74	3.85	3.65	3.70	3.69	3.75
S.D.	0.51	0.36	0.60	0.58	0.55	0.51
Mean school grade	8.10	8.16	8.13	8.19	8.11	8.11
S.D.	0.62	0.44	0.58	0.50	0.51	0.46
Percentage enrolled	96	100	93	94	92	94
Algebra II						
Mean course grade	3.61	3.67	3.57	3.60	3.60	3.62
S.D.	0.65	0.59	0.68	0.66	0.63	0.61
Mean school grade	9.39	9.49	9.49	9.53	9.48	9.58
S.D.	0.08	0.68	0.82	0.83	0.84	0.91
Percentage enrolled	94	100	92	94	92	95
Plane Geometry						
Mean course grade	3.66	3.72	3.64	3.64	3.68	3.65
S.D.	0.65	0.51	0.62	0.57	0.59	0.59
Mean school grade	9.61	9.82	9.54	9.74	9.34	9.47
S.D.	0.71	0.62	0.67	0.58	0.65	0.63
Percentage enrolled	93	99	93	94	92	94
College Algebra						
Mean course grade	3.61	3.67	3.60	3.53	3.49	3.53
S.D.	0.73	0.57	0.63	0.74	0.73	0.68
Mean school grade	10.87	11.33	10.68	10.97	10.70	10.89
S.D.	0.99	0.57	0.90	0.86	0.90	0.79
Percentage enrolled	53	35	49	40	43	35

Table 22 (Cont.)

Follow-up Wave	First		Second		Third & Fourth	
	Male (133)	Female (69)	Male (310)	Female (221)	Male (785)	Female (478)
Trigonometry						
Mean course grade	3.51	3.56	3.55	3.60	3.54	3.58
S.D.	0.75	0.65	0.66	0.66	0.67	0.66
Mean school grade	10.52	11.19	10.60	10.96	10.50	10.79
S.D.	0.77	0.54	0.75	0.64	0.77	0.67
Percentage enrolled	87	86	81	80	83	80
Analytical Geometry						
Mean course grade	3.51	3.65	3.49	3.62	3.49	3.55
S.D.	0.75	0.53	0.72	0.62	0.74	0.68
Mean school grade	10.93	11.15	10.87	11.08	10.74	10.92
S.D.	0.71	0.56	0.75	0.56	0.97	0.63
Percentage enrolled	80	67	71	61	70	60
Calculus I						
Mean course grade	3.47	3.62	3.44	3.55	3.40	3.59
S.D.	0.85	0.56	0.78	0.69	0.77	0.61
Mean school grade	11.42	11.93	11.65	11.82	11.60	11.82
S.D.	0.77	0.26	0.61	0.42	0.63	0.45
Percentage enrolled	61	42	69	34	66	43
Calculus II						
Mean course grade	3.56	3.59	3.42	3.63	3.39	3.50
S.D.	0.71	0.57	0.76	0.60	0.81	0.73
Mean school grade	11.67	11.93	11.73	11.87	11.73	11.85
S.D.	0.71	0.27	0.57	0.34	0.60	0.47
Percentage enrolled	55	39	61	30	53	29
Probability Statistics						
Mean course grade	3.62	3.90	3.59	3.87	3.69	3.84
S.D.	0.56	0.32	0.53	0.34	0.54	0.42
Mean school grade	11.28	11.80	11.47	11.30	11.17	11.55
S.D.	0.96	0.63	0.93	1.19	1.05	0.63
Percentage enrolled	22	15	18	10	17	12

Table 22 (Cont.)

Follow-up Wave	First		Second		Third & Fourth	
	Male (133)	Female (69)	Male (310)	Female (221)	Male (785)	Female (478)
Elementary Functions						
Mean course grade	3.50	3.50	4.00	3.50	3.25	3.51
S.D.	0.55	0.55	0	0.71	0.90	0.66
Mean school grade	10.83	11.33	11.33	11.33	10.92	11.11
S.D.	0.40	0.52	0.58	0.58	0.57	0.47
Percentage enrolled	5	9	1	1	6	8
Computer Science						
Mean course grade	3.64	3.75	3.65	3.88	3.66	3.68
S.D.	0.50	0.50	0.58	0.34	0.63	0.59
Mean school grade	11.00	11.00	11.32	11.33	11.21	11.53
S.D.	0.95	1.41	0.96	1.11	0.93	0.80
Percentage enrolled	9	6	19	7	23	17

[1]The differences between males and females in course grades and school grades were significant. Females received better grades ($\chi^2 = 20.5$, $p < .001$, $g = .41$, power > .98), and males took their mathematics in an earlier grade ($\chi^2 = 22.1$, $p < .001$, $g = .42$, power > .98).

ilar. Table 1 showed that the overall mean mathematics grades for boys and girls were not much different (i.e., boys had a mathematics gradepoint average of 3.5 and girls 3.6 on a scale where A=4, B=3, etc.). It becomes apparent from Table 22, however, that in almost every comparison by course and sex, girls receive slightly better grades. A sign test was employed to check if this difference was significant. It was (chi-square=20.5, $p<.001$) with a large effect size ($g=.41$). Thus, the null hypothesis was rejected. Girls do receive better grades even in mathematics.

5. SMPY males take their mathematics courses in a significantly earlier grade than SMPY females. The mean school grades when SMPY students took each of their mathematics courses are shown in Table 22. In almost every comparison by sex, SMPY males took the course in a slightly earlier grade. To test for significance a sign test was utilized, which was significant (chi-square=22.1, $p<.001$). The effect size was also large ($g=.42$). Thus, the null hypothesis of no differ-

ence was rejected.

6. SMPY males do not have a significantly stronger expressed liking for mathematics in high school than SMPY females. Table 23 shows the mean rated liking for mathematics, biology, chemistry and physics in high school by sex for the follow-up waves. Mathematics was most preferred by both the males and females. The difference between the sexes in rated degree of liking was extremely small. For the combined third and fourth wave of the follow-up, however, the sex difference was significant ($p \leq .05$) because of the large N (see Table 2). Yet the effect size equalled only .13, which is not even considered small by Cohen (1977). Thus, this significant difference was ignored. The null hypothesis of no difference in rated liking of mathematics was accepted.

7. SMPY males did not rank their preference for mathematics significantly more highly relative to biology, chemistry, and physics than SMPY females. Table 23 shows that mathematics was most highly ranked by both SMPY males and females. No sig-

Table 23

The Mean Reported Likings for Mathematics, Biology, Chemistry, and Physics[1] and Their Mean Preference Rankings Relative to Each Other by Sex and Follow-up Wave

Follow-up Wave	First		Second		Third & Fourth	
	Males (133)	Females (69)	Males (310)	Females (221)	Males (785)	Females (478)
Mathematics Liking						
Mean	4.44	4.36	4.28	4.12	4.32	4.19
S.D.	0.81	0.87	0.92	1.08	0.91	1.01
t of mean difference between sexes	n.s.		n.s.		2.2, $p < .05$	
Biology liking						
Mean	3.91	4.18	3.88	4.08	3.68	3.98
S.D.	1.07	0.88	1.04	0.96	1.12	1.08
t of mean difference between sexes	n.s.		2.2, $p < .05$		4.7, $p < .001$	
Chemistry liking						
Mean	3.87	3.47	3.62	3.53	3.82	3.59
S.D.	1.01	1.21	1.14	1.23	1.12	1.19
t of mean difference between sexes	2.5, $p < .01$		n.s.		3.2, $p < .001$	
Physics liking						
Mean	4.01	3.58	3.76	3.10	3.89	3.30
S.D.	0.99	1.10	1.17	1.17	1.11	1.21
t of mean difference between sexes	2.7, $p < .01$		6.1, $p < .001$		8.3, $p < .001$	
Mathematics Ranking						
Mean	1.93	1.87	1.81	1.90	1.88	1.86
S.D.	0.90	0.91	0.99	0.98	0.97	0.95
t of mean difference between sexes	n.s.		n.s.		n.s.	
Biology ranking						
Mean	2.65	2.21	2.67	2.10	2.82	2.16
S.D.	1.25	1.18	1.18	1.04	1.17	1.07
t of mean difference between sexes	2.4, $p < .05$		5.6, $p < .001$		9.7, $p < .001$	

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Table 23 (Cont.)

Follow-up Wave	First		Second		Third & Fourth	
	Males (133)	Females (69)	Males (310)	Females (221)	Males (785)	Females (478)
Chemistry ranking						
Mean	2.66	2.83	2.81	2.63	2.60	2.73
S.D.	0.99	0.96	0.89	0.93	1.00	0.95
t of mean difference between sexes	n.s.		2.2, $p < .05$		2.2, $p < .05$	
Physics ranking						
Mean	2.61	2.98	2.68	3.30	2.58	3.12
S.D.	1.13	1.00	1.08	0.94	1.07	0.99
t of mean difference between sexes	2.2, $p < .05$		6.4, $p < .001$		8.1, $p < .001$	

[1]The reported degree of liking was coded as follows:

5 = strong liking, 4 = moderately strong liking, 3 = neutral or mixed feelings, 2 = moderately strong disliking, 1 = strong disliking

nificant difference occurred (see Table 23). Thus, the null hypothesis was accepted.

8. Significantly more SMPY males than females took the College Board's mathematics achievement tests and the APP mathematics examinations. The number of students taking the mathematics achievement tests is shown in Table 4 and the number taking APP mathematics examinations in Table 6, both separately by sex. The difference in proportions between males and females taking the Math Level 1 achievement test, which is easier than the Math Level 2, was not significant (i.e., 20% of the boys vs. 23% of the girls). The difference for the Math Level 2 was, however, significant ($p<.01$). Approximately 34 percent of the boys took this test, while only 18 percent of the girls did. The effect size was only in the small range ($h=.37$). With this type of data where only small numbers are taking each test, it becomes difficult to achieve anything but a small effect size.

This problem is even stronger when testing for a significant difference in the number taking the two APP mathematics examinations. Approximately 12 percent of the males and 8 percent of the females took the APP Calculus AB examination, which is less advanced than the APP Calculus BC examination. Although the difference in proportions was significant at the $p<.01$ level, the effect size did not even reach the criterion for a small effect ($h=.13$). The more difficult BC examination was taken by 17 percent of the males and 5 percent of the females, significantly different at the $p<.01$ level. The effect size was small ($h=.40$). Because of the difficulty in getting anything but a small effect size, the null hypothesis was rejected despite the small h. SMPY boys took more mathematics achievement tests and APP examinations, especially the more difficult ones, than SMPY girls.

9. SMPY males scored significantly higher than SMPY females on the College Board's mathematics achievement tests. Mean scores by sex are shown in Table 4. On

the Math Level 1 boys scored on the average 695, while girls scored around 650 (see Table 4). The difference was significant beyond the $p<.01$ level, except for the first wave of the follow-up (see Table 2). The effect size equalled .58 for the second wave and .73 for the combined third and fourth waves, which are considered to be in the medium range. On the more difficult Math Level 2, the boys scored on the average 748 and the girls approximately 708 (see Table 4), significantly different beyond the $p<.05$ level (see Table 2). The effect size ranged from .47 to .86, which is in the medium to large range. Thus, the null hypothesis of no difference between the sexes on mathematics achievement test scores was rejected.

An analysis of covariance was computed on Math Level 2 achievement test scores by follow-up wave and grade. The effect of sex was tested after talent search SAT-M scores was controlled for. The results are shown in Table 24. When mathematical reasoning ability was controlled for, the effect of sex was re-

Table 24

Analysis of Covariance on Chemistry, Physics, Biology, and Math Level 2 Achievement Test Scores for Sex, Controlling for Talent Search SAT-M Score, Performed Separately by Follow-up Wave and Grade[1]

Chemistry Achievement Test	Source of Variation	SS	df	MS	F
Wave 2:	Sex	6.7	1	6.7	.2
8th graders	Error	1784.2	56	31.9	
Waves 3 & 4:	Sex	12553.5	1	12553.5	2.2
8th graders	Error	663008.6	115	5765.3	
Waves 3 & 4:	Sex	487.9	1	487.9	.1
7th graders	Error	421303.4	71	5933.9	

Physics Achievement Test	Source of Variation	SS	df	MS	F
Wave 2:	Sex	115.0	1	115.0	2.3
8th graders	Error	2063.6	42	49.1	
Waves 3 & 4:	Sex	29232.1	1	29232.1	6.3[a]
8th graders	Error	283726.0	61	4651.3	
Waves 3 & 4:	Sex	4175.4	1	4175.4	1.1
7th graders	Error	168889.0	46	3671.5	

Biology Achievement Test	Source of Variation	SS	df	MS	F
Waves 3 & 4:	Sex	10431.7	1	10431.7	1.6
8th graders	Error	289365.6	45	6430.4	
Waves 3 & 4:	Sex	4189.4	1	4189.4	.72
7th graders	Error	286000.6	49	5836.8	

Table 24 (Cont.)

Math Level 2 Achievement Test	Source of Variation	SS	df	MS	F
Wave 1: 8th graders	Sex	115.3	1	115.3	2.3
	Error	2363.7	48	49.2	
Wave 2: 8th graders	Sex	7.1	1	7.1	.3
	Error	2687.1	108	24.9	
Waves 3 & 4: 8th graders	Sex	33671.9	1	33671.9	11.6[c]
	Error	648370.7	223	2907.5	
Waves 3 & 4: 7th graders	Sex	13933.8	1	13933.8	5.1[a]
	Error	403342.3	148	2725.3	

[a] $p \leq .05$

[c] $p \leq .001$

[1] These analyses were only performed if the sex difference was significant on the achievement test for the group and the N was large enough.

duced. Yet sex still remained a significant effect for two of the four analyses performed (see Table 24). Because the effect of sex was reduced, a relationship may exist between the sex difference on the Math Level 2 achievement test and the less well developed mathematical reasoning ability of the SMPY girls compared to the SMPY boys at talent search.

The above analysis was not performed for the Math Level 1 achievement test scores, because a similar analysis was performed in sub-hypothesis 12.2. In those stepwise multiple regression analyses trying to predict Math Level 1 achievement test scores, the overall best predictor was talent search SAT-M scores. Little additional variance was accounted for when sex was added to the multiple regression equations (see sub-hypothesis 12.2). Thus, sex is not a good predictor of Math Level 1 achievement test scores after mathematical reasoning ability at talent search was contolled for. Again this seemed to indicate a possible relationship between the sex difference on the SAT-M and the one on the mathematics achievement tests.

10. SMPY males do not score significantly higher than SMPY females on the APP mathematics examinations. Mean scores on the APP Calculus AB and the more difficult APP Calculus BC examination are shown in Table 6 by sex. Mean scores were above the mean and boys did tend to score more highly. The differences were, however, for the most part not significant (see Table 2). Thus, the null hypothesis of no difference was accepted.

11. More SMPY males than females do not plan to major in the mathematial sciences in college. The percentage of males reporting that they intended to major in the mathematical sciences was 15 percent, while for the SMPY females this was 17 percent. The difference favoring girls was not significant. Thus, the null hypothesis was accepted.[12]

12. More SMPY males than females accelerated their educational progress in high school. The results for the overall measure of acceleration (age at college entrance taking advanced standing into ac-

count) revealed no significant sex differences except for the first wave of the follow-up ($p<.01$, see Table 8).

When the use of the various accelerative options (see Table 7) was analyzed, the following two (somewhat related) variables showed significant sex differences for all folow-up waves: the taking of APP examinations ($p<.01$) and entering college with advanced standing ($p<.05$). Significantly more males took APP examinations (40% males vs. 25% females, $p<.01$, $h=.32$, power>.97). The mean number of examinations taken was almost 1 for boys and about 0.5 for girls ($p<.001$, see Tables 7 and 2). No significant differences by a sign test were seen, however, in scores earned on APP examinations (Chi-Square=.92).

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12) In sub-hypothesis 8.1 the intended college majors of SMPY students were discussed. In those analyses, mathematical science majors were combined with engineering majors. A sex difference favoring the SMPY males was then found, but was due to the finding that more SMPY males than females intend to major in engineering.

Moreover, significantly more SMPY males than females enter college with advanced standing ($p<.05$ and $h=.37$, .24, and .14, respectively, for each wave of the follow-up) and with more advanced standing credits. The difference in credits earned was significant, however, only for the combined third and fourth waves of the follow-up ($p<.01$, effect size=.40, see Table 2).

For the first wave of the follow-up, SMPY boys used all the available accelerative options significantly more frequently than SMPY girls (see Table 7). The difference in proportions using an accelerative option was significant at least at the $p<.05$ level for all sex comparisons. The effect sizes were greater than .30 (small effect). These differences were reflected in the overall acceleration variable (see Table 8).

