Education in the Fast Lane: Methodological Problems of Evaluating Its Effects

Julian C. Stanley
Study of Mathematically Precocious Youth (SMPY)
Department of Psychology
The Johns Hopkins University
3505 N. Charles St.
Baltimore, MD 21218

I am pleased to be speaking to this distinguished audience. As a former testing specialist and educational research methodologist not closely identified with current developments in evaluation, I claim affiliation on only a few bases, such as the following: In 1963 Don Campbell and I published an article relevant to the field that, as a book in 1966, has been used widely; Dan Stufflebeam studied experimental design in a summer experimental design institute I conducted at the University of Wisconsin in 1965; Bob Stake and I were the academic sires of Gene Glass, Bob at the undergraduate level and I (along with Chet Harris and Henry Kaiser) at the graduate level; in his doctoral dissertation Bob Boruch extended and improved some technical work I had published in *Psychometrika* in 1961; Scarvia Anderson was my second research assistant while she worked for a master's degree; Peter Rossi and I were colleagues at Johns Hopkins for a while; and, of course, I am privileged to be associated with the numerous fine researchers in the Johns Hopkins Center for Social Organization of Schools, represented at this conference by Joyce Epstein, John Hollifield, Jim McPartland, and others. Also, Bob Ingle is an old friend from my years in Wisconsin, as is Hank Levin more recently.

AUTHOR'S NOTE: I thank Camilla P. Benbow, Lola L. Minor, Barbara S.K. Stanley, and Paula M. Zak for editorial assistance, and Joyce L. Epstein for suggesting the main title of this paper.

Though I have little direct expertise in your discipline, because of my work since 1971 with youths who reason extremely well mathematically I face no dearth of evaluation problems. In his longitudinal, one-cohort gifted-child research that began in 1921, the late Lewis M. Terman of Stanford University had plenty of trouble convincing armies of doubting Thomases that his high-IQ subjects were as successful and free of emotional problems as they seemed to be. His was meant to be purely a study of the intelligent human animal in its native habitat, without intervention on their behalf.[1] Our Study of Mathematically Precocious Youth (SMPY), which began 50 years later, was intended from the start to exert powerful academically accelerative forces on intellectually talented young students to help them pursue their educations far faster and better than is usually permitted in the regular classroom. Of course, the word "better" plunged us into the area of value judgments right away.

SMPY'S RATIONALE AND CONCERNS

The SMPY model is simple (see Stanley, 1977). It involves four Ds: Discovery of youths who reason extremely well mathematically, Description (i.e., futher study of their various cognitive and affective characteristics), Development (i.e., helping the boys and girls educationally and, to some extent, otherwise), and Dissemination of SMPY's findings so that the first three Ds may be repeated elsewhere. Our beginning was largely fortuitous, in that a stage of my professional career happened to coincide with the ready availability of substantial grants from the newly formed Spencer Foundation in Chicago. If both it and I had not been ready in 1971, 100,000 mathematically and/or verbally talented youths, most of them 12 or 13 years old, would not have been discovered, described, and developed in ways we pioneered. Might they have been as well off in the short term, middle term, and long term? Helped educationally but hurt to some extent socially and emotionally? Produced more scholarly papers but had less easy laughter? Lost their childhood in return for educational and professional gains? Distanced greatly from their relatives and old friends?

From the beginning we puzzled over and worried about such possibilities. It seemed clear to us that educational acceleration was likely to make the accelerant qualitatively somewhat or even greatly different from what he or she would have been without the identification and educational intervention. No simple worse-to-better continuum would accommodate the changes. The happiness dimension did not serve us well, either. Who is happier, the relaxed small-town lawyer handling mainly divorces and wills and having plenty of spare time, or his exceedingly busy former high-school chum, now a university professor, whom the lawyer envies for his writing and national publicity? Probably in some respects one is happier than the other, and vice versa.

Conceptually simpler than questions about ultimate life satisfaction was evaluation of the early result of special programs. We favored this, anyway, because the participants in even our earliest talent search were less than 15 years old in 1972, and therefore would by less than 43 years old in the year 2000. To anticipate the long-range effects, we studied the lives of a number of older prodigies, such as Norbert Wiener (bachelor's degree at age 14), Merrill Kenneth Wolf (Ph.D degree in chemistry from MIT at age 20), Charles Louis Fefferman (full professor of mathematics at the University of Chicago at age 22), John von Neumann (famous applied mathematician), John Stuart Mill, and of course relative failures such as William James Sidis, Evariste Galois, and Thomas Chatterton. Catharine Cox's *The Early Mental Traits of Three Hundred* [historical] *Geniuses* (1926) proved quite helpful, as did Harold Schonberg's *The Lives of the Great Composers* (1970), Ronald Clark's *Einstein* (1971), Harriet Zuckerman's *Scientific Elite* (1977), Harvey Lehman's *Age and Achievement* (1953), Wiener's *Ex-prodigy* (1953), Kathleen Montour's "William James Sidis, the Broken Twig" (1977), and many others.

