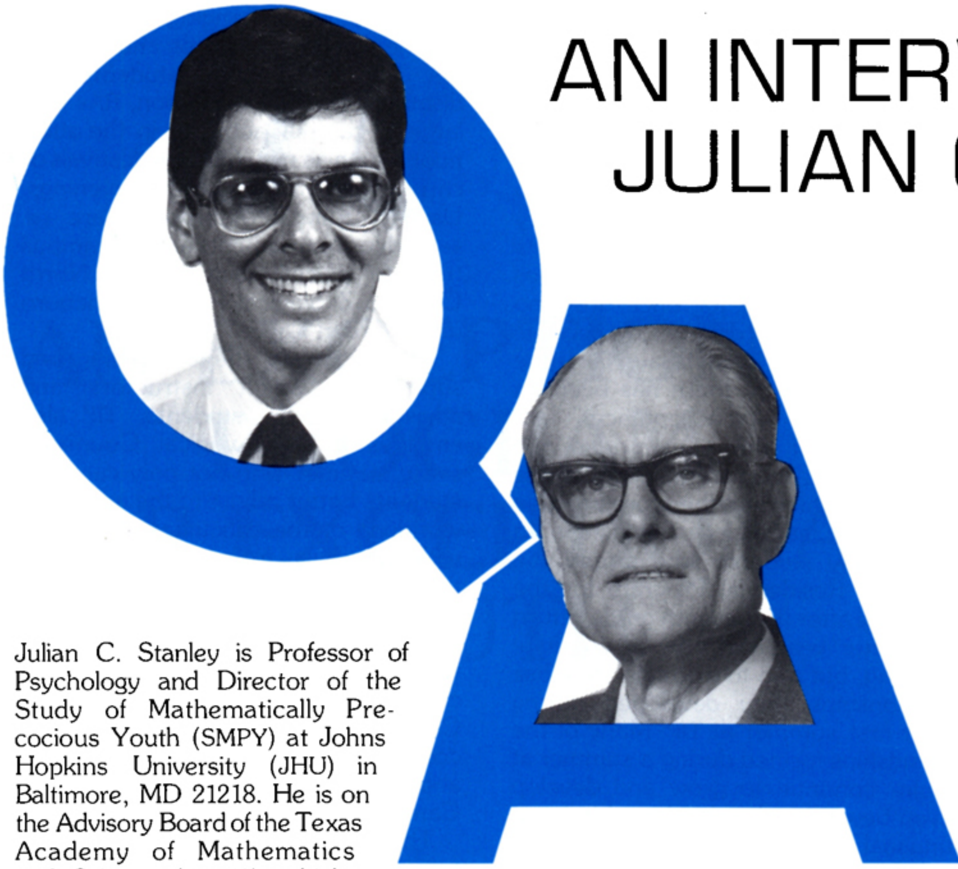
AN INTERVIEW WITH JULIAN C. STANLEY



by Robert J. Kirschenbaum

Julian C. Stanley is Professor of Psychology and Director of the Study of Mathematically Precocious Youth (SMPY) at Johns Hopkins University (JHU) in Baltimore, MD 21218. He is on the Advisory Board of the Texas Academy of Mathematics and Science (TAMS), which is situated at the University of North Texas in Denton, and the Board of Trustees of the Center for Excellence in Education, which conducts the annual Research Science Institute. Dr. Stanley went to Johns Hopkins in 1967 as a specialist in test theory, experimental design, and statistical analysis. His expertise in methodology had led in 1960 to a request from Donald T. Campbell to co-write *Experimental and Quasi-Experimental Designs for Research* (1966), a manual that immediately became a classic guide for researchers in education and psychology. After he became involved with SMPY in 1971, Dr. Stanley quit most of his work in test theory. He has helped produce a series of books on SMPY (e.g., Stanley, Keating, & Fox, 1974; Keating, 1976; Stanley, George, & Solano, 1977; George, Cohn, & Stanley, 1979; Fox, Brody, & Tobin, 1980; and Benbow & Stanley, 1983). Dr. Stanley was interviewed in Boston during the Annual Conference of the American Educational Research Association in April, 1990. Since then, he has updated the original transcript a little.

GCT: How did the Study of Mathematically Precocious Youth start?

JCS: In the summer of 1968, an instructor in computer science at Johns Hopkins University called my attention to a 12-year-old Baltimore boy in the seventh grade who was doing remarkable things on computers. He was helping graduate students use FORTRAN, a computer programming language.

GCT: Why were you contacted about this student?