Taking all these observations into account, it became necessary to reject the null hypothesis. Boys do make more use of acceleration than girls do, although the effect is small.

13. Significantly more SMPY males than females took mathematics during the first semester of college. Of the students in college, 81 percent of the males and 68 percent of the females reported that they took at least one mathematics course during their first semester of college. This difference was significant beyond the $\underline{p}<.01$ level, with a small effect size ($\underline{h}<.30$). Thus, the null hypothesis was rejected.

14. Significantly more SMPY males than females participated in mathematics contests in high school.[13] Approximately 23 percent of the boys and 12 percent of the girls had participated in at least one, significantly different beyond the $\underline{p}<.01$ level. The effect size was, however, small ($\underline{h}=.29$). The mean number of contests participated in by the boys was .47 and .25 by the girls, significantly different beyond the $\underline{p}<.001$ level (see Table 2). The effect size was small ($\underline{d}=.34$). Thus, the null hypothesis was rejected.

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13) This variable does not include TV quiz show participation.

15. Significant differences between SMPY males and females in their participation in science fairs were not found. For both boys and girls, 17 percent participated in at least one. The mean number of science fairs participated in was .25 for the whole group. Thus, the null hypothesis was accepted.

16. SMPY males scored significantly higher on the College Board's chemistry achievement test than SMPY females. Mean scores by sex are shown in Table 4. Boys scored on the average 676, while girls scored 643. The sex difference was significant for each wave of the follow-up ($p < .05$) except the first (power equaled only .43) (see Table 2). The effect sizes were all medium for the analyses (d = .71, .59, .54, respectively for each group). Thus, the null hypothesis was rejected.

An analysis of covariance was performed on the chemistry achievement scores by sex, controlling for talent search SAT-M. The results are shown in Table 24. When ability on the SAT-M at talent search participation is controlled for, the effect of sex is no longer significant. Thus, the sex difference in chemistry achievement scores might be related to that SMPY females have less well developed mathematical reasoning ability than SMPY males.

17. SMPY males score significantly higher on the College Board's physics achievement test than SMPY females. In Table 3 it can be seen that the mean score for the males was approximately 676 and for females 607. The sex difference was significant for the second and combined third and fourth waves of the follow-up ($p < .05$) (see Table 2) and could not be tested for the first wave because only one girl took the test. The effect size was large ($d = .85$ and .78). Thus, the null hypothesis of no difference was rejected.

An analysis of covariance was performed on the physics achievement scores, controlling for talent search SAT-M scores to detect the resulting effect of sex. The findings are shown in Table 24. After ability on SAT-M was controlled for, the effect of sex was significant only for one of the analyses. Thus, the sex difference in physics achievement scores may be related to the sex difference found in the talent search in mathematical reasoning ability.

18. SMPY males do not score significantly higher on the APP chemistry examinations than SMPY females. In Table 6 the mean scores are shown by sex. Boys scored 3.7 on the average and girls 3.4. Because only one girl in the first wave of the follow-up and one girl in the second took the APP chemistry examinations, a _t_-test could not be performed on those two groups. For the combined third and fourth waves a _t_-test was employed and the difference was found to be insignificant (see Table 2). The power of the test was relatively low, however (.54). The null hypothesis of no difference was accepted.

19. SMPY males do not score significantly higher on the APP physics examinations than SMPY females. Mean scores are shown in Table 6 for the three APP physics ex-

aminations. Very few girls took them. As a result, only one of the six comparisons could be tested-- Physics B for the combined third and fourth waves of the follow-up. That sex difference turned out to be not significant (see Table 2). The power of the test was low (.46), however. The null hypothesis was accepted.

20. Significantly more SMPY males than females took the College Board's chemistry achievement test and the APP chemistry examination. Approximately 18 percent of the males and 10 percent of the females took the chemistry achievement test (see Table 4), significantly different at the $p<.01$ level. The effect size was small ($h=.23$). Of the SMPY males 7 percent took the APP chemistry examination, while only 2 percent of the females did (see Table 6). The difference was significant beyond the .01 level with a small effect size ($h=.25$). As a result, the null hypothesis was rejected.

21. Significantly more SMPY males than females took the College Board's Physics Achievement Test and the APP physics examinations. Approximately 13 percent of the males and 3 percent of the females took the physics achievement test (see Table 4), significantly different beyond the .01 level. The effect size was small (*h*=.39). A significant difference between males and females was also found for the APP physics examinations ($p<.01$), which were taken by 9 percent of the males and 1 percent of the females (see Table 6). The small effect size equalled .41. Thus, the null hypothesis was rejected. SMPY males and females do differ in the taking of physics examinations in high school.

22. There was no substantial difference between SMPY males and females in the taking of College Board's Biology Achievement Test and the APP Biology Examination. The biology achievement test was taken by 8 percent of the males and 9 percent of the females (see Table 4), a difference which was not significant. Approximately 7 percent of the males and

3 percent of the females took the APP Biology Examination (see Table 6). Although the difference was significant (p<.01), the effect size did not meet the criterion for even being considered small (h=.19). Thus, the null hypothesis of no difference between the sexes in the taking of biology examinations in high school was accepted.

23. SMPY males score significantly higher on the College Board's biology achievement test than SMPY females. Mean scores on this test are shown in Table 4. Boys scored on the average 660 and the girls 623. The sex difference was not significant for the first and second wave of the follow-up, however. For the combined third and fourth wave, the difference was (p<.05) (see Table 2). The effect size for each wave of the follow-up was .76, .32, and .48. Because the overall effect size was almost medium and for the analysis with the large N the sex difference was significant, the null hypothesis was rejected.

An analysis of covariance was performed on the biology achievement scores in the combined third and fourth wave of the follow-up by grade. The effect of sex was tested while controlling for ability in the talent search on the SAT-M. The results are shown in Table 24. When mathematical reasoning ability was controlled for, the effect of sex was no longer significant. Thus, the sex difference on the biology achievement test may be related to the sex difference in mathematical reasoning ability detected in the 7th or 8th grade for this group.

24. There was no significant difference between SMPY males and females in their performance on the APP biology examination. The mean scores are shown by sex in Table 6. Although the males scored slightly better, the difference was not significant (see Table 2). Thus, the null hypothesis was accepted.

25. Stepwise multiple regression analyses performed separately by follow-up wave and grade revealed that talent search SAT scores and sex can fairly accurately pre-

dict the number of science and/or mathematics achievement or APP examinations taken in high school. Table 25 shows the multiple regression analyses. Between 16 and 23 percent of the variance in the taking of these examinations could be accounted for by the talent search SAT scores and sex (see Table 25). The associated effect sizes ranged in value from .19 to .30, which are considered to be in the medium range.

For the criterion variable, the R^2 change for each predictor variable was tested for significance at the .05 level. The resulting equations and their standard error of estimate are shown in Table 11. By itself talent search SAT-M, the overall best predictor, could account for between 15 and 21 percent of the variance.

Comparing the standard error of estimate with the criterion variable's standard deviation revealed that prediction was somewhat improved by use of the equations, although many errors would still be made. Because the effect size

Table 25

Stepwise Multiple Regression Analyses
in Predicting the Total Reported Number of
Science and/or Mathematics Achievement or
APP Examinations Taken in High School by
Grade and Follow-up Wave

Follow-up: Wave 1 - 8th graders (N = 184, f^2 = .22, power > .96)[1]

Order of Entering Predictor Variables	Predictor Variables	R	R^2	R^2 Change	F	β
1	T.S. SAT-M	.39	.15		19.1	.31
2	Sex (Males=1,Females=0)	.43	.18	.036	8.0	.20

Follow-up Wave 2 - 8th graders (N = 451, f^2 = .27, power > .99)

Order of Entering Predictor Variables	Predictor Variables	R	R^2	R^2 Change	F	β
1	T.S. SAT-M	.43	.18		54.6	.35
2	Sex (Males=1,Females=0)	.44	.19	.012	10.0	.14
3	T.S. SAT-V	.45	.21	.013	7.1	.12

Follow-up Wave 2 - 7th graders (N = 56, f^2 = .19, power = .72)[1]

Order of Entering Predictor Variables	Predictor Variables	R	R^2	R^2 Change	F	β
1	T.S. SAT-M	.39	.15		9.8	.40
2	Sex (Males=1,Females=0)	.39	.16	.006	0.3	-.08

Follow-up: Waves 3 & 4 - 8th graders (N = 736, f^2 = .24 , power > .99)[1]

Order of Entering Predictor Variables	Predictor Variables	R	R^2	R^2 Change	F	β
1	T.S. SAT-M	.42	.18		129.2	.39
2	Sex (Males=1,Females=0)	.44	.19	.017	15.3	.13

Table 25 (Cont.)

Follow-up: Waves 3 & 4 - 7th graders (N = 500, f^2 = .24, power > .99) [1]

Order of Entering Predictor Variables	Predictor Variables	R	R^2	R^2 Change	F	β
1	T.S. SAT-M	.43	.19		102.2	.42
2	Sex (Males=1,Females=0)	.44	.19	.007	4.2	.08

Follow-up: Waves 3 & 4 - 7th & 8th graders (N = 147, f^2 = .30, power > .99)[a]

Order of Entering Predictor Variables	Predictor Variables	R	R^2	R^2 Change	F	β
1	T.S. SAT-M	.46	.21		32.0	.42
2	Sex (Males=1,Females=0)	.48	.23	.022	4.2	.15

[a]The F-level or tolerance was insufficient to include T.S. SAT-V in the analyses.

[1]Talent Search SAT-V scores were unavailable.

was medium, the null hypothesis was rejected.

26. There was no significant difference between SMPY males and females in their expressed liking for chemistry. Table 23 shows the mean expressed liking for chemistry and the mean of the rankings of chemistry relative to biology, mathematics, and physics. The mean of the chemistry likings was equated to a moderate liking for both boys and girls. Although the boys preferred chemistry slightly more than the girls, the difference was not significant for the second wave of the follow-up and was too small (yet significant) for the combined third and fourth waves to be considered even a small effect ($\underline{d}$=.19).

Of the four subjects: biology, chemistry, physics, and mathematics, chemistry was the least preferred by the boys and was ranked third by the girls. The difference in the ranks given to chemistry by the boys and girls was significant for the second and combined third and fourth waves of the follow-up (see Table 23). The effect sizes were too small to be considered even a small effect, however (i.e., less than .20). Thus, the null hypothesis was accepted.

27. SMPY males do like physics significantly more than SMPY females. The mean of the expressed likings for physics and the mean of its ranking relative to biology, chemistry, and physics is shown in Table 23. The boys appear to have a moderately strong liking, while the girls like it somewhat. The difference was significant beyond the .01 level (see Table 2), with effect sizes that were in the medium range (d=.41, .56, and .50, respectively, for the three groups).

Relative to biology, chemistry, and mathematics, physics was the least liked by the girls, while for the boys it was ranked second in preference. The difference was significant beyond the .05 level (see Table 23), with a medium effect size (d=.35, .62, and .53, respectively, for the three groups). Thus, the null hypothesis was rejected. Boys do prefer physics more than girls do.

28. SMPY females have a stronger expressed liking for biology than SMPY males do. The mean of the expressed likings for biology and the mean of its rankings relative to chemistry, physics, and mathematics are shown in Table 23. Liking for biology was equated to a moderately strong liking. The difference between the boys and girls was significant for the second and combined third and fourth waves of the follow-up ($p < .05$), but not for the first wave (see Table 23). The effect sizes were in the small range ($d = .27$, .20, .22).

Girls ranked biology second in preference relative to chemistry, physics, and mathematics, while boys ranked it third. The difference was significant for all waves of the follow-up (see Table 23) and had a medium effect size ($d = .37$, .51, and .59, respectively, for the three groups). Thus, the null hypothesis was rejected. Girls prefer biology more than boys do.

4.12 HYPOTHESIS 12

Ability at talent search participation can rather accurately predict achievement at the beginning of college.

1. In stepwise multiple regression analyses performed separately by grade and follow-up wave, the following variables can accurately predict reported high school SAT-M score: talent search SAT scores, paternal occupational status, parental educational level, number of siblings, sibling position, mathematics liking, number of semesters of mathematics taken in high school, and rated importance of mathematics for future career (see Table 26). The R^2 for the analyses ranged from .37 to .55. Thus, from 37 to 55 percent of the variance in reported high school SAT-M scores can be accounted for by these variables (see Table 26). The effect sizes ranged from .59 to 1.22, which were all in the large range. The power of the analyses were all greater than .97.

Table 26

Stepwise Multiple Regression Analyses
in Predicting Reported High School SAT-M
Scores by Grade and Follow-up Wave

Follow-up: Wave 1 - 8th graders (N = 173, f^2 = .59 power > .96) [1]

Order of Entering Predictor Variables	Predictor Variables	R	R^2	R^2 Change	F	β
1	T.S. SAT-M	.55	.30		38.2	.43
2	Mothers' education	.58	.34	.036	1.9	.11
3	Semesters of Math in high school	.60	.35	.019	5.3	.15
4	Father's education	.61	.37	.013	3.4	.14
5	Sibling position	.61	.37	.001	0.1	.02
6	Math Liking in high school	.61	.37	.000	0.1	.02
7	No. of siblings	.61	.37	.000	0.0	-.01

[1] Talent Search SAT-V scores were unavailable

Follow-up: Wave 2 - 8th graders (N = 298, f^2 = .82, power > .96)

Order of Entering Predictor Variables	Predictor Variables	R	R^2	R^2 Change	F	β
1	T.S. SAT-M	.62	.38		112.6	.55
2	Semesters of Math in high school	.66	.43	.053	24.8	.23
3	Math Liking at T.S.	.66	.44	.007	4.8	.10
4	Sibling position	.67	.45	.007	4.6	.12
5	Father's education	.67	.45	.003	2.0	.10
6	Father's Occupational status	.67	.45	.002	1.2	-.07
7	No. of siblings	.67	.45	.001	0.4	-.04
8	Importance of Math for Job at T.S.	.67	.45	.000	0.2	-.02
9	Mother's education	.67	.45	.000	0.1	.02
10	T.S. SAT-V	.67	.45	.000	0.1	.01

Table 26 (Cont.)

Follow-up: Wave 2 - 7th graders (N = 45, f^2 = .79, power = .98)[2]

Order of Entering Predictor Variables	Predictor Variables	R	R^2	R^2 Change	F	β
1	T.S. SAT-M	.48	.23		16.0	.51
2	Sibling position	.58	.33	.099	5.7	.40
3	Father's Occupational status	.61	.38	.044	2.4	.27
4	No. of siblings	.64	.40	.026	0.7	-.14
5	Math Liking in high school	.65	.42	.018	0.2	.07
6	Father's education	.65	.43	.007	0.7	-.16
7	Mother's education	.66	.43	.003	0.4	.11
8	Semesters of Math in high school	.66	.44	.006	0.4	.09

[2]Talent search SAT-V scores and ratings of liking for mathematics and importance of mathematics for future job were unavailable.

Follow-up: Waves 3 & 4 - 8th graders (N = 630, f^2 = 1.13, power > .99)[3]

Order Entering Predictor Variables	Predictor Variables	R	R^2	R^2 Change	F	β
1	T.S. SAT-M	.66	.44		419.8	.59
2	Semesters of Math in high school	.71	.50	.058	68.4	.23
3	Math liking at T.S.	.72	.51	.016	14.2	.12
4	Father's education	.72	.52	.008	5.6	.11
5	Importance of Math for job at T.S.	.72	.52	.001	1.6	.04
6	Sibling position	.72	.52	.001	3.2	.07
7	No. of siblings	.72	.53	.002	2.1	-.05
8	Mother's education	.72	.53	.000	0.5	.02
9	Father's Occupational status	.73	.53	.000	0.3	-.02

[3]Talent Search SAT-V scores were unavailable.

Table 26 (Cont.)

Follow-up: Waves 3 & 4 - 7th graders (N = 421, f^2 = .72, power = .99) [4]

Order of Entering Predictor Variables	Predictor Variables	R	R^2	R^2 Change	F	β
1	T.S. SAT-M	.59	.35		210.2	.56
2	Semesters of Math in high school	.61	.38	.026	18.5	.16
3	Father's Occupational status	.63	.40	.025	3.9	.10
4	Sibling position	.64	.41	.008	6.6	-.13
5	Father's education	.64	.41	.003	1.5	.07
6	Math Liking at T.S.	.64	.42	.003	1.6	.05
7	No. of siblings	.65	.42	.003	2.0	.08
8	Importance of Math for Job at T.S.	.65	.42	.001	1.1	.04
9	Mother's education	.65	.42	.000	0.2	.02

[4] Talent Search SAT-V scores were unavailable.