YOUNG COLLEGE GRADUATES

To supplement the published sources, we commissioned a number of longitudinal follow-ups of well-publicized prodigies of yesteryear. Also, Camilla Benbow and I determined who were the youngest known graduates of Johns Hopkins in its 106-year history and how successful they have been thus far (Stanley & Benbow, in press). Interpreting these data raises a critical issue that should permeate the professional and semiprofessional literature about educational acceleration (e.g., see Daurio, 1979). Unitl our efforts began in September of 1971, only 12 persons were known to have received their bachelor's degree from Johns

Hopkins before the age 19 during the 95-year period. From 1973 through 1982, at ten commencements, another 20 did so. Three of these were graduated younger than any of the original 12, the youngest being 15 years 7 months old at the time his baccalaureate in physics was awarded. Eighteen of the 20 had been associated with SMPY, and the other two were probably influenced, at least indirectly, by us. The success rate among the 32 was astounding. Thus far there have been no failures.

The issue is as follows: How different are the professional and personal prospects of youths accelerated greatly educationally more or less on their own, versus those of youths encouraged to move ahead fast and helped to do so? This is a special case of the "natural experiment" versus the variable systematically manipulated experimentally (Stanley, 1973). We see the contrast in many guises but do not always recognize the difference. For example, even if students currently in private schools tend to succeed somewhat better than students in public schools matched with them for ability and background, what implications would that finding in the natural "volunteering" situation have for the academic performance of students choosing private schools because of voucher plans or tuition tax credits?

Or why do programs specifically designed to help smokers quit seem far less successful than the private efforts of numerous smokers? Stanley Schachter (1982) attacked this problem ingeniously. Coming for help seems counterindicative of ability to quit smoking or lose weight. To some extent the same may be true of consulting a psychiatrist versus working on one's personal problems more privately. On simply cannot assume that the volunteering and nonvolunteering populations are equivalent.

For the young graduates, conflicting plausible alternative hypotheses readily suggest themselves. Those who graduated early without systematic assistance and encouragement such as SMPY provided may have had better academic motivation, greater scholarship, and more "fire in the belly" for achievement than the aided young graduates. Conversely, their acceleration might have been largely adventitious, very likely without planned smooth transition from high school to college or powerful allies along the way. Some, like Mills, Sidis, and Wiener, were probably driven or strongly encouraged by their parents. Others roared ahead mainly in terms of their own motivation and whatever help or obstruction their schools happened to provide. For most cases, probably a mixture of parental encouragement and personal drive, plus almost chance opportunities, culminated in the early graduation. Zuckerman's concept of cumulative educational advantage helps us understand the most successful of these 12 graduates of 1887 through 1953: Be unusually talented intellectually, have facilitative parents with great expectations for their child, live in educationally stimulating homes and neighborhoods, attend schools whose curricula are flexible enough for the person's intellectual and personal needs, find excellent academic and professional role models, attend a highly selective college, and so on.

FAST-PACED ACADEMIC SUMMER PROGRAMS

The problem, of course, is that most intellectually brilliant youths lack some of the ingredients needed for cumulative educational advantage. Most do not have nearly enough contact with their true intellectual peers or with appropriately stimulating mentors. SMPY has tried hard to fill the educational and social stimulation gaps, perhaps most effectively via special, fast-paced residential academic programs during summers conducted by the Johns Hopkins Center for the Advancement of Academically Talented Youth (CTY). In these, some 250 11-15-year-olds who reason better mathematically and/or verbally than 199 out of 200 of their agemates associate with each other intensively for three or six weeks. Like a shot of adrenalin, this has powerful effects, but they may be largely temporary unless effective articulation with home and school is maintained.

The "volunteering" bias of students in the summer programs is huge. Only about one or two percent of the participants in Johns Hopkins's annual talent search enroll, even though all such participants are of upper three percent ability. Surely one would hesitate to use the the startlingly successful experience we have had to set up *compulsory* programs for intellectually brilliant young students, even though results thus far encourage wide extension of this type of program to volunteering students elsewhere. Cost may be a greater deterrent to enrollment than parental unwillingness or students' lack of interest, but driving an unwilling youth to the program may prove counter productive. Academic demands are great, and it is the student rather than his or her parents who must do the work and make the social adjustments. Nevertheless, some students who came reluctantly the first time have chosen enthusiastically to attend subsequent sesssions. Predicting human behavior is no simple task!