JCS: Doris Lidtke, who referred the boy, had attended Michigan State University and initially called Dr. Elizabeth Drews, who taught there. Dr. Drews knew me and gave her my name. I couldn't check on the student until January of 1969, and then had him take the Scholastic Aptitude Test (SAT). I had been on the College Board's SAT committee, 1961-1968, and was very familiar with the test. I also knew that Dr. Leta S. Hollingworth, a pioneer in gifted education who worked with students having very high IQ scores, had used out-of-level testing procedures. The tests she used were developed by E.L. Thorndike to screen applicants to the graduate program at Columbia University. I had written some papers in the 50s that supported the use of high-level tests for advanced students.

I gave this computer whiz the SAT and an achievement test with absolutely no time to do even a few practice problems. He made a score of 690 on the math and 590 on the verbal portions of the SAT, so I had him admitted to JHU. First, however, I tried to get his high school to let him take the Advanced Placement courses offered to eleventh and twelfth graders. They thought I was being ridiculous. So, reluctantly, I went to the Dean at JHU and asked if a student I knew could be admitted. He looked at the student's test scores and said that they showed he was well qualified to take college courses.

"Well," I said, "would you admit him if he's only 13 and just finished the eighth grade?"

"Sure," he said, "go down and tell the admissions office to let him in." Things might have been different if not for the fact that JHU has never required students to have a high school diploma in order to be admitted. A student doesn't even need a baccalaureate in order to be admitted to the graduate school.

In 1971 the Spencer Foundation provided funds to start SMPY. We wanted to help intellectually talented youths improve their education, but we needed to specialize because our funds and staff were small. Research on precocity in mathematics demonstrated that it is an area more dependent for its mastery on intellectual ability than life experiences, so we decided to help mathematically precocious youth use their abilities more effectively. The fact that Lynn H. Fox, who helped begin the study, and I had been teachers of high school mathematics encouraged us to make this decision. I also have a Master's from Harvard in eductional and vocational counseling and guidance, which has proved invaluable because there is a large counseling component to SMPY.

Our program started rather small, with only 450 students participating in the first talent search in 1972. Our chief talent search instrument is the mathematical portion of the Scholastic Aptitude Test (SAT-M), although we also use the verbal part (SAT-V). When we tested some very bright 12-year-old students who were referred to us at the beginning, we found that they could score quite well, but none received perfect scores. It appeared that the test had enough "ceiling" so that most students would not be able to get the highest score; only 1 in 10,000 can correctly answer 55 of the 60 problems on the SAT-M correctly. About 1 in 30 of participants in the talent searches can score as high as the average male high school senior, which is a score of 500 on a 200-800 scale.

GCT: Why are students tested at the age of 12 or 13 in the talent searches?

JCS: We wanted to help students who already had basic math skills and were as young as possible. No matter how advanced their ability, students are seldom allowed to take algebra before the eighth or ninth grade. Our initial research revealed that we could find very high scorers on the SAT who were as young as 12. If not allowed to take appropriate coursework, young students with very high math reasoning ability will either daydream in class, harass the teacher and arrogantly show off their knowledge, become overconcerned with getting perfect grades, or get bored and frustrated and perhaps become discipline or truancy problems.

Math reasoning ability seems to pass a critical developmental level at about the same age that Piaget's formal operational stage is supposed to be reached. At that stage, children are able to manipulate two variables at the same time. Below the age of 12, the SAT is too difficult and there are few high scorers, although some students have done very well. A seven-year-old made 670 and an eight-year-old made 760 on the SAT-M, but they are truly rare exceptions.

GCT: Your studies validated the Piagetian formal operational stage as occurring at age 12?

JCS: Dr. Daniel P. Keating, who was the first doctoral recipient in our program, did his dissertation in 1973 on this topic. He gave the Raven Standard Progressive Matrices, a test of nonverbal reasoning ability, to fifth graders and picked out the students who scored at the 98th percentile or above and the students who scored around the 50th percentile. He did the same thing with seventh graders. Then he gave formal operational tasks to all these students and found that the fifth graders scoring at the 98th percentile and most of the seventh graders had reached the formal operational stage. Most of the fifth graders scoring at the 50th percentile had not reached that stage. This result demonstrated that students with very high nonverbal reasoning ability can reach the formal operational stage by age 10, but that most average students reach that stage by age 12.

GCT: Those results imply that efforts to improve the critical thinking ability of gifted students who are much younger than 12 are going to be met with limited success.

JCS: Not necessarily. Keating studied only the status quo. He did not try to improve critical thinking ability.

GCT: How high must a student score to be eligible to take a fast-paced class at JHU?