Follow-up: Waves 3 & 4 - 7th graders (N = 117, f^2 = 1.3, power = .97)

Order of Entering Predictor Variables	Predictor Variables	R	R^2	R^2 Change	F	ββ
1	T.S. SAT-M	.68	.46		78.9	.63
2	Semesters of Math in high school	.71	.50	.047	12.6	.24
3	T.S. Math Liking	.73	.53	.024	3.2	.12
4	Importance of Math for Job at T.S.	.73	.54	.009	3.6	.13
5	Mother's education	.74	.54	.005	3.2	-.13
6	Father's education	.74	.55	.011	1.4	.12
7	No. of siblings	.75	.56	.003	0.7	.07
8	T.S. SAT-V	.75	.56	.001	0.1	.02
9	Sibling position	.75	.56	.000	0.1	-.02
10	Father's Occupational status	.75	.56	.000	0.0	.01

For the criterion variable, the R^2 change for each predictor variable was tested for significance at the .05 level. The resulting equations and their standard error of estimate are shown in Table 11. In all the analyses the talent search SAT-M score was the best predictor and was the first variable to be entered in the stepwise multiple regression analyses. By itself it could account for from 23 to 44 percent of the variance in high school SAT-M scores (see Table 26). Following the talent search SAT-M score, the best predictors of high school SAT-M were the number of semesters of mathematics taken in high school and one of the highly correlated parent education or occupational status variables (see Table 26). The change in R^2 with the addition of these variables was not large, however.

Comparing the standard error of estimate with the criterion variable's standard deviation revealed that substantial improvement in prediction is made by using the above equations. Thus, the null hypothesis was rejected. The above variables could rather accurately predict high school SAT-M scores, and talent search SAT-M was the best predictor.

2. In stepwise multiple regression analyses performed separately by grade and follow-up wave, the following variables can accurately predict reported high school Math Level 1 achievement test score: talent search SAT, paternal occupational status, parental educational level, number of siblings, sibling position, mathematics liking, number of semesters of mathematics taken in high school, and rated importance of mathematics for future career (see Table 27). The lowest R^2 was .42 and the highest .56. The effect sizes ranged from .72 to 1.27, which are all in the large range.

For the criterion variable, the R^2 change for each predictor variable was tested for significance at the .05 level. The resulting equations and their standard error of estimate are shown in Table 11. The best overall predictor of Math Level 1 achievement score across all analyses was the talent search SAT-M. By

Table 27

Stepwise Multiple Regression Analyses in Predicting Reported High School Achievement Scores on College Board's Mathematics Level 1 Test by Grade and Follow-up Wave

Follow-up: Wave 1 - 8th graders (N = 47, $f^2 = 1.04$, power > .99)[1]

Order of Entering Predictor Variables	Predictor Variables	R	R^2	R^2 Change	F	β
1	Semesters of Math in high school	.50	.25		19.5	.56
2	Talent Search SAT-M	.65	.42	.167	8.6	.37
3	Mother's education	.69	.48	.063	1.9	.18
4	No. of siblings	.70	.50	.017	0.1	.05
5	Sibling position	.71	.50	.006	1.0	.14
6	Father's education	.72	.51	.011	0.9	.14
7	High school math liking	.72	.51	.000	0.02	.01

Follow-up: Wave 2 - 8th graders (N = 64, $f^2 = 1.27$, power > .99)[1]

Order of Entering Predictor Variables	Predictor Variables	R	R^2	R^2 Change	F	β
1	Talent Search SAT-M	.62	.38		21.7	.48
2	T. S. math liking	.67	.44	.060	8.2	.32
3	Semesters of math in high school	.70	.49	.044	5.7	.23
4	Father's occupational status	.72	.52	.028	3.0	.22
5	Talent Search SAT-V	.73	.53	.010	2.8	.17
6	Mother's education	.73	.54	.013	1.9	-.15
7	No. of siblings	.74	.55	.008	1.7	.15
8	Sibling position	.75	.56	.009	1.0	-.12
9	Importance of math for job at T.S.	.75	.56	.002	0.2	.05
10	Father's education	.75	.56	.000	0.02	.02

[a]This analysis was not computed for the 7th graders because of too small an N.

Table 27 (Cont.)

Follow-up: Waves 3 & 4 - 8th graders (N = 123, f^2 = .72, power > .99)[1]

Order of Entering Predictor Variables	Predictor Variables	R	R^2	R^2 Change	F	β
1	Talent Search SAT-M	.48	.23		25.9	.39
2	Semesters of math in high school	.58	.34	.107	16.6	.30
3	T.S. math liking	.64	.41	.073	6.3	.22
4	Importance of math for job at T.S.	.65	.42	.008	1.4	.09
5	Sibling position	.65	.42	.003	1.1	-.10
6	No. of siblings	.65	.42	.003	0.6	.07
7	Mother's education	.65	.42	.000	0.0	-.01
8	Father's occupational status	.65	.42	.000	0.0	-.01

Follow-up: Waves 3 & 4 - 7th graders (N = 97, f^2 = .75, power > .99)

Order of Entering Predictor Variables	Predictor Variables	R	R^2	R^2 Change	F	β
1	Talent Search SAT-M	.48	.23		35.7	.50
2	Sibling position	.58	.33	.104	13.4	-.41
3	T.S. math liking	.61	.37	.034	3.1	.17
4	Mother's education	.63	.39	.021	3.1	.18
5	Semesters of math in high school	.64	.41	.018	2.0	.12
6	No. of siblings	.65	.42	.009	1.5	.13
7	Father's occupational status	.65	.43	.008	1.3	-.13
8	Importance of math for job at T.S.	.65	.43	.004	0.5	-.07
9	Father's education	.66	.43	.001	0.2	.05

[1]Talent Search SAT-V scores were unavailable.

itself it could account for up to 38 percent of the variance in mathematics achievement scores (see Table 27). The next best predictor appeared to be the number of semesters of mathematics taken in high school.

Comparing the standard error of estimate with the criterion variable's standard deviation revealed that substantial improvement in prediction is made by using the equations. Because of these results the null hypothesis was rejected.

3. In stepwise multiple regression analyses performed separately by grade and follow-up wave, the following variables can accurately predict reported high school SAT-V score: talent search SAT scores, paternal occupational status, parental educational level, number of siblings, sibling position, and having rated English as your favorite subject in high school (see Table 28). Because talent search SAT-V scores were available only for the participants in the 1973 Talent Search, SAT-V score from talent search could be included in only two of the a-

Table 28

Stepwise Multiple Regression Analyses
in Predicting Reported High School SAT-V
Scores by Grade and Follow-up Wave

Follow-up: Wave 1 - 8th graders (N = 171, f^2 = .27, power > .96)[1]

Order of Entering Predictor Variables	Predictor Variables	R	R^2	R^2 Change	F	β
1	T.S. SAT-M	.37	.13		21.1	.34
2	English Rating	.43	.19	.052	9.4	.22
3	Mother's education	.46	.21	.027	3.1	.15
4	Father's education	.46	.21	.001	0.2	.04
5	No. of siblings	.46	.21	.000	0.1	.02
6	Sibling position	.46	.21	.000	0.1	-.02

[1]Talent Search SAT-V scores and father's occupational status ratings were unavailable.

Follow-up: Wave 2 - 8th graders (N = 379, f^2 = 1.33, power = .63)

Order of Entering Predictor Variables	Predictor Variables	R	R^2	R^2 Change	F	β
1	T.S. SAT-V	.74	.54		282.7	.66
2	Father's education	.75	.56	.013	6.2	.14
3	English Rating	.75	.56	.003	4.4	.07
4	T.S. SAT-M	.75	.56	.005	4.9	.08
5	Mother's education	.75	.57	.002	1.4	-.05
6	No. of siblings	.75	.57	.001	3.4	-.08
7	Sibling position	.76	.57	.004	3.2	.08
8	Father's Occupational status	.76	.57	.000	0.07	.01

Table 28 (Cont.)

Follow-up: Wave 2 - 7th graders ($N = 46$, $f^2 = .47$, power = .20)[2]

Order of Entering Predictor Variables	Predictor Variables	R	R^2	R^2 Change	F	β
1	English Rating	.42	.17		8.8	.50
2	Sibling position	.50	.25	.075	1.4	-.20
3	Mother's education	.54	.29	.046	0.5	.12
4	Father's Occupational status	.56	.31	.015	0.4	.12
5	No. of siblings	.56	.31	.005	0.3	-.12
6	Father's education	.56	.32	.001	0.1	.05

[2]Talent Search SAT-V scores were unavailable. The F-level was insufficient to test Talent Search SAT-M.

Follow-up: Waves 3 & 4 - 8th graders ($N = 663$, $f^2 = .33$, power. > .96)[3]

Order of Entering Predictor Variables	Predictor Variables	R	R^2	R^2 Change	F	β
1	T.S. SAT-M	.41	.17		112.1	.37
2	English Rating	.47	.22	.058	44.4	.23
3	Mother's education	.49	.24	.020	7.1	.11
4	Father's education	.50	.25	.004	1.0	.05
5	Sibling position	.50	.25	.002	1.6	-.06
6	No. of siblings	.50	.25	.000	0.3	.03
7	Father's Occupational position	.50	.25	.000	0.1	.02

[3]Talent Search SAT-V scores were unavailable.

Table 28 (Cont.)

Follow-up: Waves 3 & 4 - 7th & 8th graders ($N = 131$, $f^2 = .61$, power > .99)

Order of Entering Predictor Variables	Variable	R	R^2	R^2 Change	F	β
1	T.S. SAT-V	.56	.31		38.9	.48
2	Father's Occupational status	.58	.34	.025	3.8	.19
3	English Rating	.59	.35	.013	2.9	.13
4	T.S. SAT-M	.60	.37	.013	3.7	.15
5	No. of siblings	.61	.37	.008	0.9	.09
6	Mother's education	.61	.38	.002	0.2	-.04
7	Father's education	.61	.38	.001	0.2	-.04
8	Sibling position	.61	.38	.000	0.1	.02

Follow-up: Waves 3 & 4 - 7th graders ($N = 454$, $f^2 = .39$, power > .99) [4]

Order of Entering Predictor Variables	Variable	R	R^2	R^2 Change	F	β
1	T.S. SAT-M	.42	.17		99.5	.41
2	English Rating	.46	.22	.041	22.7	.19
3	Father's Occupational status	.51	.26	.040	9.2	.17
4	Mother's education	.52	.27	.014	7.7	.13
5	Sibling position	.53	.28	.010	6.1	-.10
6	Father's education	.53	.28	.000	0.2	-.03

[4] Talent Search SAT scores were not included in analysis. Only these variables were entered into equation because the F-level was insufficient for further computations.

nalyses. For these two analyses, the R^2 equalled .57 and .63 and talent search SAT-V was the best single predictor (see Table 28). The effect sizes were 1.33 and 1.70,respectively (see Table 28). The next best predictor after talent search SAT-V was one of the highly correlated parental educational and occupational level variables. They accounted for only a very small percentage of additional variance after the talent SAT-V score had been entered into the equation, however.

For the remaining analyses R^2 was much lower. The smallest R^2 was .21 and the largest .32 (see Table 28). The effect sizes ranged from .27 to .47, which encompasses both medium and large effect sizes (see Table 28). The best predictor in these analyses was the talent search SAT-M score, accounting for about 17 percent of the variance in high school SAT-V score. Following the talent search SAT-M score as the best predictor were having rated English as your favorite subject in high school and one of the highly correlated parental educational and occupational variables. They could account for approximately an additional 10 percent of the variance in reported high school SAT-V scores (see Table 28).

For the criterion variable, the R^2 change for each predictor variable was tested for significance at the .05 level. The resulting equations and their standard error of estimate are shown in Table 11. By comparing the standard error of estimate with the high school SAT-V's standard deviation, it reveals that prediction is substantially improved by using the equations. Because of these results the null hypothesis was rejected.

4. Talent search SAT, paternal occupational status, and parental educational level can not accurately discriminate between students having been accelerated and the ones who had not been accelerated in their educational progress (see Table 29). Acceleration was judged on the basis of age at time of college entrance. This variable was discussed more extensively in hypothesis 3.

Table 29

Discriminant Analyses of SMPY Students Classified into Two Groups in Terms of Whether the Student was Accelerated by Time of College Entrance Performed Separately by Follow-up Wave and Grade

Follow-up Wave and Grade		Discriminant Function	Eigen value	Relative Percentage	Canonical Correlation	Functions Derived	Wilks' Lambda	Chi-Square	df	Sig.
1 - 8th	(N = 178)					0	.82	34.4	3	.001
		1	.22	100	.42					
2 - 8th	(N = 419)					0	.94	24.7	5	.001
		1	.06	100	.24					
2 - 7th	(N = 51)					0	.94	2.7	4	n.s.
		1	.06	100	.24					
3&4 - 8th	(N = 719)					0	.94	42.9	4	.001
		1	.06	100	.24					
3&4 - 7th	(N = 486)					0	.90	51.4		.001
		1	.11	100	.32					
3&4 - 7th & 8th	(N = 139)					0	.89	15.1	5	.01
		1	.12	100	.33					

Standardized Discriminant Function Coefficients

Follow-up and Grade:	1 - 8th	2 - 8th	2 - 7th	3&4 - 8th	3&4 - 7th	3&4 - 7th & 8th
T.S. SAT-M	-.82	-.66	.46	.90	-.87	.90
T.S. SAT-V	-	-.38	-	-	-	-.09
Father's Occupational Status	-	-.05	.77	.56	-.33	.08
Father's Education	-.17	.04	-.42	-.23	-.10	.45
Mother's Education	-.23	-.33	-.89	-.04	-.22	-.32

Prediction Results

Follow-up and Grade:	1 - 8th	2 - 8th	2 - 7th	3&4 - 8th	3&4 - 7th	3&4 - 7th & 8th
Percent False Positive	11	28	33	28	24	23
Percent False Negative	19	8	6	8	8	12
Percent Correctly Classified	70	64	61	64	68	65

Except for the first wave of the follow-up, the eigenvalues of the resulting discriminant functions derived from the discriminant analyses performed separately by grade and follow-up wave were low (see Table 29). Among this set the highest eigenvalue equalled .12. In those analyses 11 percent or less of the variance in the decision to accelerate could be accounted for by the resulting discriminant function. Wilks' Lambda was high even before the first discriminating function was removed (see Table 29). It varied between .89 and .94 for the analyses with the low eigenvalues and equalled .82 for the first wave. Even the function with the largest eigenvalue (for the first wave of the follow-up) can account only for 18 percent of the variance.

Classification based on the discriminant function was correct for approximately 60 percent of the students for the analyses with the low eigenvalues (see Table 29). Classification was correct for about 70 percent of the students in the first wave. All these classifications were based on posterior probability.

Clearly, the discriminant function does not improve classification accuracy substantially, since by chance 50 percent would be correctly classified. With regard to classification errors, more false positives than negatives were made (see Table 29). Across all analyses talent search SAT-M score received the largest weight in the discriminant function (see Table 29). The null hypothesis was accepted since only a small percentage of the variance in the decision to become accelerated could be accounted for by the above variables in the discriminant analyses performed on the samples with large N's.

5. When separating the students into three groups according to academic difficulty of the college attended, the following variables can rather accurately discriminate between the groups: talent search SAT, paternal occupational status, parental educational level, number of awards and honors won, and the degree of acceleration (see Table 30). When separating the students into groups by their colleges' status scores, these variables

Table 30

Discriminant Analyses of SMPY Students Classified into Three Groups on the Basis of their Colleges' Intellectualism Score (Bottom 25%, Middle 50%, Top 25%) Performed Separately by Grade and Follow-up Wave[1]

Follow-up Wave and Grade		Discriminant Function	Eigen value	Relative Percentage	Canonical Correlation	Functions Derived	Wilks' Lambda	Chi-Square	df	Sig.
2 - 8th	(N = 419)					0	.92	33.5	16	.01
		1	.05	63	.22	1	.97	12.3	7	n.s.
		2	.03	37	.17					
2 - 7th	(N = 51)					0	.75	13.1	14	n.s.
		1	.25	77	.44	1	.93	3.2	6	n.s.
		2	.07	23	.26					
3&4 - 8th	(N = 719)					0	.82	137.3	14	.001
		1	.20	93	.40	1	.99	10.0	6	n.s.
		2	.01	7	.12					
3&4 - 7th	(N = 486)					0	.78	120.5	14	.001
		1	.24	86	.44	1	.96	18.0	6	.01
		2	.04	14	.19					
3&4 - 7th & 8th	(N = 139)					0	.64	59.6	16	.001
		1	.33	65	.50	1	.85	21.8	7	.01
		2	.18	35	.39					

[1]This analysis could not be performed for the first wave of the follow-up.