WHY NOT A CONTROLLED EXPERIMENT?

Evaluating the results of specific programs was not easy, especially because at the beginning we had decided not to have an indigenous control group. Experimentation is a strong force in psychology and in my own backround, so we were tempted to set SMPY up as a rigorously controlled experiment. Upon reflection, however, we came to believe that there were cogent reasons for not doing so. These are set forth in my long chapter entitled "Rationale of SMPY During Its First Five Years of Promoting Educational Acceleration" (Stanley, 1977, pp. 87-89), which appeared in SMPY's *The Gifted and the Creative*. They seem as applicable today as when first formulated systematically some seven years ago:

1. We were rather sure that the smorgasbord of accelerative educational opportunities we planned to offer the "experimental" subjects in the study were much more likely to help than to harm them. Therefore, it would be inadvisable to withhold such opportunities from a portion of the subjects (probably half of them) who in a controlled experiment would be assigned randomly to a "control" group.

2. There were not likely to be enough extremely high scorers to make the numbers in both the experimental and the control group sufficiently large to yield statistically powerful or precise comparisons between groups and subgroups. It seemed more sensible to take the N ablest subjects and mass the experimental efforts on them.

3. The procedures, principles, and techniques that SMPY planned to develop would be disseminated widely by the press and in speeches, letters, articles books, and newsletters, so withholding knowledge of opportunities from a control group of subjects would be impossible. The control group would be substantially exposed to influences designed only for the experimental group, and that type of contamination would greatly weaken or even nullify the experiment.

4. By not having a control group from which certain presumably beneficial opportunities and information were withheld, it is possible to keep the study completely on an above-board basis, with no need to deceive anyone about

anything. This openness is important in gaining the confidence of the students, their parents and teachers, and the general public.

5. Certain comparisons could be made by matching and other quasi-experimental procedures. Fox (1976a) did this in her study of sex differences in mathematical aptitude and achievement, as have other SMPY researchers in trying to determine how well a certain special procedure worked. . . . Experimentation with humans in important, relevant "field" situations is seldom as easy or neat as experimentation under laboratory conditions can be. Often, however, it yields more important, albeit perhaps somewhat equivocal, information.

6. A great deal of SMPY's analysis of the results of its programs depends heavily on case-study clinical methods, using all known information about each individual with as much insight as can be mustered on the basis of considerable experience with many mathematically precocious youths.

Though we massed our efforts on the ablest, without assigning any of them randomly to one or more control groups, upon occasion controlled experiments could be set up ad hoc by randomization, or approximations to experiments could be formed by matching or the analysis of covariance. For example, if one wants to try two "treatments" on N able girls, it is straightforward to form a randomized-block design with the girls and then to match N/2 boys with them on antecedent variables relevant to the dependent variable of the experiment. This is nearly what Lynn Fox (1974a) did for her doctoral dissertation.

SMPY'S FIRST FAST-PACED MATHEMATICS CLASS

Many natural comparisons and planned quasi-experimental possibilities exist, too. Our first fast-paced precalculus class (Fox, 1974b) illustrates the natural comparisons and some of their advantages and problems. We formed this class quickly in June of 1972, enrolling mostly 12-year-olds of upper one percent mathematical ability. Of the 19 boys and 12 girls invited, 14 boys and 7 girls accepted. Two of these dropped out quickly, and three others were added in September. One who quit early because he was too young entered the next fast-paced mathematics class and did well. He is included in this analysis.

Those 10 persons not enrolling constituted a strong comparison group, because many of them already had other plans for the summer such as going to camp, rather than failing to enroll due to lack of interest. Most of the enrollees had no such plans. This introduced socioeconomic differences between the two groups, apparently favoring the nonenrollees. The social status of the colleges the two groups attended later were consistent with that inference.

The 24 enrollees were divided into three groups: those 11 who persisted, two hours per week, from June 1972 until June or August 1973, completing most or all of the entire precalculus sequence from introductory algebra through analytic geometry in 100-120 hours; the 7 who had dropped out of the class by the end of the summer of 1972; and those 6 who continued during the academic year but in a slower class because they could not maintain the pace of the faster one.

This four-group partitioning has made various comparisons possible over a nine-year period. Of course, they must be interpreted with the limitations of the group firmly in mind. Scholastic Aptitude Test differences in high school were not large. Many comparisons were made and reported in a paper scheduled to appear in an SMPY symposium volume edited by Camilla P. Benbow and me that is now under production by Johns Hopkins University Press. The strongest findings were that seven of the 8 males of the top 11 students from the "fast" section of the class attended Johns Hopkins and that 10 of the 11 were graduated from college one to five years early. Only one other student, a male from the "slow" class, enrolled at Johns Hopkins. He was graduated two years early, and so was a female from that group who attended a private college. As of the survey two years ago, one male from the dropout group had not enrolled in any college, and one female from the "slow" group and one male from the "did not enroll" group had dropped out of state universities. Thus, it seems probable that at least 31 out of the 34 invitees have a bachelor's degree or more by now. We shall survey again soon to bring our records up to date.

POWERFUL EFFECTS

A fundamental principle in experimentation, unknown to some researchers or misunderstood, is that if the effect produced is strong enough, common sense suggests that is hardly likely to have occurred by chance, even though no explicit, internal control group was used. Hit someone hard enough and that person will reel or fall. A control person not hit is unnecessary. In the more formal terminology Don Campbell and I (1966) employ in our little book about experimentation and quasi-experimentation, rival alternative hypotheses that the individual reeled or fell from causes other than the blow are implausible.

In 1959 I observed a powerful experiment for which the experimental subjects' prior medical histories served as the only control observations. Despite casual conduct of the study, which concerned individuals with fungus-infected fingernails, no rational person could fail to be impressed by the findings. The 40 subjects had been afflicted with this unsightly condition for a long time (some of them 25 years or more) and had undergone almost every conceivable treatment to no avail—surgery, X-rays, ugly tinctures, and so on. Yet after four to six months of oral treatment with a then-new antifungal drug call Griseofulvin they each had ten healthy fingernails. In a few more months their toenails were OK, also. Try suggesting to one of those 40 happy patients that their relief was coincidental, unrelated to the Griseofulvin! Only the "inter-ocular traumatic test of statistical significance" was needed: Such dramatic results strike you between the eyes!

When the signal-to-noise ratio is this strong (note the zero within-group variability in that study and hence the virtually infinite statistical power), one need not fear the Campbell and Stanley "one-shot case study," which of course he and I deplore when used for ascertaining small, uncertain effects. The Griseofulvin experiment is atypical of outcomes in medicine, the behavioral sciences, and agriculture, where Ronald Fisher (1925, 1935) originated formal principles of experimental design, but for studying the direct effects of accelerative influences it is probably not a bad model. As with B. F. Skinner's rats, each of which changed behavior in the predicted direction as Skinner altered the reinforcement ratio substantially, we of SMPY expect our presumably powerful educational interventions to have readily descernible effects on most of the persons receiving them.

MORE ABOUT THE FIRST CLASS

After that digression, let's go back to the 11 students who achieved best in SMPY's first fast-paced mathematics class. Like the others, they were local boys and girls. Students in the class came two hours weekly and provided their own transportation. Thus, obviously they were within commuting distance of the Johns Hopkins campus. All 8 boys in that top group wanted to become full-time students at Johns Hopkins while quite young, and 7 of them were permitted to do so. The other, who for special reasons had been in the class though older than the rest of its students, had too poor an academic record in high school. All of the 8 except the youngest, who was only 9 years old when the class began, have graduated from college earlier than the typical age-in-grade progression. The most accelerated earned his bachelor's degree in mathematical sciences in five semesters from Johns Hopkins at barely age 17, his M.B.A. from the University of Chicago at 19, and his Ph.D in social science aspects of finance the month he turned 22. At age 21 he had become an assistant professor in the graduate school of management of a major university. Another male earned a bachelor's and a master's degree in mathematical sciences concurrently in a total of seven semesters at age 20 years 2 months. Three other young men finished the baccalaureate, respectively in mechanics and material sciences, mathematical sciences, and humanities (Phi Beta Kappa), at age 18. Three years later two of them had master's degrees. The third, a 1982 graduate, entered law school. Another, majoring in both electrical engineering and biomedical engineering, finished at 19 and had his master's degree in electrical engineering two years later. The non-Hopkins male took his B.A. in mathematics elsewhere at age 20.

Though perhaps the most potentially brilliant member of the class, the youngest person in it would not study enough in his major field, mathematical sciences, to succeed at Johns Hopkins, so near the end of four years he transferred to an academically much less demanding institution to major in another field. It is anticipated that he will receive the baccalaureate a month after his twentieth birthday.