Table 30 (continued)

Standardized Discriminant Function Coefficients

Wave and Grade	2 - 8th		2 - 7th		3&4 - 8th		3&4 - 7th		3&4 - 7th & 8th	
Function	1	2	1	2	1	2	1	2	1	2
T.S. SAT-M	-.32	.51	-.43	.19	.63	-.33	.59	.13	.69	-.49
T.S. SAT-V	-.05	-.09	-	-	-	-	-	-	-.02	.47
Father's Occupational Status	-.30	-.84	-.06	.55	-.03	-.35	.31	-.56	.31	-.06
Father's Education	-.58	.41	.02	-1.07	.48	1.2	.02	-.12	.03	.48
Mother's Education	.00	.58	-.32	.26	.15	-.46	.41	.11	.09	.29
No. Academic Awards	-.30	-.47	.42	-.27	.11	-.43	.02	-.31	.21	-.22
No. other Awards	.22	.17	-.64	.04	-.00	.47	-.01	-.42	-.40	-.43
Degree of Acceleration	-.03	.18	.19	.54	-.11	.10	-.19	-.50	.04	.38

Prediction Results

Follow-up Wave and Grade	2 - 8th	2 - 7th	3&4 - 8th	3&4 - 7th	3&4 - 7th & 8th
Percent Correctly Classified	43	45	44	47	54

could not accurately discriminate between the groups (see Table 31). For both of these analyses the groups were formed by separating the students into the bottom 25 percent, the middle 50 percent, and the top 25 percent in terms of their colleges' scores. The analyses were performed separately by grade and follow-up wave. Since college ratings were not available for the students in the first wave of the follow-up, this analysis could not be performed on that sample.

For the first set of analyses between groups separated on the basis of their colleges' intellectualism scores, two discriminant functions were derived (see Table 30). The first function was significant for every analysis except one (the 51 7th-graders in wave 2 of the follow-up). The second function was significant for only two analyses. The amount of variance between the groups accounted for by the first function was approximately 20 percent (see Table 30). For the second function this was between 1 and 15 percent of the remaining variance unaccounted for by the first func-

Table 31

Discriminant Analyses of SMPY Students Classified Into Three Groups on the Basis of Their College's Status Score (Bottom 25%, Middle 50%, Top 25%) Performed Separately by Grade and Follow-up Wave[1]

Follow-up Wave and Grade	Discriminant Function	Eigen Value	Relative Percentage	Canonical Correlation	Functions Derived	Wilks' Lambda	Chi-Square	d.f.	Sig.
2 - 8th					0	.91	40.7	16	.001
(N = 419)	1	.08	83	.28	1	.98	7.1	7	n.s.
	2	.02	17	.13					
2 - 7th					0	.88	5.5	14	n.s.
(N = 51)	1	.08	66	.28	1	.96	1.9	6	n.s.
	2	.04	34	.21					
3 & 4 - 8th					0	.88	91.4	14	.001
(N = 719)	1	.11	85	.32	1	.98	14.3	6	.05
	2	.02	15	.14					
3 & 4 - 7th					0	.83	91.4	14	.001
(N = 486)	1	.16	81	.38	1	.96	18.5	6	.01
	2	.04	19	.19					
3 & 4 - 7th & 8th					0	.83	23.9	16	n.s.
(N = 139)	1	.18	91	.39	1	.98	2.4	7	n.s.
	2	.02	9	.13					

Table 31 (Cont.)

Standardized Discriminant Function Coefficients

Follow-up Wave and Grade	2 - 8th		2 - 7th		3 & 4th - 8th		3 & 4th - 7th		3 & 4th - 7th & 8th	
Function	1	2	1	2	1	2	1	2	1	2
Talent Search SAT-M	-.11	.19	-.08	.13	-.33	.02	-.31	-.48	.33	-.13
Talent Search SAT-V	.15	.15	--	--	--	--	--	--	.18	-.85
Father's Occupational Status	-.37	1.19	-.08	-.36	.24	-.54	-.29	-.22	.09	.11
Father's Education	.98	-.46	.66	-.21	-.83	-.20	-.53	.18	.70	.02
Mother's Education	.22	-.27	.33	.71	-.22	.87	-.21	.32	-.11	.57
No. of Academic Awards	.28	-.21	-.39	.40	-.12	-.09	-.06	-.42	.28	-.06
No. of Other Awards	-.33	.26	.24	.48	-.18	-.02	-.21	.28	-.11	-.14
Degree of Acceleration	.31	.16	-.18	.30	-.01	.56	-.16	.51	.20	.21

	2 - 8th	2 - 7th	3 & 4 - 8th	3 & 4 - 7th	3 & 4 - 7th & 8th
Percent Correctly Classified	41	43	45	46	46

[1]This analysis could not be performed for the first wave of the follow-up.

tion. From the initial Wilks' Lambda it is clear that there existed some discriminating power in the variables being used (see Table 30). The first function accounts for between 63 and 93 percent of that variance.

Classification based on the discriminant function was correct for approximately 45 percent of the students, compared to the 33 percent expected by chance (Table 30). Classification was performed on the basis of posterior probability. Clearly there is a great amount of overlap between groups. They are not clearly separated even though the discrimination was statistically significant.

The first function seems primarily to represent mathematical ability and parental education or occupational status.

When interpreting the above findings it must be kept in mind that there was considerable restriction in range in intellectualism scores. Although there was considerable degree of overlap between the groups, it was accepted that the eigenvalue was significantly different from zero to permit the conclusion that the groups differ on the basis of the linear combination of the variables.

When the same analyses were performed for the students' status scores rather than intellectualism scores, considerably less discriminating power existed in the variables being used (see Table 31). For all analyses except two (the ones with the smallest N's), the first discriminating function was significant. The second discriminating function was significant only for the two analyses on the samples with the largest N (see Table 31). The Wilks' Lambda was relatively high before even the first discriminating function was removed (between .83 and .91). After the first discriminating function is removed, Lambda varies between .96 and .98 for the analyses. Although the second discriminating function was significant in two analyses, it is clearly useless when trying to discriminate between the groups. For the first function between 8 and 15 percent of the variance could be accounted for by the variables.

Classification was correct for approximately 45 percent of the students, compared to the 33 percent figure expected by chance. Thus, there is considerable overlap between the groups. They are not clearly separated even though the discrimination was statistically significant.[14] Therefore, the null hypothesis of no differences between the groups on the population parameters was accepted.

6. Quality of college attended by a student correlated significantly with the student's talent search SAT, paternal occupational status, parental educational level, number of awards and honors won, and degree of acceleration. The above relationship was tested by use of canonical correlation between college intellectualism and status scores and the above variables (see Table 32). The analysis was performed separately by grade and follow-up wave. It could not be performed for the first wave of the fol-

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14) From Table 31 it is apparent that the first discriminating function mainly represents the students' fathers' educational level.

Table 32

Canonical Correlation Analyses Between SMPY Students' College's Intellectualism and Status Scores and Students' Talent Search SAT Scores, Parental Education, Father's Occupational Status, Number of Awards Won in High School, and Degree of Acceleration, Performed Separately by Grade and Follow-up Wave[1]

Follow-up Wave and Grade	Number	Eigen Value	Canonical Correlation	Wilks' Lambda	Chi-Square	d.f.	Sig.
2 - 8th	1	.18	.42	.77	94.4	16	.001
	2	.07	.26	.93	24.1	7	.001
2 - 7th	1	.25	.50	.71	13.3	14	n.s.
	2	.05	.22	.95	2.0	6	n.s.
3 & 4 - 8th	1	.13	.36	.85	108.1	14	.001
	2	.02	.16	.98	16.4	6	.01
3 & 4 - 7th	1	.12	.35	.85	72.7	14	.001
	2	.03	.19	.97	15.6	6	.05
3 & 4 - 7th and 8th	1	.25	.50	.67	49.6	16	.001
	2	.11	.33	.89	14.6	7	.05

Coefficients for Canonical Variables

Second Set

Follow-up Wave and Grade	2 - 8th		2 - 7th	3 & 4 - 8th		3 & 4 - 7th		3 & 4 - 7th & 8th	
Canonical Correlation	1	2	1	1	2	1	2	1	2
Talent Search SAT-M	.29	-.65	.48	.68	-.39	.76	-.09	.79	-.35
Talent Search SAT-V	.25	-.02	—	—	—	—	—	.03	.23
Father's Occupational Status	.11	.05	.47	.00	-.59	.13	-.03	.09	-.41
Father's Education	.66	.52	-.05	.41	1.09	.08	.73	.20	1.20
Mother's Education	.10	-.39	.07	.16	-.01	.38	-.02	.07	-.44
No. of Academic Awards	.14	.43	-.33	.16	.00	.11	.03	-.22	.02
No. of Other Awards	-.08	-.44	.42	-.12	.54	.05	.36	-.34	.14
Degree of Acceleration	.14	.33	-.28	-.08	.20	-.05	.62	.31	.44

Table 32 (Cont.)

First Set

Follow-up Wave and Grade	2 - 8th		2 - 7th	3 & 4 - 8th		3 & 4 - 7th		3 & 4 - 7th & 8th	
College Intellectualism	.69	-1.63	1.44	1.43	-1.24	1.70	-.92	1.16	-.92
College Status	.35	1.74	-.57	-.56	1.81	-.98	1.67	-.24	1.46

[1]This analysis could not be performed for the first wave of the follow-up.

low-up, however.

The first canonical correlation was significant in every analysis except one where the N was small (see Table 32). The first canonical correlation values varied between .35 and .50 in the analyses. The amount of variance in one canonical variate accounted for by the other ranged between 12 and 25 percent (see Table 32). In the first canonical variate talent search SAT-M score receives the largest weight in the second set of variables, while in the first set college intellectualism score receives the largest weight (see Table 32). Thus, the first canonical variate is primarily measuring academic ability.

The second canonical variate is also significant in every analysis except the one with the small N (see Table 32). The second canonical correlation values ranged between .16 and .33 in the analyses. The second set of canonical variates is accounting for the maximum amount of the relationship between the two sets of variables left unaccounted for by the first canonical variates. In the analyses, the amount of remaining variance in one canonical variate that is accounted for by the other ranges between 2 and 11 percent (see Table 32). In the second set of canonical variates, college status scores and the correlated parental occupational and educational levels receive the largest weights (see Table 32). Thus, the second set primarily measures socio-economic status. The null hypothesis was rejected.

4.13 HYPOTHESIS 13

SMPY students felt that their association with SMPY had benefited them educationally, while not detracting from their social and emotional development (see Table 33). Although subsequent to the talent search itself, SMPY had had little contact with most of the students from its talent searches (only through its bulletin-- the ITYB-- for the most part), the students were asked to rate how much SMPY had affected them educationally and how SMPY had affected their social and/or emotional development. Since most felt that SMPY had

Table 33

Follow-up Students' Ratings on Degree of Educational Help Received by SMPY and How SMPY Affected Their Social and/or Emotional Development

	First Wave (202)	Second Wave (531)	Third & Fourth Waves (1263)
Educational Help			
At least some, percent	61	63	60
None, percent	39	36	38
Unfavorable influence, percent	0	1	2
Mean[1,2]	2.9	2.8	2.8
Standard Deviation	0.9	0.8	0.8
Social and/or Emotional Development			
Positively, percent	21	18	21
No influence, percent	79	80	77
Negatively, percent	--	2	3
Mean[3]	--	3.2	3.2
Standard Deviation	--	0.5	0.5

[1]The perceived degree of educational help received from SMPY was coded as follows:

1 = hurt me   2 = none   3 = a little   4 = considerably   5 = much

[2]The distribution of responses was significantly skewed and had a significant amount of kurtosis.

[3]The rated influence of SMPY on students' social and/or emotional development was coded as follows:

1 = much for the worse   2 = negatively   3 = no influence   4 = positively

5 = much for the better

helped them educationally-- a major purpose of SMPY-- and few felt SMPY had negatively affected their social and/or emotional development, the main goal of SMPY can be said to have been fulfilled.

1. Over 60 percent of the students felt that SMPY had helped them educationally at least some. Less than 2 percent felt that SMPY had hurt them (see Table 33). The over all mean was equivalent to SMPY's having helped the students a little. The distribution of responses to this question on the questionnaire was tested for skewness and kurtosis. The analysis was performed separately by follow-up wave. The resulting skewness values ranged between .69 and .96, which are all significant at the $p<.01$ level by a one-tailed test of significance. The kurtosis ranged between 4.3 and 4.6, which were all significantly different from mesokurtosis at the $p<.01$ level. Thus, the students did significantly more often view SMPY as having helped them educationally than the converse. Therefore, the null hypothesis was rejected.

2. The majority of SMPY students (almost 80%) felt that SMPY had not affected their social and/or emotional development (see Table 33). Moreover, less than 3 percent felt that SMPY had negatively affected their social and/or emotional development. The overall mean for this variable equated to no influence on social and/or emotional development. Since no effect was found, it proved unnecessary to test the distribution of responses for significant skewness or kurtosis. The null hypothesis of no influence was accepted.

4.14 HYPOTHESIS 14

When separating the SMPY students into three groups according to their degree of educational acceleration by the time of college entrance, the following variables can not discriminate among the groups: high school SAT, number of awards and honors won, participation in mathematics contests, intellectualism and status scores of their colleges, number of semesters of mathematics taken, and number of science courses taken (see Table

34). The measure of acceleration was the one described extensively in hypothesis 3. It is a measure of age at college entrance, taking the amount of advanced standing credits earned at college entrance into account. The three groups were formed on the basis of the following criteria: (1) no acceleration, (2) some acceleration but less than 1 year, and (3) 1 year or more acceleration. The discriminant analyses yielded two discriminant functions.

Before any functions were removed, the Wilks' Lambda values ranged between .85 and .90. This indicated that not much discriminating power existed in the variables being used. Yet from the chi-square test it becomes apparent that a significant amount of discriminating information exists (see Table 34). The first discriminant function is therefore significant. Its associated canonical correlation values range between .30 and .37 (see Table 34). Thus, the discriminant function can account for about 9 to 14 percent of the variance among the groups. The contributions of the discriminating variables to the function can be seen in the lower half of Table 34. The first function seems primarily to represent mathematical ability.

Table 34

Discriminant Analyses of SMPY Students Classified into Three Groups in Terms of Degree of Acceleration (None, Some, Much) by the Time of College Entrance, Performed Separately by Follow-up Wave

Follow-up Wave	Discriminant Function	Eigen value	Relative Percentage	Canonical Correlation	Functions Derived	Wilks' Lambda	Chi-Square	d.f.	Sig.
1					0	.85	30.5	14	.01
(N = 196)	1	.16	90	.37	1	.98	3.1	6	n.s.
	2	.02	10	.13					
2					0	.89	51.5	18	.001
(N = 437)	1	.10	80	.30	1	.98	10.5	8	n.s.
	2	.02	20	.16					
3 & 4					0	.90	120.3	18	.001
(N = 1106)	1	.10	86	.30	1	.98	17.1	8	.05
	2	.02	14	.12					

Standardized Discriminant Function 1 Coefficients

	First Wave	Second Wave	Third and Fourth Waves
High School SAT-M	.79	.55	.57
High School SAT-V	.00	.21	.21
No. Academic Awards	.10	.14	.10
No. Other Awards	-.27	-.25	-.17
No. Math Contests	-.04	.32	.34
College Intellectualism	--	.64	.52
College Status	--	-.61	-.53
Semesters of Math in High School	-.14	-.28	-.45
No. of Science Courses	-.68	-.40	-.26

Percent Correctly Classified

Follow-up Wave	First	Second	Third and Fourth
	54	49	54

The second discriminating function was significant only for the analysis on the very large sample. Judging from the Wilks' Lambda, there is not much discriminating information left after the discriminating power of the first function was removed. Clearly, the second function was useless and was thus disregarded.

Classification based on the discriminant functions was correct for approximately 50 percent of the students, compared to the 33 percent expected by chance. Hence, there was considerable overlap between the groups. They are not clearly separated even though the discrimination was significant. Classification was performed on the basis of posterior probability.

Because of these results the null hypothesis of no difference between the population parameters corresponding to the sample estimates was accepted.