This accounts for the 8 boys in the top group, all of whom were considerably accelerated and (except for one) majored in quantitative fields. One doctorate has already been earned by them, and at least one other person is currently on the doctoral track. What about the 3 girls, only one of whom attended during the summer of 1973 and thereby completed the full precalculus sequence through analytic geometry? That young lady took a bachelor's degree in architecture from a famed Ivy League university, age-in-grade (less than two months before her twenty-second birthday). Another female received her baccalaureate in

Russian from a major southern state university shortly after her twenty-first birthday—that is, one year accelerated. The third young woman received her B.S. in computer engineering from one of the academically greatest of the Big Ten universities four months after her twenty-first birthday.

Thus the acceleration score for the 11 can be estimated as 10:1. For the six in the "slow" group it was 2:4, making a total of 12:5 for the entire class. By contrast, not one of the 7 persons in the "dropout" group or the 10 in the "not-enrolled" group is at all accelerated educationally, and at least two in the latter group are decelerated a year. Therefore, it appears reasonable to infer that successful participation in the special class fostered radical acceleration in grade placement.

This inference is strengthened by knowing the grade placement and educational progress of the 34 persons before we "discovered" them. Not one had been accelerated at all. The fastest-moving person later, who completed all requirements for a Ph.D while still 21 years old, was actually the oldest-in-grade of the lot when we first encountered him in the fall of 1971, being 11 years 9 months old as he began the sixth grade and by far the ablest youngster in the class. We helped him skip the seventh grade in order to become one of the youngest students in the eighth grade. From there he took off like a rocket, skipping grades 9, 10, and 12 and earning his baccalaureate at Johns Hopkins in five semesters rather than the customary eight. Furthermore, he took mostly advanced courses in a variety of fields. This young man's mother had not attended college. His father, a sales manager, holds a baccalaureate earned at night after he married.

Similar themes can be gleaned from the other accelerants' folders. Of the 12 young college graduates, only two boys have parents (two fathers and a mother) who are physicians, lawyers, or professors. These three parents have M.D. degrees: the son of one of them dropped out of Johns Hopkins. Only one took his or her baccalaureate at a college or university as selective as Johns Hopkins. It seems persuasive that the talent identification and facilitation via the special, fast-paced pre-calculus sequence on Saturday mornings strongly speeded progress toward the baccalaureate at selective universities (only two of the 12, a two-year-accelerated female who majored in religion and a male mathematics major, attended a college). The effect seems much stronger for the 10 males in the class than for the 7 females, perhaps partly because all but two of the males enrolled at Johns Hopkins and in a subject area closely related to their major intellectual talents; the females enrolled elsewhere, most of them in less quantitative areas.

The young men's choice of major fields tended to militate against their going on to graduate school to pursue doctorates. Most were too immediately employable a high salaries. Two, both of whom also participated in the second fast-paced mathematics class, went on to law school.

SUBSEQUENT FAST-PACED INSTRUCTION

Our little Saturday program in 1972-1973 was based on zero prior experience and a pool of talent far less than the 16,000 able youths from the Middle Atlantic Region who participated in Johns Hopkins's January 1982 talent search among seventh graders of upper three percent ability verbally, mathematically, or overall. Many fast-paced mathematics classes later, we have learned to do in three intensive weeks in a residential summer program virtually as much as was accomplished in those 100-120 classroom hours spread over 11 to 13 months. The typical student now learns two new years of mathematics, well beyond the knowledge with which he or she started. Some learn "only" the equivalent of 135-150 classroom hours of introductory algebra during the three weeks, as measured by high standards on a standardized mathematics examination, whereas some proceed through analytic geometry well, and a few into the calculus. With these consistent findings during three residential summer sessions thus far, we do not worry about an explicit control group. As with the Griseofulvin experiment, alternative hypotheses of spontaneous erudition are implausible. Of course, the concomitants and long-term consequences of learning precalculus this fast this way are extremely important, so detailed longitudinal evaluations continue.

Biology

Let me close by telling you about our latest venture with fast-paced instruction. Emboldened by ten years of success with fast-paced mathematics classes under various circumstances, we decided to try helping highly able students, mostly 12-14 years old, learn the full school year of high school biology in three residential summer weeks and also (instead of biology, or in addition to it) high school chemistry. With this in mind, we secured the services of two high school teachers, one of them retired and the other still active. Twenty-five students, six of them female, from all over the country enrolled in biology. One boy was a bit short of his twelfth birthday, and a girl and a boy had already turned 15. The rest were 12-14. None had yet studied a course entitled "biology." Most, however, had already tried the College Board's high school biology achievement examination in a national administration. Also, on the first day of class my wife and I administered to all 25 students another form of that 100-item, 60-minute multiple-choice test. This formed a baseline for the group, the prior testing having already soaked up most of the practice effects. The mean difference between scores on that testing several months earlier and the pretesting was only 20 points on the scale running from 200 to 800.