On a more informal basis the extra-curricular interests and jobs held during high school by the SMPY students were studied. The students were asked to list the number of in-school and out-of-school activities engaged in during grades 8 through 12. They were grouped into 17 categories ranging from number of academic activities to number of religious activities. The mean of the total number of such activities was 23 across all four waves of the follow-up. The total reported numbers ranged from 0 to 91 activities per student. The three most popular categories of extra-curricular interests for both males and females were, in order, reading, social, and performing arts.

The number of jobs held by the students was also ascertained. Across all waves of the follow-up approximately 87 percent of the students reported having had at least one job in grades 8 through 12. The mean number of jobs held was 2.2.

Thus, the SMPY students were actively doing many different things throughout high school. There appeared no evidence that these gifted students had a narrow range of interests.

4.15 SUMMARY

The results of the statistical analyses for Hypotheses One through Fourteen were presented. For Hypothesis One it was demonstrated that SMPY students took significantly more semesters of mathematics than students in general and college-bound seniors do in high school. Approximately one year more of mathematics was taken by SMPY students than by college-bound seniors. In addition, SMPY students were ten times more likely to take calculus in high school than high school students in general. Their achievement in science was almost as outstanding, but significantly less than in mathematics. SMPY students did not take significantly more semesters of science than college-bound students.

For Hypothesis Two it was shown that SMPY students performed significantly better on both aptitude and achievement tests taken during high school than other students. SMPY students reaffirmed their initial academic superiority by scoring on the average 200 points and 170 points better, respectively, on the SAT-M and SAT-V in high school than college-bound seniors. Their mean scores on the College Board Achievement Tests for all such tests were 100 points above the average for college bound seniors. The highest scores were not necessarily in mathematics. On the college-level APP examinations SMPY students scored above the mean for every test, and took these examinations more frequently than students in general.

The analyses presented in Hypothesis Three revealed that SMPY students became significantly more accelerated than students in general in high school. The reported use of accelerative options was higher than the norm.

For Hypothesis Four it was shown that SMPY students won many awards and honors in high school, especially academic ones. Within this high ability group, however, SAT scores from talent search could not predict the number of scholastic awards and honors won.

The analyses utilized to test Hypothesis Five revealed that over 90 percent of SMPY students were attending college before the summer of 1980, typically at academically and socially prestigious universities, and said they were enjoying it. At least half of the SMPY students intended to major in the mathematical sciences, science, or engineering. The academic difficulty of the colleges attended was significantly higher than their social selectivity. Yet both ratings were significantly above the mean.

For Hypothesis Six it was revealed that over 96 percent of the SMPY group wanted to receive at least a bachelor's degree. A doctoral degree was their most frequently named goal. Thus, the group's educational aspirations were high.

The analyses employed to answer Hypothesis Seven revealed that mathematics and science courses were significantly the favorite courses of SMPY students in high school. Both were equally liked and were significantly more strongly preferred by them than by students in general. Since SMPY students also frequently participated in science fairs and mathematics contests, they exhibit strong interests for mathematics and science.

The discriminant analysis and canonical correlation anlyses utilized to test Hypothesis Eight revealed that, although SMPY students show a strong interest for mathematics and science, the degree of mathematical aptitude within this group can not predict the degree of liking for science or mathematics nor whether a student intends to major in the physical, biological, or mathematical sciences in college.

It was established above that a fairly high percentage of SMPY students had utilized at least one of the accelerative options in high school. For Hypothesis 9 it was shown that the students who considered themselves to be somewhat accelerated felt that their acceleration had affected their social and/or emotional development somewhat positively. They also considered that they had made significantly better use of available educational opportunities.

For Hypothesis Ten it was demonstrated that SMPY males performed significantly better than SMPY females on the SAT-M but not the SAT-V in high school. On both SAT-M and SAT-V the males had improved more than the females during high school.

The results of the statistical analyses testing Hypothesis 11 established that significant sex differences in mathematics and science achievement exist during high school among SMPY students. Males took more science and mathematics courses, took more mathematics and science achievement tests or APP examinations, and scored better on these tests than SMPY females. The SMPY females, however, received significantly better grades in their mathematics course-work than SMPY males and slightly more SMPY females were planning to major in the mathematical sciences in college. Few significant differences were found in attitudes toward mathematics and science. The analyses of covariance and the multiple regression analyses revealed a relationship between the sex difference on the SAT-M and the sex differences in achievement.

For Hypothesis 12 it was shown that demonstrated ability in talent search can accurately predict achievement at the beginning of college for those SMPY students who were attending college.

For Hypothesis Thirteen it was found that the influence of SMPY upon the students it had identified was perceived as beneficial. Most felt SMPY had helped educationally, while not detracting from their social and/or emotional development.

The discriminant analyses employed to answer Hypothesis Fourteen revealed that accelerated SMPY students achieved similarly to their non-accelerated counterparts who went to college. The accelerated students did, however, tend to go to more academically difficult institutions.

On a more informal basis than above, the activities participated in by SMPY students was discussed. SMPY students engaged in a wide variety. Reading, social, and performing arts activities were the most popular. Overall, the SMPY students had a wide range of interests.

RESULTS

In conclusion, it appears that the SMPY students have on the whole lived up to their academic promise or potential discovered in the talent search.

CHAPTER 5

CONCLUSIONS AND IMPLICATIONS

Presentation of the conclusions of this work was broken down into five sections. The first section deals with the characteristics of mathematically precocious students (i.e., SMPY students) in high school. More specifically, the findings with respect to aptitude and achievement test scores, course-taking in the sciences and mathematics, interest in and attitudes toward mathematics and science, and the number of awards and honors won are discussed. The second section covers acceleration. In the third section the SMPY students' college attendance and their educational aspirations are discussed. The findings relating to sex differences are presented in the fourth section. Finally, in the fifth section the findings evaluating the effectiveness of SMPY are covered.

5.1 CONCLUSIONS

5.1.1 Hypotheses 1, 2, 4, 7, 8, 11, And 12

A major purpose of this study was to ascertain the degree to which the mathematical talent of students in grades seven and eight related to subsequent course-taking, achievements, interests, and attitudes in high school. The analyses of the data for hypotheses 1, 2, 4, 7, 8, 11, and 12 suggest strong relationships.

The mathematically talented SMPY students took significantly more semesters of mathematics than students in general and college-bound seniors do in high school. Boys took approximately 9.2 semesters, while girls took approximately 8.4. This was significantly different beyond the .001 level. Both boys and girls received mainly A's and B's in their mathematics course work. As a group the SMPY students took one year more of mathematics than college-bound seniors. With respect to calculus, almost 2/3 of the boys took at least one calculus course, compared to 40 percent of the girls. This is ten times the rate at which high school students in general take calculus. Thus, for both boys and girls, respectively, it was concluded that students identified as mathematically gifted in grade seven or eight did have a high level of participation in high school mathematics courses.

SMPY students' course-taking in science was almost as high as in mathematics. Almost all SMPY students reported having taken science in grades 8 through 12. Biology and chemistry courses were the most frequently taken. For the SMPY group, the mean number of semesters of science completed was 7.6; the grades received in those classes were mostly A's and B's. Although the number of courses taken was slightly more than what college-bound students take, the difference was not significant.

When the number of semesters of mathematics and science taken in high school was compared, it was revealed that SMPY students were significantly more likely to take a mathematics course than a science course. It is possible that this difference reflects a greater access to mathematics courses than science courses.

Not only did the students achieve well in science and mathematics courses, they also showed a strong interest in these areas of study. Mathematics and science courses were rated as the favorite courses of SMPY students in high school (64% reported them as their favorite high school course). While they did prefer science and mathematics significantly more than liberal arts courses, they did not prefer mathematics courses over science courses. When the students were asked to rate their liking for biology, chemistry, mathematics, and physics, the students had, on the average, a moderately strong liking for them. Mathematics was most preferred by both males and females.

The students' interest in mathematics and science was further illustrated by the fact that approximately 23 percent of the boys and 12 percent of the girls had participated in at least one mathematics contest.[15] With regard to science fairs, 17 percent of both boys and girls participated in at least one. Finally, over half of the SMPY students intended to major in college in mathematics, science, or engineering, which is a higher number than what is found for college-bound seniors.

SMPY students did perform significantly better on both aptitude and achievement tests taken during high school than other students. By scor-

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15) This variable does not include TV quiz show participation or the SMPY talent search.

ing on the average 200 points and 170 points better on the SAT-M and SAT-V, respectively, in high school than college-bound seniors, SMPY students reaffirmed their initial academic superiority. SMPY boys and girls showed a mean score gain on SAT-M of 155 points and 145 points, respectively, from the time of the talent search until they took them again in high school. On the SAT-V males improved by 159 points and females by 144. Thus, males improved more than females during high school in both their verbal and mathematical abilities. Furthermore, SAT-V scores were lower than SAT-M scores on the 200 to 800 point scale and in percentile ranks by sex both at time of talent search participation and in high school, as would be expected on the basis of regression towards the mean.

The mean scores of the SMPY groups on the College Board achievement tests were found to be above the mean for college-bound students on every test taken by at least 8 percent of the SMPY group. SMPY boys scored on the average 107 points better and the girls 97 points better than college-bound students for all such achievement tests taken. The highest scores were not necessarily in mathematics.

Of the college-level APP examinations taken in high school, SMPY students took significantly more than students in general do. Furthermore, on every single test taken by at least 10 persons, SMPY students scored above the mean, as they had done on the achievement tests. Again, scores on the mathematics examinations were not necessarily the highest.

SMPY students also excelled with respect to academic awards and honors won in high school. More than 50 percent won at least a Letter of Commendation in the National Merit Scholarship Competition (5% won scholarships). In addition, a majority of the students received at least two other awards or honors. The number of academic awards won in high school by this talented group, however, could not be predicted from ability demonstrated in the talent search. It seems likely that all the students in the group had the prerequisite ability needed to win several awards or honors. Motivational factors and local opportunities probably account for the differences within such a highly able group.

In a previous section, it was shown that mathematically talented students show an interest in science and mathematics. This indicates a possible correlational relationship between mathematical aptitude and interest in science and mathematics. Within the mathematically talented SMPY group, however, scores on the SAT-M in grade seven or eight can not predict the degree of liking for mathematics or science nor whether a student intends to major in a physical, biological, or mathematical science in college.

In contrast to the above findings, it was found that SAT scores in talent search can rather accurately predict achievement at the beginning of college. The variables studied to which ability was related were: high school SAT-M score, Math Level 1 achievement test score, high school SAT-V score, academic difficulty of colleges attended, and selectivity of college attended. Relationships between ability on the SAT at talent search and whether or not a student was accelerated and between the social selectivity of college attended were not found. Most SMPY students may have had the minimum ability needed to warrant being accelerated or to make good use of available educationally accelerative options, which differ greatly from one school system to another. The choice of a college was probably influenced by many factors, including family related influences.

In conclusion, it appears that students identified as mathematically gifted in the 7th or 8th grade have a strong interest in mathematics and the related field of science. Their strong interest in mathematics and science was not only exhibited in the number of courses taken in these fields in high school and in intended college majors, but also in the high degree of participation in science fairs and mathematics contests.

Furthermore, the academic ability discovered in the 7th or 8th grade for the SMPY students did continue to develop in high school and remain in the superior range. It was manifested in above-average achievement in high school.

5.1.2 Hypotheses 3, 9, And 14

Several hypotheses (i.e., 3, 9, and 14) were concerned with acceleration. The use of accelerative options was at a high level in this group. Significantly more of the SMPY students were accelerated in school than students in general. The most common form of acceleration was advanced standing in college, which is an index, for the most part, of the number of APP examinations and college courses taken in high school. The students who considered themselves at least somewhat accelerated felt that this acceleration had benefited their social and/or emotional development. The accelerated students also considered that they had made significantly better use of their available educational opportunities than their non-accelerated counterparts.

When the students were separated into three groups according to their degree of acceleration, it was discovered that several variables measuring achievement could not discriminate among them. Thus, accelerated and non-accelerated students achieved similarily in high school in terms of SAT scores, mathematics and science course-taking, number of awards and honors won, and participation in mathematics contests. But they did it in less time. Accelerated students did, however, attend more academically difficult schools and of course, were superior in the taking of APP examinations and college courses in high school, since those two variables were used in classifying the students into groups.

5.1.3 Hypotheses 5 And 6

The educational aspirations and college attendance of mathematically precocious students were studied in hypotheses 5 and 6. More than 90 percent of SMPY students were attending college at academically and socially selective universities and were enjoying it.[16] Furthermore, the educational aspirations of the whole follow-up group were extremely high, significantly higher than students in general. At least 96 percent wanted to receive a bachelor's degree or more. A doctorate was the most popular choice. Thus, the SMPY group greatly valued an education.

5.1.4 Hypotheses 10 And 11

Sex differences as examined in hypotheses 10 and 11 were a major concern in this study. Initially in the talent search a significant sex difference favoring males was found on the SAT-M. In the follow-up group (though not in the talent searches themselves) a significant sex difference favoring females was also found on the SAT-V.

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16) Over half of them were intending to major in mathematics, science, or engineering. This is a high percentage compared to college-bound seniors.

Later in high school, when the SAT was taken again, SMPY males still scored significantly better than SMPY females on the SAT-M, but no significant sex differences were found for the SAT-V. Both on the SAT-M and SAT-V SMPY males improved more in high school than their female counterparts.

Significant sex differences among SMPY students were also found in mathematics and science achievement during high school. Males took more science and mathematics courses, took more mathematics and science achievement tests or APP examinations, and scored higher on the mathematics and science achievement tests than SMPY females. Moreover, SMPY males took their mathematics in an earlier grade, participated in more mathematics contests, and used educationally accelerative options more frequently. More SMPY males than females took calculus in high school and enrolled in mathematics courses during their first semester of college. There appeared to be a relationship between the sex difference on the SAT-M and these differences.

Surprisingly, slightly more females than males were planning to major specifically in the mathematical sciences in college,[17] and SMPY females received better grades in their mathematics courses than SMPY males.

Furthermore, few sex differences were found in attitudes towards mathematics and science. Mathematics was most preferred by both males and females. SMPY males did, however, seem to prefer physics more than SMPY females, and the SMPY females had a slightly greater preference for biology.

5.1.5 Hypothesis Thirteen

It is clear that this group of intellectually able students identified by SMPY were in general quite successful in high school. But how much had SMPY to do with that? In many cases a great deal, it appears. It is difficult, however, to reach and personally help 2000 students. Yet, this group of SMPY students did feel that SMPY had given them some help educationally, while not detracting from their social and/or emotional de-

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17) This result was based on mathematical science majors only. In a previous analysis, it was found that SMPY males intended to major more frequently than SMPY females in the mathematical sciences and engineering. This was due to that more SMPY males than females were planning to major in engineering in college.

velopment.

5.2 LIST OF MAJOR FINDINGS

1. SMPY students reaffirmed their initial academic superiority by scoring almost 200 points higher on the SAT than college-bound seniors.

2. Their academic aptitude manifested itself in superior achievement in high school, as judged by achievement test scores that were on the average 100 points above the mean for college-bound students.

3. SMPY students took approximatly one year more of mathematics than college-bound seniors do. In science course-taking no significant differences were found between SMPY students and college-bound seniors.

4. Strong interests and favorable attitudes were exhibited by the SMPY group towards science and mathematics, as judged from their ratings of these areas, their course-taking, their participation in science fairs and mathematics contests, their ratings of science and mathematics

as their favorite subjects in high school, and by the large percentage of these students intending to major in these fields in college.

5. SMPY students had become significantly more accelerated in school placement during high school than what is the norm for college freshmen. The acceleration had been accomplished by using the accelerative options recommended by SMPY.

6. SMPY students won a high number of awards, especially academic ones. They also participated in a wide range of activities.

7. Over 90 percent of the students were attending college, typically at academically and socially prestigious institutions, and said they were enjoying it. Their educational aspirations were significantly higher than the norm for high school students. A doctoral degree was their most frequently named goal.

8. Sex differences favoring males were found in participation in mathematics and science, performance on the SAT-M, and the

taking of and performance on mathematics and science achievement tests. SMPY females received better grades in their mathematics course-work, while the males took mathematics in a slightly earlier grade and became more accelerated. Few significant differences were found in attitudes toward mathematics and science.

9. A relationship between the sex difference on SAT-M in talent search and sex differences in mathematics and science achievement was established.

10. Acceleration was deemed a viable approach to facilitate the education of gifted children. The accelerated SMPY students felt acceleration had affected them positively. In addition, accelerated SMPY students achieved similarily to their non-accelerated counterparts but in less time. They also tended to attend slighly more academically difficult colleges.