Most surprising were the scores of these "raw recruits" on the difficult biology examination, which tends to be taken only by a select group of high school students (many of them aspiring to become physicians) who have had at least a year of extensive instruction in biology. The median pretest score was 560, which is the fifty-second percentile of the national norm group. The scores ranged from one 420 (fourteenth percentile) to one 690 (eighty-ninth percentile). Before they had studied biology formally, these students already scored better on this comprehensive examination than most students in most of the best biology classes in the country could do at the end of the school year. At that point it seemed somewhat foolhardy to expect large gains during the three-week class.

Posttest results astounded us. The median leapt from 560 to 727, the ninety-fifth percentile. The lowest scorer improved from 420 to 730 (he had scored only 370 a month before the three-week course began). The lowest score on the posttest was 590, the sixty-first percentile, and the top two scores were 800's, the highest attainable and well above the ninety-ninth percentile. Less than a third of the students scored below 710, the ninety-second percentile.

Responses by the students to a questionnaire confirmed our impression that the instructor, a retired school teacher, had stimulated them magnificently. He is now our mentor-by-mail in biology for 10 of these 25 students. Under his tutelage they are preparing to take the College Board's Advanced Placement Program examination in May 1983 and thereby earn college credit for two semesters of biology.

The other 15 students are encouraged to work with whatever local resources are available to them to prepare for that examination. This is our first experience with mentoring by mail in biology, though we have tried that procedure with considerable success for both pre-calculus and introductory college calculus. Because it seems likely that many of the students in the class could have earned good grades on the APP biology examination at the end of three weeks, we're expecting from these mentees mostly 4s and 5s on the scale where 4 is equivalent to A in two semesters of the subject at an institution such as Johns Hopkins, and 5 is equivalent to A+. We give loving care to the instructional process, but clearly we are also strongly product-oriented.

Chemistry

The three weeks of concentrated instruction worked splendidly in biology. How well did chemistry succeed the following three weeks? Because many intellectually brilliant 12-15-year-olds know little about the symbols for chemical elements, valences, molecular weights, combining principles, and the like, we did not pretest the 13 students (two of whom were female). Several had already taken the College Board's high school chemistry examination, however. Most of these scored below the thirtieth percentile. Posttest scores at the end of the three weeks ranged from 600 (fifty-ninth percentile of the highly able norms group) to two 800s (above the ninety-ninth percentile). The median was 743 (ninety-fourth percentile). Only two students scored below 700 (eighty-seventh percentile). These results were at least as excellent as for biology, even though the chemistry teacher was not viewed by his students as nearly as stimulating as the biology instructor had been rated by his students.

Both Biology and Chemistry

Four of the students took both courses, thereby learning high school biology and high school chemistry well in a total of six consecutive weeks. Their scores were as follows: 790 biology and 780 chemistry for one 14-year-old boy and 740 biology and 800 chemistry for another 14-year-old boy, legally blind but using no visual aids other than his regular eyeglasses; 790 biology and 740 chemistry for the 15-year-old female;

and 720 biology and 700 chemistry for a 14-year-old girl who was also "Miss Personality" in the summer sessions. We were staggered to find that all four persons who double-enrolled could maintain the apparently grueling pace for six weeks with only a Saturday and Sunday break between sessions.

A 20-year-old junior majoring in chemistry at Johns Hopkins is our mentor-by-mail in chemistry, working with four students from the chemistry class and one from the biology class to help prepare them to score high on the APP chemistry examination in May 1983. Many of the other nine students are preparing on their own for the college credit examination.

OTHER CONSIDERATIONS

There is much more I might say about our evaluation attempts and problems, but time will permit only brief mention of several topics. We are greatly concerned about the social, emotional, and academic stresses and strains that early entrance to college may cause, especially on attractive young women aged 16 or less. (The 13-year-old who entered with sophomore standing brought as her apartment housekeeper her former nanny. That seems to have worked out well for more than two school years thus far.) Radical acceleration has been attempted thus far chiefly by males; we do know that for those boys able enough and well enough adjusted initially the results are generally highly favorable. Most of our youths entering at 12-15 years of age have lived at home; we have not yet had much experience with that age group in residence halls, because Johns Hopkins has no special provisions for them.