11. Ability in talent search could predict achievement at the beginning of college even in this quite homogeneous group.

12. The influence of SMPY upon these students was perceived as beneficial. It had helped them educationally, while not detracting from their social and emotional development. Furthermore, SMPY had devised an effective way of identifying students who would achieve academically at a superior level in high school.

13. The SAT was shown to be a good predictor of achievement almost five years after the test was taken.

5.3 DISCUSSION AND IMPLICATIONS

5.3.1 Hypotheses One Through Eight

In the "justification for the study" section of chapter one, the need for updating the characteristics of gifted children was discussed. Most of the research describing intellectually gifted children was done in the 1920's by Terman (1925-1959) and Hollingworth (1942). The major focus of this study was to provide a more current view of gifted youth. The longitudinal investigation of SMPY students reveals important information on the development in high school of mathematically talented students. The results from hypotheses one through eight are relevant to this purpose.

As Terman (1925) and Hollingworth (1942) had found for students with high IQ's, as determined by the Stanford Revision of the Binet-Simon Scale, the highly able students, especially mathematically, identified by SMPY were also vastly superior in the mastery of school subjects. The high school course-taking in mathematics and science was studied. It was shown that the SMPY students not only took a considerable number of these courses but they also received excellent grades in them, mainly A's and B's. Their level of achievement, as determined by the College Board Achievement Tests, was vastly superior to students in general by the end of high school. On all the tests studied, SMPY students scored above the mean score for college-bound students. Furthermore, the highest scores they had were not necessarily on the mathematics tests. Thus, SMPY students are not only superior in the mastery of mathematics and science but also in the other areas of the high school curriculum.

Further support for this view was obtained from the performance on the college-level APP examinations. A high percentage of SMPY students took these difficult tests, and they scored better than the mean on every test. This mean is based on performance of the highly able students who take the tests. Thus, it was found that SMPY students took much advanced course-work in high school and did very well on the standardized measures used to determine competency in the subject.

Finally, mathematically talented students did take more semesters of mathematics in high school than semesters of science, although this could be the result of the possibility that there are more mathematics courses available for students to take. Alternatively, SMPY students might be steered towards mathematics because of their aptitude for it.

Terman (1925) found that his high IQ children were not one-sided in their abilities. Even though the SMPY students were specifically identified on the basis of high mathematical reasoning ability, they too were not one-sided. As the results from the achievement tests revealed, their highest scores were not necessarily found on the mathematics examinations. Scores on all the tests were substantially above the mean for college-bound students.

When selecting for highly mathematically talented students, one also tends to select for high verbal talent. The talent search SAT scores revealed that. As would be expected on the basis of regression towards the mean, these student' verbal ability was somewhat lower than their mathematical ability.[18] During high school the SMPY students maintained their superior ability, as the Terman group did through their adult life (Oden, 1968). SMPY students improved on both the SAT-M and SAT-V and scored 200 and 170 points, respectively, better than college-bound seniors. Thus, the score differential stayed with the SMPY students. They remained somewhat more able mathematically than verbally.

Like the subjects in Terman's study, SMPY students won numerous awards, especially academic ones, in high school. Ability within this rather intellectually homogeneous group could not, however, predict the number of academic awards won. Probably, most of the SMPY students had the prerequisite ability needed to win many awards. As a result, motivational factors and availability of

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18) SAT-V scores were lower than SAT-M scores on both the 200 to 800 point score scale and in the percentile ranks by sex.

local opportunities become more important.

Although these students were highly successful academically, they also had a wide variety of extra-curricular interests in high school. The mean number was 23, with reading, social, and performing arts as the most popular. It can thus be concluded that SMPY students did not have a narrow range of interests or were one-sided in their activities. These findings are again similar to those of Terman.

Even though variety was evidenced, a clear preference for scientific and mathematical pursuits was found for these students. A high percentage participated in science fairs and mathematics contests. In addition, mathematics and science were consistently rated as the students' favorite courses in high school. When the students were asked to rate their liking for mathematics, biology, chemistry, and physics, a moderately strong liking was found. Thus, a concomitant of high mathematical aptitude appears to be a high degree of interest in mathematics and science. Within this highly mathematically able group, ability could not, however, predict the degree of interest in science and mathematics and whether a student intended to major in it. Perhaps after a certain threshold of ability, mathematical aptitude no longer relates much to attitudes towards mathematics and science.

SMPY students tended to be somewhat accelerated in their education as compared to students in general. Many had made use of the educationally accelerative options that are available. This aspect will be discussed more extensively in another section. The finding is, however, again consistent with what Terman and Oden (1947) and Hollingworth (1942) found.

Clearly, an education was valued by the SMPY students, as can be judged from the fact that over 90 percent were attending academically and socially selective universities and were enjoying it. Furthermore, their educational aspirations were extremely high. The students' interest for science and mathematics was manifested in their educational goals. Over half of the students were intending to major in mathematics, science, or engineering. The educational achievements of the Terman group were ranked as substantially better than the general population (Oden, 1968). On the basis of their records to date, it seems likely that the SMPY group will also rank substantially better.

It would appear that gifted children of today are quite similar to the ones of over 50 years ago. Both groups revealed superior academic achievements, along with having a wide range of interests. Furthermore, education was highly valued. Such results indicate that intellectually talented students have a need for academic stimulation. Moreover, students who have high aptitudes and the academically oriented values are likely to benefit from it.

The result, however, with the most important impact on educational theory and practice is the demonstration of the predictive validity of the SAT. The SAT can select for highly able students in the seventh grade who are likely to exhibit superior academic achievements in high school. Thus, by utilizing the SAT (for the most part only SAT-M in this study), a group of students can be identified who would greatly benefit from educational facilitation and who are likely to make significant contributions as adults to such fields as science and engineering. SMPY students are truly deserving of educational facilitation.

In chapter two the typical stereotypes associated with gifted children were outlined. For example, a common association with gifted children is that they will "burn out" or "early ripe, early rot" (Stanley, 1974). Clearly, the SMPY students' early ripeness for academic situations did not make them rot early. Instead, their potential that was discovered in the 7th or 8th grade was manifested in a high level of academic achievement in high school. Similar findings were demonstrated by Terman in his Genetic Studies of Genius.

5.3.2 Hypotheses 3, 9, And 14

One of the most unfortunate controversies in the field of education for gifted children is acceleration versus enrichment (George, Cohn, & Stanley, 1979). Much concern has been expressed about the presumed dangers of acceleration, especially with respect to social and/or emotional development (Robinson, 1981). The SMPY students had made use of educationally accelerative options to a high degree. Thus, some of the possible benefits and dangers of acceleration could be tested in hypotheses 3, 9, and 14.

The SMPY students who had considered themselves to be accelerated educationally felt that their acceleration had affected their social and/or emotional development somewhat positively. Only 5 out of 1104 such students felt that acceleration had affected their social and/or emotional development much to the worse, while 203 felt the opposite. Clearly, this leads one to conclude, as Robinson (1981), Daurio (1979), and Keating (1979) did, that until some valid evidence appears regarding the dangers to social and/or emotional development from acceleration, this concern ought to be abandoned.

With regard to acceleration's educational benefits, accelerated SMPY students did feel that they had made better use of their educational opportunities than their non-accelerated counterparts. This was indicative of some perceived degree of benefit of acceleration for their education.

On a more objective basis it was shown that accelerated SMPY students achieved similarily to non-accelerated SMPY students. But of course the accelerated students did that in less time. We can thus conclude that acceleration is beneficial, since it speeds up the process of receiving ones formal education without being detrimental to achievement, and thereby, it increases the time in which most creative contributions are likely to be made (Lehman, 1953).

5.3.3 Hypotheses 10 And 11

Significant sex differences in mathematical reasoning ability have been found in every talent search conducted by SMPY (Benbow & Stanley, 1980b). Hypotheses 10 and 11 were concerned with the question of what happens to this sex difference during high school and how might it relate to mathematics and science achievement. During the high school years the sex difference on SAT-M increased by approximately 10 points (i.e., from approximately a 40 to a 50 point mean difference). At the same time, SMPY boys also improved more verbally than their female counterparts (also by approximately 10 more points). For some unknown reason the abilities of SMPY boys appeared to develop more rapidly or improve more during high school than SMPY females .

Fennema and Sherman (1977) postulated that sex differences in mathematical ability are due to that in high school boys take more semesters of mathematics than girls (i.e., differential course-taking). Since SMPY boys did take more mathematics in high school than SMPY girls, this might possibly be the reason why the boys improved more on the SAT-M in high school. But this hypothesis can not explain why the boys also improved more on the SAT-V, which was a result found to be in contradiction with previous studies.[19] Furthermore, the Fennema and Sherman (1977) hypothesis can not explain why there is a sex difference on the SAT-M and probably can not even account for the increase in the sex difference in high school for the following reasons: 1. the initial sex difference was found in the 7th or 8th grade, before differential course-taking took effect; 2. equal percentages of girls and boys took mathematics in high school up to the twelfth grade, when the SAT's are normally taken in high school; 3. SMPY boys took only about one semester more of mathematics than SMPY girls, which was mostly accounted for by the larger number of SMPY boys than girls taking calculus (calculus items do not appear on the SAT); 4. the best predictor of high school SAT-M score was talent search SAT-M, not the number of semesters of mathematics taken in high school, which accounted for little additional variance in high school SAT-M. Clearly, the Fennema and Sherman (1977) hypothesis does not explain the ability differences found in this popu-

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19) Shaycoft (1967) found that the sex with the initial superior ability improved more in that ability during high school. This group of SMPY females had been better verbally than the boys at talent search participation.

lation, at the very least.

It is of interest to note that the 10 point increase in the sex difference on the SAT-M during high school made the mean difference for the SMPY group equal the mean difference found for college-bound seniors in high school (ATP, 1979).

With regard to mathematics achievement, several significant sex differences favoring males were found during high school. Males took more science and mathematics courses, took more science and mathematics achievement tests or APP examinations, and scored better on them. More SMPY boys than girls also took calculus and then mathematics during their first semester of college and participated in more mathematics contests in high school.

Some of these differences appeared to be related to the sex difference on SAT-M in the talent search. When ability on the SAT-M at talent search was controlled, the significant sex differences in performance on the science achievement tests were no longer significant. For the Math Level 2 achievement test, the sex difference was either no longer significant or greatly reduced. For the Math Level 1 achievement test, talent search SAT-M was the best predictor and sex could not account for much additional variance. With regard to the taking of mathematics and/or science achievement or APP examinations, talent search SAT-M score was the best predictor. Sex accounted for little additional variance. It appears then that the sex difference on SAT-M may later contribute to sex differences in mathematics achievement.

With regard to attitudes towards science and mathematics, few of the expected sex differences were found. This was contrary to Kelly's (1979) findings from an international study of not necessarily gifted individuals. SMPY boys and girls reported that they liked mathematics equally. SMPY boys did, however, seem to prefer physics slightly more than the girls, while the girls seemed to prefer biology slightly more than the boys. Reported attitudes towards mathematics, however, had little relationship with achievement in and aptitude for mathematics. Attitudes toward mathematics at talent search and in high school could not predict the number of semesters of mathematics taken in high school, high school SAT-M score, and score on Math Level 1 achievement test.

Furthermore, sex and mathematical ability could not predict whether a student intended to major in the physical, biological, or mathematical sciences. Also, mathematical ability did not relate to liking for mathematics or science in this restricted in ability group.

Contrary to the conclusions of Fox, Tobin, and Brody (1979), there doesn't appear to be much relationship between attitudes toward mathematics and achievement in mathematics unless the variables measured were not good indicators of attitudes toward mathematics (mathematics liking, importance of mathematics for future job, and having rated mathematics a favorite course in high school). Mathematical reasoning ability seemed to be a better predictor of achievement in mathematics even in this intellectually rather homogeneous group.

This work, therefore, demonstrated that the differential course-taking hypothesis of Fennema and Sherman (1977) is incorrect for this group, and that mathematical reasoning ability is a better predictor of mathematics achievement than sex or attitudes toward mathematics.

Large sex differences were found for the taking of higher level mathematics. Among the SMPY group, almost twice as many boys than girls took calculus in high school. In college fewer females than males took mathematics during their first semester. Actually, the time when less SMPY females than males were taking mathematics began in the twelfth grade. Thus, if one wants to increase the particpation of women in mathematics, this would seem to be the time to utilize some intervention strategies. As Sells (1980) pointed out, women are closed out of certain career options because they do not take enough mathematics.

5.3.4 Hypothesis 12

In the section discussing hypotheses 1 through 8, the value of the SAT in identifying students who would achieve academically at a superior level in high school was demonstrated. The results from hypothesis 12 reaffirm this finding.

Talent search SAT-M score was the best predictor of high school SAT-M reported by the student. It could account for between 23 and 44 percent of the variance in high school SAT-M. This attests to the long-term reliability of the SAT-M.

Similar findings were found for the SAT-V test. Talent search SAT-V was the best predictor of reported high school SAT-V. In the two analyses, the correlation between high school SAT-V and talent search SAT-V was .74 and .56, respectively for the 1973 8th and 7th-graders. It appears that SAT-V scores are more stable than SAT-M scores. But the SAT-V scores suffered less from restriction of range than did the SAT-M scores.

Further evidence for the validity of the SAT was the fact that talent search SAT-M score was the overall best predictor of Math Level 1 achievement test score. It was even better than the number of mathematics courses taken.

Finally, talent search SAT could rather accurately predict the academic difficulty of the college attended by SMPY students and related to the quality of college attended, even though there was a serious restriction of range.

This study has, therefore, demonstrated the predictive validity and long-term reliability of the SAT. Stronger effects would have been found if there had not been so much restriction in range.

5.3.5 Hypothesis 13

Another purpose of this study was to evaluate the effectiveness of the identification, research, and educational facilitation programs of SMPY. It was demonstrated that SMPY had discovered an effective way to screen for students with high academic potential who then later in high school live up to that potential. This was further discussed in the section dealing with hypotheses 1 through 8. Clearly, the first purpose of SMPY, discovering mathematically precocious youth, is effective over a long-term basis.

The second stated purpose of SMPY is description or characterizing the talented youths it finds. This study, along with several others discussed previously, fulfilled that goal.

The third and very important component of SMPY is developing the academic potential of the students it finds. In hypothesis 3 it was shown that a great number of students had made use of the accelerative options as recommended by SMPY and were quite successful. Furthermore, the group had become significantly more accelerated than students in general or even students who attend college. Thus, SMPY's approach to counseling the students it identified was effective. The students did find out about various acceleraive approaches to advance their education.

Direct and personal educational facilitation, however, was provided to only the very ablest of the students identified by SMPY, through such approaches as fast-paced mathematics classes. In a separate study but utilizing the data provided by this work, the students in the first fast-paced mathematics classes were followed up and their progress evaluated. The students in these fast-paced classes achieved substantially better in high school than their comparison group (Benbow, Perkins, & Stanley, 1981). It appears then that SMPY's development role is effective. It does result in the students' becoming higher in academic quality.

Moreover, the students themselves did find that SMPY had helped them at least some educationally without detracting from their social and/or emotional development. As a result, we can conclude that SMPY is serving its function.

5.3.6 External Validity

There are some limitations in the generalizability of this study, especially with respect to the part concerning sex differences. What was found for this intellectually gifted sample who had volunteered for a search for youths who reason extremely well mathematically might not relate to sex differences in the general population. Because SMPY students (the subjects) were identified on the basis of high mathematical aptitude, their characteristics might not be generalizable to all gifted students. Mathematically talented students probably differ in certain aspects from verbally talented students or students identified on the basis of high IQ's.

Although there are limitations in generalizability of the results for the predictive validity and reliability of the SAT, stronger effects probably would be seen for the general population, since the range of ability would not be as restricted. Stronger effects of ability on the sex difference in mathematics achievement also might be seen for the general population.

Clearly, acceleration is a viable way to facilitate the education of mathematically talented students. This also might be true for gifted students at large, but the data of this study do not bear directly on that.

5.4 RECOMMENDATIONS

Emanating from the findings of this study are several recommendations for current educational practice and for directions for future research. These suggestions are presented separately below under the two sections of research and current practice.

5.4.1 Research

1. Further longitudinal follow-up of the SMPY students is needed at their various life stages to determine their characteristics. The resulting data could be used to evaluate each component of this study further.