SMPY and CTY have yet to study systematically the social interactions that occur at the beginning of the three-week residential summer program as large numbers of intellectual stars from all over the country meet their true intellectual peers or superiors. No matter how able the typical student in this group is, he or she will be only average among the summer-session participants. What is it like to be 1 in 200 of one's agemates mentally, but to interact for the first time with some persons one's age who are 1 in 1000 or even 1 in 10,000 or 100,000? Why boast about the 600 or 700 you scored on SAT-M when across the dinner table from you is a 12-year-old from Michigan who earned the top possible score, 800, the first time he took the test, only the second person in SMPY's vast experience to do so?

Closely related to the above is the topic of homesickness, its causes and treatments. Is it more prevalent among only children? Among those who have not been away from home overnight much? Among those who sense that their huge intellectual superiority to their classmates has suddenly disappeared? Will adjustment to highly able associates help these students avoid later the usual academic shock of entering an extremely selective college or university? Which types of youngsters are hurt more than they are helped by being plunged into the academic maelstrom of the concentrated summer program? How may the transition be made better? We need one or more knowledgeable, full-time participant observers on the staff each session to study these matters and formulate variables that help explain behaviors in ways that lead to improvement of the process.

SMPY'S GOALS

For every evaluation problem we half-solve we uncover more problems demanding attention. some progress has been made in SMPY's numerous books and articles this far. Our basic philosophy guarantees that we shall be kept busy for the foreseeable future. It is summed up in the following quotations from three famous writers. They speak, respectively, to discovering intellectually talented youths, giving them high goals toward which aim, and helping them create personal bonds with a great variety of intellectual peers nearly their own age. Thomas Gray wrote:

> Full many a gem of purest ray serene
> The dark unfathomed caves of ocean bear;
> Full many a flower is born to blush unseen,
> And waste its sweetness on the desert air.[2]

This reminds me of a story some of you may already have heard. A man died and went to heaven. He was met at the pearly gates by St. Peter, who greeted him cordially and offered to introduce him to anyone in heaven. The man asked to meet the greatest general who had ever lived. St. Peter immediately summoned an unimpressive looking old man. The new entrant to heaven stared disbelievingly and said to St. Peter, "This man is a fraud. In my own home town he was only a lowly cobbler." "Yes," said St. Peter, "I know that. But if he had been a general, he would have been the best the world has ever known."

It is our responsibility and opportunity to help prevent potential Miltons, Einsteins, and Wieners from coming to the "mute inglorious" ends Gray viewed in that country churchyard long ago. The problem has changed little, but the prospects are much better now. To paraphrase Robert Browning's assertion that "a man's [or a woman's] reach should exceed his [or her] grasp, Or what's a heaven for?"[3] surely we can extend both the reach and the grasp of mathematically precocious youths, or what's an educational system for?

Rudyard Kipling framed the affiliation component splendidly:

Oh, East is East, and West is West,
  and never the twain shall meet,
Till Earth and Sky stand presently
  at God's great Judgment Seat;
But there is neither East nor West,
  Border, nor Breed, nor Birth,
When two strong men stand face to face,
  though they come from the ends of the earth![4]

Consider Kipling's male chauvinistic "two strong men" as "mathematically precocious youths" and one has a summing up of the rationale for SMPY. We believe that mathematical talent transcends sex, circumstance, and nationality and mandates special educational treatment of mathematical prodigies with respect to their area(s) of great talent. For this, accelerative procedures seem crucial. Therein lies the need and opportunity for innovative evaluation. Many of the methodological tools already exist, from, for example, the regression-discontinuty quasi-experimental design Campbell and I (1966) emphasized and Benbow and I are currently using to the most sophisticated new procedures the members of your two organizations have devised. May we all keep employing those tools as effectively as possible on important issues such as educational acceleration.[5]

NOTES

1. The best summary of Terman's "Genetic Studies of Genius" is Oden (1968). Also see Pauline S. Sears (1977) and Robert R. Sears (1977).

2. This is the fourteenth stanza of Grey's "Elegy Written in a Country Churchyard," which first appeared in 1750.

3. From Browning's "Andrea del Sarto."

4. From Kipling's "The Ballad of East and West."

5. Other pertinent references, not cited specifically in this paper, are Heims (1980) and Stanley and Benbow (1981-82, 1982).

REFERENCES

Benbow, C. P., & Stanely, J. C. (Eds.). *Academic precocity: Aspects of its development.* Baltimore, MD: Johns Hopkins University Press, in press.

Campbell, D. T., and Stanley, J. C. *Experimental and quasi-experimental designs for research.* Boston: Houghton Mifflin, 1966. (originally appeared as "Experimental and quasi-experimental designs for research on teaching" in Nathaniel L. Gage (Ed.), *Handbook of research on teaching,* Chicago: Rand McNally, 1963, pp. 171-246.)