2. Replication of this study for verbally gifted students and students with overall high ability would be desirable.

3. Educational facilitation was mainly accomplished through accelerative options. The effectiveness of these options was

assessed. Similar evaluation of enrichment procedures is needed.

4. Relationships between ability and interests need to be further studied in a sample that is not restricted in range in both measures.

5. The relationship between the sex difference on the SAT-M and subsequent achievement in mathematics and science needs to be studied for a sample of the general population.

6. The relationship between attitudes towards mathematics and sex differences in mathematical aptitude and achievement needs to be further investigated in view of the fact that no relationship was found in this study.

7. Research is needed to study girls and boys before the 7th grade to try to determine why there is a sex difference in mathematical aptitude.

8. Further research should be promoted to determine why the abilities of boys seem to improve more than the girls' in high school. E.g., are the boys merely pro-

ceeding at a faster rate, such as 1.5 versus 1.4 for girls?

9. The relationship of specific mental abilities to achievement ought to be investigated.

10. It needs to be determined which students are likely to benefit from acceleration and/or educational facilitation.

11. The creative achievements of this group should be investigated.

12. Parental occupational and educational level related somewhat to achievement in this group. These variables need to be studied further to determine their effects on achievement in high school among this rather homogeneous group.

13. The lack of a relationship between number of siblings in a family and sibling position of the student and various measures of achievement should to be investigated further. Perhaps among gifted populations, at least, these variables are not important influences on achievement.

14. Personality and motivational factors need to be studied to reveal their influence on academic achievement.

15. The achievement of this group in other areas besides science and mathematics should be more closely investigated.

16. Appropriate strategies for facilitating the educational progress of the intellectually gifted youths need to be further researched.

17. The benefits and liabilities of educational facilitation of the gifted ought to be further established.

5.4.2 Current Practice

1. The idea that differential course-taking causes the sex difference in mathematical reasoning ability ought to be abandoned.

2. Effective intervention strategies for mathematically gifted females, starting before the twelfth grade, should be developed, so that these girls continue to take mathematics then.

3. When studying sex differences in achievement in science and mathematics, the sex difference in mathematical aptitude must be taken into consideration as a possible determinant of the sex difference.

4. More use of accelerative options in providing for the gifted, educationally, should be implemented, since no harmful effects were and have been found.

5. The SAT is effective at selecting for students who will achieve at a high level in high school.

6. Some attention (i.e., through newsletters) given to the education of the gifted appears to result in above average achievement, while more focused and personal attention produces dramatically higher achievement.

7. Mathematically talented students are highly interested in the fields of science and mathematics.

8. Mathematically talented students also value educational and academic pursuits. Clearly, they are good prospects for educational facilitation.

5.5 SUMMARY

Discussion, implications, and suggestions for further research were presented for Hypotheses One through Fourteen. It was revealed that SMPY students did achieve academically at a superior level in high school, were similar to the Terman group, had become accelerated in school placement by use of the options recommended by SMPY, valued educational and scientific endeavors, and felt that SMPY had been of some help to them. Sex differences in mathematical ability and achievement were also noted. Furthermore, sex differences in achievement in high school could be accounted for by the difference in mathematical ability in the talent search.

Acceleration was deemed a viable alternative for educating gifted children. In addition, the predictive validity and long-term reliability of the Scholastic Aptitude Test were determined to be high. Its use was shown to be an effective way of identifying students in the 7th grade who will achieve academically at a superior level in high school.

Finally, the Study of Mathematically Precocious Youth was evaluated. It was shown that it had helped educationally the students it identified, while not detracting from their social and/or emotional development. SMPY was seen as fulfilling its stated purpose: discovery, description, and development of youths who reason exceptionally well mathematically.

Further longitudinal follow-up was deemed necessary to further test the main components of this study. In addition, replicating this work for students who are verbally gifted or have overall high general ability would seem desirable. Fortunately, the last two (seventh and eighth) talent searches conducted by Johns Hopkins permit verbally or generally talented youths, as well as mathematically talented ones, to take all three parts of the SAT: verbal, mathematical, and knowledge of the mechanics of written English. The 9040 cases in January of 1980 and the 15,000 in January of 1981 (sex ratio, 1:1) already provide a huge pool of varied talent to study for the next 50 years or so.

APPENDIX A

TALENT SEARCH QUESTIONNAIRE

Questionnaire for Maryland Mathematics Talent Search

This is your ticket of admission to the testing. Please fill all of it out carefully and be sure to bring it with you to the test center. See page 4 for test site information.

PRINT NAME: ____

Last First Middle

1. Name of school that you attend ______________________ Grade _____

Name of County ______________ Public ___ Private ___ Parochial ___ (Check one.)

2. Full address of school ______________________________________

3. Your home address ____ (Including zip code)

4. Home phone number (including area code) ______________________

5. Date of birth __________ Month __________ Day __________ Year

6. How many older brothers do you have? ___ Their birthdates __________

How many older sisters do you have? ___ Their birthdates __________

How many younger brothers do you have? ___ Their birthdates __________

How many younger sisters do you have? ___ Their birthdates __________

7. Is your father alive? ___ Yes ___ No

His full name ____

a. Check the highest educational level he completed:

Less than high school ___ High school graduate ___

Some college ___ College graduate ___ More than college ___

b. College(s) attended, if any, location, and degrees received (both undergraduate and advanced, and date of receipt) ______________________

____

c. His occupation (or if he is deceased, his main occupation when alive). Please be quite specific. ____________________________________

____

8. Is your mother alive? ___ Yes ___ No

Her full name ____

a. Check the highest educational level she completed:

Less than high school ___ High school graduate ___

Some college ___ College graduate ___ More than college ___

b. College(s) attended, if any, location, and degrees received (both undergraduate and advanced, and date of receipt) ______________________

____

c. Her occupation (or if she is deceased, her main occupation when alive). Please be quite specific ______________________________

____

Former occupations other than homemaker ______________________

____

9. Any comments you care to make to clarify question Nos. 7 or 8: ________

____

10. What mathematics courses are you taking this year?

___ General 7th grade ___ General 8th grade ___ Algebra I ___ Algebra II

___ Geometry ___ Other: Specify ______________________

11. Circle the words which best describe each of the following:

a. Your liking for school

Very strong   Fairly strong   Slight liking   Positive dislike

b. Your liking for arithmetic and mathematics

Very strong   Fairly strong   Slight liking   Positive dislike

12. Check the one statement which best describes how well you are doing in your mathematics class this year.

a. ___ Better than all of your classmates

b. ___ Better than all but one or two other classmates

c. ___ About as well as most of your classmates

d. ___ Less well than the majority of your classmates

13. This school year, how are you learning most of your arithmetic and mathematics? Check only one.

a. ___ In regular classwork with other students

b. ___ In school, but working on your own with some help or direction from your teacher

c. ___ On your own outside of school, helped by a tutor or parent

d. ___ On your own outside of school with little help from anyone

14. If you are working on your own in arithmetic or mathematics, rank the main types of work you are doing (1 = highest rank):

a. ___ Working with a textbook mostly on your own

b. ___ Working with a textbook aided by someone

c. ___ Working on math puzzles in books or magazines

d. ___ Working on assignments made by your teacher other than just extra problems in the class arithmetic book

15. Please list the three specific occupations that, at the present time, appeal to you most for your life work. List them in order of preference, 1 being the most preferred one.

1. ____________________

2. ____________________

3. ____________________

16. How important do you think math will be for the job you will someday have? (Circle one.)

Very Fairly Slightly Not at all

17. If you have been considering college, which ones have you thought about applying for?

1. __________ 3. __________

2. __________ 4. __________

18. What is your main reason for wanting to participate in the Mathematics Talent Search? ____________________

____

____

19. Where did you find out about the Mathematics Talent Search? Check all that apply:

___ parent ___ guidance counselor

___ math teacher ___ friend

___ library poster ___ newspaper

___ radio or TV ___ letter from Math Talent Search

___ Other: Specify ____________________

20. From whom did you receive the most encouragement to enter the Mathematics Talent Search? ____________________

____

21. Comments of any sort: ____________________

____

____

____

Maryland Mathematics Talent Search

Room Registration Form

PRINT NAME: ______________________________

Test Site to which you are assigned:

- ___ Frostburg State College (January 19)
- ___ Johns Hopkins University (January 26)
- ___ Salisbury State College (January 26)
- ___ University of Maryland-College Park (January 26)

You are assigned to the following building and room. Study the enclosed map and locate the building (circled in red) to which you have been assigned.

____

Please arrive on time! Plan to reach the test center not later than 12:30 p.m. on January 26 if you are being tested at Johns Hopkins University, University of Maryland at College Park, or Salisbury State, or at 12:30 p.m. on January 19 if you are being tested at Frostburg State College. We ask you to arrive early so you can locate the building and be in your seat by 12:45 p.m. The test is timed and therefore all students in a room must start at the same time. The test will start promptly at 1:00 p.m. There will be signs in the parking lots and on the campus to help you locate your assigned building. The test should be over at 3:00 p.m.

Parents are welcome to stay at the test site during the tests but will not be allowed in the testing room. Parking space will be available and is shown on your map. Lounging space will be available for parents from 12:30 p.m. until 3:00 p.m. at the various test sites. The building is circled on the map and the room is indicated as well. Further information will be given concerning this on the various test days.

APPENDIX B

FOLLOW-UP QUESTIONNAIRE

The Johns Hopkins University - Baltimore, MD 21218 **1979/1980**
Study of Mathematically Precocious Youth (SMPY)

Follow-up survey of SMPY students who are of High School graduate age

Please fill out **ALL** of this questionnaire carefully and completely. Please print or type all answers. For any questions that do not apply, write N/A; if your answer is "None" write None. Please send it as soon as possible in the enclosed envelope to **SMPY,** The Johns Hopkins University, Baltimore, Maryland 21218. All information will be kept **STRICTLY CONFIDENTIAL**; you will not be publicly identified with the information herein in any way. If you have any questions, please feel free to call (301) 338-7086.

I. GENERAL INFORMATION

A. PRINT your full name: ______________________
Last First Middle Maiden (if applicable)

Print your parents' names: Father: ______________________
Last First Middle

Mother: ______________________
Last First Middle Maiden

Your home address: ______________________
Street No. Street

______________________ County: ______________
City State Zip Code

Your telephone no: ( ) -
Area Code 7-digit number

B. Your mailing address, if different from your home address:

____

IMPORTANT

C. Please print the name and address of a relatively young but stably located adult, not living in your home, who would know your address in case you move. We need this information in order to keep in touch with you in the coming years if you move.

Name: ______________________ ( )
Last First Middle Relationship

Address: ______________________
Street No. Street

______________________ ( )
City State Zip Code Tel. No. with Area Code

IMPORTANT

D. Your sex (circle): F M

Your marital status:
- ☐ Single
- ☐ Married
- ☐ Divorced

Your birthdate: ______________
Month/day/year

Today's date: ______________
Month/day/year

Spouse's name: ______________
Given name Former Surname

E. Social Security No.: ☐☐☐ ☐☐ ☐☐☐☐

F. Driver's license number: ______________ State: ______________

G. Which, if any, grade(s) have you skipped? ______________

H. When did you enter kindergarten? ______________
Month/Year

I. When did you enter the first grade? ______________
Month/Year

Go to the next page.

II. GRADES 8 THROUGH 12

A. List all the schools below the college level that you have attended from September of 1974 onward, in order of attendance, with dates of attendance. Indicate with a checkmark (✔) each of the schools from which you were graduated and the dates of your graduation.

School	City, State	Years during which you attended	Gradu-ated?	Year of Graduation

B. Indicate all of the math courses you took in grades 8 through 12. When possible, list the final (overall) grade (e.g., A,B,C,D, or F) you received for the subject, as well as the school grade you were in when you took the course. Also list how long you were in the course (e.g., half year, whole year) and any special comments about the course (such as, no grade received). If you took a college course in lieu of a high school course, list it under "D. College courses while in high school," which is on the next page. (If more room is needed, continue on separate sheet.)

Subject	Final course grade	School grade	Length of course	Special comments
1. Algebra I				
2. Algebra II				
3. Plane geometry				
4. College algebra				
5. Trigonometry				
6. Analytic geometry				
7. Calculus I (Differential)				
8. Calculus II (Integral)				
9. Probability				
10. Statistics				
11. Computer Science				
12. Other (specify)				

13. Unified Math Curriculum (please describe under "Comments" on last page of questionnaire) ☐ yes

C. Indicate all of the science courses you took in grades 8 through 12. When possible, list the final (overall) grade (e.g., A,B,C,D, or F) you received for the subject, as well as the school grade you were in when you took the course. Also list how long you were in the course (e.g., half year, whole year) and any special comments about the course (such as, no grade received). If you took a college course in lieu of a high school course, list it under "D. College courses while in high school," which is on the next page. (If more space is needed, continue on separate sheet.)

Subject	Final course grade	School grade	Length of course	Special comments
1. General science				
2. Biology				
3. Chemistry				
4. Physics				
5. Advanced biology				
6. Advanced chemistry				
7. Advanced physics				
8. Other (specify)				

Go to the next page.

D. List all the courses you took **for credit** at a college **before** becoming a **full-time** college student, as well as the name of the institution, the year you took the course, the grade you were in at the time, the final (overall) grade you received in the course, and the number of credits.

Title of college course	College	Year	School grade	Course grade	Number of credits

E. List in the appropriate spaces below the exact name **and level** (such as, Calculus AB or BC, or Physics C Mechanics) of all Advanced Placement Program (APP) **examinations** you have taken. (Omit those subjects for which you took APP courses but did not take the APP exams.) Show the year(s) you took the exam(s) and the school grade(s) you were in at the time.

Name of APP exam	Score on APP exam	Year exam taken	School grade at the time

F. List your scores on the following standardized examinations, as well as the month and year you took the exam and the grade you were in at that time. If you took the exam more than once, list each score in order of when taken. If you took the exam but cannot locate the scores, so indicate.

Exam	Math	Verbal	TSWE*	Date (Mo./year)	School grade
Scholastic Aptitude Test (SAT)					
Preliminary Scholastic Aptitude Test (PSAT)					

*Test of Standard Written English

	Subject and level	Score	Date (Mo./year)	School grade
College Board Achievement Tests				

	Subject and level	Score	Date (Mo./year)	School grade
College-level Examination Program (CLEP) Test				

	Mathematics	Verbal	Natural Science	Social Science	Total	Date (Mo./year)	School grade
American College Testing Program (ACT)							

Go to the next page.

G. What were your favorite subjects in grades 9 through 12? (Let 1 mean "most preferred.")

1. ______________ 2. ______________ 3. ______________

H. Check the **one** of the five rating-scale categories below that most appropriately describes your attitude toward **each** subject listed. Then in the column entitled "Ranking" rank your preference (1=most preferred, 2=next, 3=next, and 4=least. Please rank all 4 and use **no** ties in ranking.)

Subject	Strong liking	Moderate liking	Neutral or mixed feelings	Slight dislike	Strong dislike	Ranking
Biology						
Chemistry						
Mathematics						
Physics						

I. Have you considered a career in any of the areas listed in item H? ☐ Yes ☐ No

If yes, which one(s)? ______________

Why? ______________

J. List all of the science fair projects you submitted to science fairs in your school, state, region, or nation. Please indicate the title of the project, science area (e.g., biology, chemistry, physics), year, the school grade you were in at the time, and any prizes you received.

Science fair project title	Level	Area in science	Year	School grade	Prize

K. List all of the national, regional, or state mathematics contests in which you have competed. Please indicate which contest, your score, and awards you received.

Contest	Year	Score	Award(s)

L. Did you take the PSAT? ☐ Yes ☐ No

Did you receive a National Merit Letter of Commendation? ☐ Yes ☐ No

Were you a National Merit Scholarship semi-finalist? ☐ Yes ☐ No

Were you a National Merit Scholarship finalist? ☐ Yes ☐ No

Did you receive a National Merit Scholarship? ☐ Yes ☐ No

M. List (next to the appropriate categories) all honors or awards you won while in grades 8 through 12. Under the column entitled "Total number" indicate the total number of awards and/or honors you won for each category.

Type of Award	Total number	Name(s) of award(s)	How won	Year	School grade
National scholastic					
Regional scholastic					
School scholastic					
Artistic (music, theatre, art)					
Athletic					
Community, service, religious or political					

Go to the next page.

N. List (next to the appropriate categories) the fairly important in-school activities in which you participated during grades 8 through 12. Under the column entitled "Total number of years" indicate in the appropriate box the total number of school years you participated in each type of activity in this time period. Then name the activities and next to each one list each school grade during which you participated in it.