Clark, R. W. *Einstein: The life and times.* New York: World, 1971.

Cox, C. M. The early mental traits of three hundred geniuses. In *Genetic studies of genius* (vol. II.) Stanford: Stanford University Press, 1926.

Daurio, S. P. Educational enrichment versus acceleration: A review of the literature. In William C. George, Sanford J. Cohn, & Julian C. Stanley (Eds.), *Educating the gifted: Acceleration and enrichment.* Baltimore, MD: Johns Hopkins University Press, 1979., Pp. 13-63.

Fisher, R. A. *Statistical methods for research workers.* Edinburgh: Oliver and Boyd, 1925.

Fisher, R. A. *The design of experiments.* Edinburgh: Oliver and Boyd, 1935.

Fox, L. H. Facilitating the development of mathematical talent in young women. Unpublished Ph.D. degree dissertation in psychology, Johns Hopkins University, 1974. (a)

Fox, L. H. A mathematics program for fostering precocious development. In Julian C. Stanley, Daniel P. Keating, & Lynn H. Fox (Eds.), *Mathematical talent: Discovery, description, and development.* Baltimore, MD: Johns Hopkins University Press, 1974. Pp. 101-125. (b)

Heims, S. J. *John von Neumann and Norbert Wiener: From mathematics to the technologies of life and death.* Cambridge: MIT Press, 1980.

Lehman, H. C. *Age and achievement.* Princeton: Princeton University Press, 1953.

Montour, K. M. William James Sidis, the broken twig. *American Psychologist* 1977, 32 (4), 265-279.

Oden, M. H. The fulfillment of promise: 40-year follow-up of the Terman gifted group. *Genetic Psychology Monograph,* 1968, 77 (1st half), 3-93.

Schachter, S. Recidivism and self-cure of smoking and obesity. *American Psychologist,* 1982, 37 (4), 436-444.

Schonberg, H. C. *The lives of the great composers.* New York: Norton, 1970.
Sears, R. E. Sources of life satisfaction of the Terman gifted men. American Psychologist, 1977, 32 (2) 119-128.
Sears, P. S., & Barbee, A. H. Career and life satisfaction among Terman's gifted women. In Julian C. Stanley, William C. George, & Cecilia H. Solano (Eds.), *The gifted and the creative: A fifty-year perspective.* Baltimore, MD: Johns Hopkins University Press, 1977. Pp. 28-65.
Stanley, J. C. Analysis of unreplicated three-way classifications, with applications to rater bias and trait independence. *Psychometrika,* 1961, 26, 205-220.
Stanley, J. C. Designing psychological experiments. In Benjamin B. Wolman (Ed.), *Handbook of general psychology.* Engelwood Cliffs, NJ: Prentice-Hall, 1973. Pp. 90-106.
Stanley, J. C. Special fast-mathematics classes taught by college professors to fourth- through twelfth-graders. In Daniel P. Keating (Ed.), *Intellectual talent: Research and development.* Baltimore, MD: Johns Hopkins University Press, 1976. Pp. 132-159.
Stanley, J. C. Rationale of the Study of Mathematically Precocious Youth (SMPY) during its first five years of promoting educational acceleration. In Julian C. Stanley, William C. George, & Cecilia H. Solano (Eds.), *The gifted and the creative: A fifty-year perspective.* Baltimore, MD: Johns Hopkins University Press, 1977. Pp. 75-112.
Stanley, J. C., & Benbow, C. P. Using the SAT to find intellectually talented seventh graders. *College Board Review,* 1981-82, No. 122 (Winter), 2-7, 26-27.
Stanley, J. C., & Benbow, C. P. Educating mathematically precocious youths: Twelve policy recommendations. *Educational Researcher,* 1982, 11 (5), 4-9.
Stanley, J. C. & Benbow, C. P. Extremely young college graduates: Evidence of their success. *College and University,* in press (Summer 1983).
Wiener, N. *Ex-prodigy.* New York: Simon & Schuster, 1953. (Paperbound edition is available from Massachusetts Institute of Technology Press, Cambridge, MA.)
Zuckerman, H. *Scientific elite: Nobel laureates in the United States.* New York: Free Press, 1977.

SETTING AGENDAS FOR A MEETING

—As a rule of thumb, schedule about seven items for a two-hour meeting.
—Begin and end the meeting with the least controversial items.
—Make item 4 the one needing the most time and the one most likely to be controversial.