Type of activity	Total number of years	Activities	School grades
Academic			
Leadership			
Membership (non-academic clubs, committees)			
Performing arts			
Sports			
Technical (stage crew, photography, etc.)			
Writing			

O. List (next to the appropriate categories) your hobbies and out-of-school activities (including summer activities) in which you participated from the summer following your seventh grade through the summer following your twelfth grade. Under the column entitled "Total number of years" indicate in the appropriate box the total number of calendar years you participated in each type of activity. Then name the activities and next to each one list the years during which you participated in it.

Type of activity	Total number of years	Activities	Year(s)
Academic			
Arts & crafts			
Collections (coins, stamps, etc.)			
Community service/ volunteer			
Performing arts			
Political			
Reading & spectator activities (watching sports, listening to music, etc.)			
Religious			
Social hobbies (cards, dating, etc.)			
Technological hobbies			

P. How many different types of summer or part-time jobs did you have during grades 8 through 12? ☐
List your three most recent jobs, along with the employer(s) and dates of employment.

Type of job	Employer (firm)	Dates (from/till)

Go to the next page.

III. HIGHER EDUCATION

A. When did you become a **full-time** student or trainee beyond high school? ____________________
Month/year

At which school or program? ____________________
Name of school or program

____________________ ____________________
City State

B. Did you enter any college, university, or other school or training program **full-time** earlier than your agemates? ☐ Yes ☐ No

If yes, after which grade? ☐

C. Did you enter with advanced standing? That is, had you earned any applicable credits before entering the post-secondary institution? ☐ Yes ☐ No

If yes, what was the total number of semester, or quarter, hours of advanced-standing credits of all sorts you received?

Semester hour ☐ Quarter hour ☐

D. What college, university, or other school or training program are you now attending? (If none, so state.)

____
Name of school or program

What is your mailing address at this school or program? ____________________
Street no. & street

____________________ ( ) -
City State Zip Code Tel. no. (including area code)

E. List **all** of the colleges and universities and/or other schools or programs to which you submitted a complete application for admission.

College, school or program	accepted	waiting list	rejected
	☐	☐	☐
	☐	☐	☐
	☐	☐	☐
	☐	☐	☐
	☐	☐	☐
	☐	☐	☐
	☐	☐	☐

F. List **all** scholarships or fellowships you were awarded, and for each one list the amount and the sponsor of the award.

Description	Amount	Sponsor

G. As far as you know now, what is your major field of study likely to be? ____________________

H. List the **titles** of the courses you have taken thus far at college as a full-time student. (If you prefer, enclose a xeroxed copy of the transcript of your college credits.)

____

____

____

____

Go to the next page.

I. List (next to the appropriate categories) the program activities in which you are participating now either in school or outside of school, or which you plan to join this school year. Under the column entitled "Total number of activities," indicate in the appropriate box the total number of activities within each category shown.

Type of activity	Total number of activities	Name of activities
Academic	☐	______
Leadership	☐	______
Membership (non-academic clubs or committees)	☐	______
Performing	☐	______
Sports	☐	______
Technical (e.g., stagecrew)	☐	______
Writing	☐	______
Religion	☐	______

J. How well do you like college? (Check **one.**)

- ☐ Strong liking
- ☐ Moderate liking
- ☐ Neutral/mixed feelings
- ☐ Moderate dislike
- ☐ Strong dislike

K. What is the highest level of education you hope to obtain? (Check **one.**)

- ☐ Less than high school
- ☐ High school diploma
- ☐ Less than two years of college
- ☐ Two or more years of college, but not a bachelor's degree
- ☐ R.N. (Registered Nurse, but not a bachelor's degree)
- ☐ Bachelor's degree
- ☐ Master's degree
- ☐ Doctorate (e.g., Ph.D., Ed.D., M.D., D.D.S., LL.B., J.D., D.V.M.)
- ☐ Post-doctoral study

In what field(s) of study? ______

IV. ATTITUDES

A. How well, to date, do you feel that you have used all available educational opportunities? (Check **one.**)

- ☐ Extremely well
- ☐ Rather well
- ☐ About average
- ☐ Rather poorly
- ☐ Extremely poorly

Go to the next page.

B. To what extent do you feel that your association with the Study of Mathematically Precocious Youth (SMPY) has helped you educationally via its talent searches, various mailouts, letters, personal contacts, articles, local and national publicity, and special opportunities? (Check **one**.)

- ☐ Much
- ☐ Considerably
- ☐ A little
- ☐ None
- ☐ It has hurt me educationally.

Please explain your answer: ______________________________

____

C. How does your social and/or emotional development seem to have been influenced by your association with SMPY? (Check **one**.)

- ☐ Much for the better
- ☐ Positively
- ☐ No influence
- ☐ Negatively
- ☐ Much for the worse

Comments: ______________________________

____

D. Have you been accelerated in subject matter placement? ☐ Yes ☐ No

Have you been accelerated in grade placement? ☐ Yes ☐ No

If yes to either of the above, how do you feel your social and/or emotional development has been affected by this acceleration? (Check **one**.)

- ☐ Much for the better
- ☐ Positively
- ☐ No influence
- ☐ Negatively
- ☐ Much for the worse

Comments: ______________________________

____

E. How might SMPY have been of more value to you, especially if its resources had been greater?

____

____

____

____

F. Any other comments you care to make:

G. I hereby certify that I have read over my responses carefully and thoroughly. They are as complete and accurate as I can make them.

____
Signature

APPENDIX C

TALENT SEARCH RESULTS

Sex Differences in Mathematical Ability: Fact or Artifact?

Abstract. *A substantial sex difference in mathematical reasoning ability (score on the mathematics test of the Scholastic Aptitude Test) in favor of boys was found in a study of 9927 intellectually gifted junior high school students. Our data contradict the hypothesis that differential course-taking accounts for observed sex differences in mathematical ability, but support the hypothesis that these differences are somewhat increased by environmental influences.*

Huge sex differences have been reported in mathematical aptitude and achievement (*1*). In junior high school, this sex difference is quite obvious: girls excel in computation, while boys excel on tasks requiring mathematical reasoning ability (*1*). Some investigators believe that differential course-taking gives rise to the apparently inferior mathematical reasoning ability of girls (*2*). One alternative, however, could be that less well-developed mathematical reasoning ability contributes to girls' taking fewer mathematics courses and achieving less than boys.

We now present extensive data collected by the Study of Mathematically Precocious Youth (SMPY) for the past 8 years to examine mathematical aptitude in approximately 10,000 males and females prior to the onset of differential course-taking. These data show that large sex differences in mathematical aptitude are observed in boys and girls with essentially identical formal educational experiences.

Six separate SMPY talent searches were conducted (*3*). In the first three searches, 7th and 8th graders, as well as accelerated 9th and 10th graders, were eligible; for the last three, only 7th graders and accelerated students of 7th grade age were eligible. In addition, in the 1976, 1978, and 1979 searches, the students had also to be in the upper 3 percent in mathematical ability as judged by a standardized achievement test, in 1972 in the upper 5 percent, and in 1973 and 1974 in the upper 2 percent. Thus, both male and female talent-search participants were selected by equal criteria for high mathematical ability before entering. Girls constituted 43 percent of the participants in these searches.

As part of each talent search the students took both parts of the College Board's Scholastic Aptitude Test (SAT)—the mathematics (SAT-M) and the verbal (SAT-V) tests (*4*). The SAT is designed for able juniors and seniors in high school, who are an average of 4 to 5 years older than the students in the talent searches. The mathematical section is particularly designed to measure mathematical reasoning ability (*5*). For this reason, scores on the SAT-M achieved by 7th and 8th graders provided an excellent opportunity to test the Fennema and Sherman differential course-taking hypothesis (*2*), since until then all students had received essentially identical formal instruction in mathematics (*6*). If their hypothesis is correct, little difference in mathematical aptitude should be seen between able boys and girls in our talent searches.

Results from the six talent searches are shown in Table 1. Most students scored high on both the SAT-M and SAT-V. On the SAT-V, the boys and girls performed about equally well (*7*). The overall performance of 7th grade students on SAT-V was at or above the average of a random sample of high school students, whose mean score is 368 (*8*), or at about the 30th percentile of college-bound 12th graders. The 8th graders, regular and accelerated, scored at about the 50th percentile of college-bound seniors. This was a high level of performance.

A large sex difference in mathematical ability in favor of boys was observed in every talent search. The smallest mean difference in the six talent searches was 32 points in 1979 in favor of boys. The atistically significant *t*-tests of mean differences ranged from 2.5 to 11.6 (*9*). Thus, on the average, the boys scored about one-half of the females' standard deviation (S.D.) better than did the girls in each talent search, even though all students had been certified initially to be in the top 2nd, 3rd, or 5th percentiles in mathematical reasoning ability (depending on which search was entered).

One might suspect that the SMPY talent search selected for abler boys than girls. In all comparisons except for two (8th graders in 1972 and 1976), however, the girls performed better on SAT-M relative to female college-bound seniors than the boys did on SAT-M relative to male college-bound seniors. Furthermore, in all searches, the girls were equal verbally to the boys. Thus, even though the talent-search girls were at least as able compared to girls in general as the talent-search boys were compared to boys in general, the boys still averaged considerably higher on SAT-M than the girls did.

Moreover, the greatest disparity between the girls and boys is in the upper ranges of mathematical reasoning ability. Differences between the top-scoring boys and girls have been as large as 190 points (1972 8th graders) and as low as 30 points (1978 and 1979). When one looks further at students who scored above 600 on SAT-M, Table 1 shows a great difference in the percentage of boys and girls. To take the extreme (not including the 1976 8th graders), among the 1972 8th graders, 27.1 percent of the boys scored higher than 600, whereas not one of the girls did. Over all talent searches, boys

Table 1. Performance of students in the Study of Mathematically Precocious Youth in each talent search (N = 9927).

Test date	Grade	Number		SAT-V score* ($\bar{X}$ ± S.D.)		SAT-M scores† $\bar{X}$ ± S.D.		SAT-M scores† Highest score		Percentage scoring above 600 on SAT-M	
		Boys	Girls	Boys	Girls	Boys	Girls	Boys	Girls	Boys	Girls
March 1972	7	90	77			460 ± 104	423 ± 75	740	590	7.8	0
	8+	133	96			528 ± 105	458 ± 88	790	600	27.1	0
January 1973	7	135	88	385 ± 71	374 ± 74	495 ± 85	440 ± 66	800	620	8.1	1.1
	8+	286	158	431 ± 89	442 ± 83	551 ± 85	511 ± 63	800	650	22.7	8.2
January 1974	7	372	222			473 ± 85	440 ± 68	760	630	6.5	1.8
	8+	556	369			540 ± 82	503 ± 72	750	700	21.6	7.9
December 1976	7	495	356	370 ± 73	368 ± 70	455 ± 84	421 ± 64	780	610	5.5	0.6
	8‡	12	10	487 ± 129	390 ± 61	598 ± 126	482 ± 83	750	600	58.3	0
January 1978	7 and 8‡	1549	1249	375 ± 80	372 ± 78	448 ± 87	413 ± 71	790	760	5.3	0.8
January 1979	7 and 8‡	2046	1628	370 ± 76	370 ± 77	436 ± 87	404 ± 77	790	760	3.2	0.9

*Mean score for a random sample of high school juniors and seniors was 368 for males and females (*8*). †Mean for juniors and seniors: males, 416; females, 390 (*8*). ‡These rare 8th graders were accelerated at least 1 year in school grade placement.

outnumbered girls more than 2 to 1 (1817 boys versus 675 girls) in SAT-M scores over 500. In not one of the six talent searches was the top SAT-M score earned by a girl. It is clear that much of the sex difference on SAT-M can be accounted for by a lack of high-scoring girls.

A few highly mathematically able girls have been found, particularly in the latest two talent searches. The latter talent searches, however, were by far the largest, making it more likely that we could identify females of high mathematical ability. Alternatively, even if highly able girls have felt more confident to enter the mathematics talent search in recent years, our general conclusions would not be altered unless all of the girls with the highest ability had stayed away for more than 5 years. We consider that unlikely. In this context, three-fourths as many girls have participated as boys each year; the relative percentages have not varied over the years.

It is notable that we observed sizable sex differences in mathematical reasoning ability in 7th grade students. Until that grade, boys and girls have presumably had essentially the same amount of formal training in mathematics. This assumption is supported by the fact that in the 1976 talent search no substantial sex differences were found in either participation in special mathematics programs or in mathematical learning processes (*6*). Thus, the sex difference in mathematical reasoning ability we found was observed before girls and boys started to differ significantly in the number and types of mathematics courses taken. It is therefore obvious that differential course-taking in mathematics cannot alone explain the sex difference we observed in mathematical reasoning ability, although other environmental explanations have not been ruled out.

The sex difference in favor of boys found at the time of the talent search was sustained and even increased through the high school years. In a follow-up survey of talent-search participants who had graduated from high school in 1977 (*10*), the 40-point mean difference on SAT-M in favor of boys at the time of that group's talent search had increased to a 50-point mean difference at the time of high school graduation. This subsequent increase is consistent with the hypothesis that differential course-taking can affect mathematical ability (*2*). The increase was rather small, however. Our data also show a sex difference in the number of mathematics courses taken in favor of boys but not a large one. The difference stemmed mainly from the fact that approximately 35 percent fewer girls than boys took calculus in high school (*10*). An equal proportion of girls and boys took mathematics in the 11th grade (83 percent), however, which is actually the last grade completed before taking the SAT in high school. It, therefore, cannot be argued that these boys received substantially more formal practice in mathematics and therefore scored better. Instead, it is more likely that mathematical reasoning ability influences subsequent differential course-taking in mathematics. There were also no significant sex differences in the grades earned in the various mathematics courses (*10*).

A possible criticism of our results is that only selected mathematically able, highly motivated students were tested. Are the SMPY results indicative of the general population? Lowering qualifications for the talent search did not result in more high-scoring individuals (except in 1972, which was a small and not widely known search), suggesting that the same results in the high range would be observed even if a broader population were tested. In addition, most of the concern about the lack of participation of females in mathematics expressed by Ernest (*11*) and others has been about intellectually able girls, rather than those of average or below average intellectual ability.

To what extent do girls with high mathematical reasoning ability opt out of the SMPY talent searches? More boys than girls (57 percent versus 43 percent) enter the talent search each year. For this to change our conclusions, however, it would be necessary to postulate that the most highly talented girls were the least likely to enter each search. On both empirical and logical grounds this seems improbable.

It is hard to dissect out the influences of societal expectations and attitudes on mathematical reasoning ability. For example, rated liking of mathematics and rated importance of mathematics in future careers had no substantial relationship with SAT-M scores (*6*). Our results suggest that these environmental influences are more significant for achievement in mathematics than for mathematical aptitude.

We favor the hypothesis that sex differences in achievement in and attitude toward mathematics result from superior male mathematical ability, which may in turn be related to greater male ability in spatial tasks (*12*). This male superiority is probably an expression of a combination of both endogenous and exogenous variables. We recognize, however, that our data are consistent with numerous alternative hypotheses. Nonetheless, the hypothesis of differential course-taking was not supported. It also seems likely that putting one's faith in boy-versus-girl socialization processes as the only permissible explanation of the sex difference in mathematics is premature.

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2. For example, E. Fennema and J. Sherman, *Am. Educ. Res. J.* 14, 51 (1977).
3. W. George and C. Solano, in *Intellectual Talent: Research and Development*, D. Keating, Ed. (Johns Hopkins Univ. Press, Baltimore, 1976), p. 55.
4. The SAT-V was not administered in 1972 and 1974, and the Test of Standard Written English was required in 1978 and 1979.
5. W. Angoff, Ed., *The College Board Admissions Testing Program* (College Entrance Examination Board, Princeton, N.J., 1971), p. 15.
6. C. Benbow and J. Stanley, manuscript in preparation.
7. This was not true for the accelerated 8th graders in 1976. The N for the latter comparison is only 22.
8. College Entrance Examination Board, *Guide to the Admissions Testing Service* (Educational Testing Service, Princeton, N.J., 1978), p. 15.
9. The t-tests and P values for 7th and 8th graders, respectively, in the six talent searches were 2.6, $P < .01$; 5.3, $P < .001$; 5.1, $P < .001$; 5.2, $P < .001$; 4.9, $P < .001$; 7.1, $P < .001$; 6.6, $P < .001$; 2.5, $P < .05$; 11.6, $P < .001$; and 11.5, $P < .001$.
10. C. Benbow and J. Stanley, in preparation.
11. J. Ernest, *Am. Math. Mon.* 83, 595 (1976).
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