JCS: Students who score at or above the 97th percentile in at least one major area (mathematical, verbal, or total score) of a nationally normed standardized achievement test battery may enter the annual talent search conducted by the Center for the Advancement of Academically Talented Youth (CTY) at JHU and take the SAT. Students must score at or higher than 500 on the SAT-M, with a combined total of 930 or higher on the math and verbal sections, to take courses in math and the sciences, or a score of 430 or higher on the SAT-V with a score of 35 or better on the Test of Standard Written English (TSWE) to take a verbal course. Fast-paced classes are now provided through the Center of the Advancement of Academically Talented Youth at many sites around the country. CTY also conducts an annual talent search in 19 states and the District of Columbia. Some other programs around the country require slightly different scores to take fast-paced classes. At JHU itself, we offer only fast-paced classes to commuting students in the summertime, but Franklin and Marshall College, Dickinson College, Duke University, Northwestern University, the University of Denver, Iowa State University, and a number of other schools have residential classes on their campuses.

About 14% of the boys and 7% of the girls who participate in the talent search score at or above 500 on the SAT-M. Students who score at least 430 on the SAT-V or 500 on the SAT-M are in the top 1% of all twelve-year-olds in the country in verbal or math reasoning ability. The latter can learn the first year of algebra, which normally takes 135 class hours, in 90 hours or less with expert, individualized instruction in a fast-paced class.

GCT: Why do you use the TSWE?

JCS: The TSWE is part of the SAT testing program. It's a 30-minute 50-item test that provides an assessment of the student's grasp of the mechanics of expression and writing ability. It offers problems in areas like punctuation and subject-verb agreement. The scores on the TSWE go from 20 to 60. It's a short screening test used to make sure that students planning to take one of the 3-week writing courses already have some basic writing skills.

GCT: Is there a difference between students with very high math and verbal SAT scores and students with very high math and medium or low verbal scores?

JCS: Since 1980, SMPY has concentrated on assisting boys and girls who score 700 or higher on the SAT-M before their 13th birthday. Math scores for these students range from 700 to 800, with a mean of 720. Their scores on the SAT-V range from 250 to 780, which corresponds to scores that are 50 points above chance to 20 points below a perfect score. The average SAT-V score for these students is about 520, which is pretty high. The students with moderately high verbal scores (e.g., 600) but extremely high SAT-M scores (700-800) before age 13 tend to have more aptitude in the field of mathematics. They seem to have a stripped-down math-symbolic manipulation ability. Those with high math and extremely high verbal ability tend to do less well in learning algebra through calculus. Perhaps they verbalize math problems too much. Some kind of mental confusion keeps them from being as effective as their low-verbal-scoring counterparts. They are very bright, but their high math scores may be a consequence of high intellectual ability rather than high math aptitude itself. Their high general intelligence allows them to figure out how to do the math without resorting to pure math reasoning that is essentially nonverbal.

I helped a student with 720 math and 750 verbal scores at age 12 participate in a special high-level math program, and he was the worst student they had. Another student had 760 math and 310 verbal scores, with the 310 achieved on the second try after he had received a 300 on his initial attempt; he obtained a score of 32 out of 36 on the Advanced Raven Progressive Matrices, while the first student scored 30, which is still very high. The second student was not nearly as bright overall, but he was better at math-symbolic reasoning. He could read a math formula and use algorithms by doing the operations necessary without verbalizing steps to himself or looking for a logical reason behind the answer.

GCT: Isn't it necessary for students to figure out what kind of answer to expect in a math problem so that they know if the answer they obtain is reasonable?

JCS: Yes, students have to be aware of what kind of answer can be expected, given the circumstances set up by a problem. If a student is working on equations with two unknown variables and has to solve for one, and the answer obtained is much larger than all the other numbers, then he or she has to realize that a computational error may have been made. But algorithms themselves should be applied and solved somewhat mechanically, because certain skills have become automated and essentially "second nature."

I once was asked by a reporter, "What do you think about President Bush's statement that our national achievement level in math should be the best in the world by the year 2000?" It is absurd to believe that we could be the best in the world by then, when in 1990 we're at or near the very bottom. I said that there was hardly any feasible way in the world that we could even reach the average international level by 2000 A.D. The reporter, who was of Vietnamese background but spoke excellent English, wrote that I said we could not be first in the world by 2080! She misheard me ("A.D." sounded to her as "eighty"). Fortunately, that quote was tucked in at the end of a long article. That's an example of careless thinking and unfamiliarity with Christian calendar number symbols. She should have known that neither President Bush nor I would try to predict over a 90-year period.

GCT: Please tell me about the fast-paced classes available to SMPY students at JHU and other locations.

JCS: SMPY's primary intent is to help students move ahead in math at a faster rate and to be better prepared in math and the physical sciences than is possible in most schools, public or private. We started by offering students fast-paced introductory algebra because they already had many of the skills necessary to do problems in that course. We wanted to help them move quickly on to second-year algebra. A fast-paced course is individually paced, which is different from self-pacing. We do diagnostic testing, followed by individually prescribed instruction, which we refer to by the acronym DT—PI. In a fast-paced class, there are about 15-20 students who are working on points they found difficult on the diagnostic test. An instructor and two teaching assistants walk around the room to help the students. These DT—PI "mentors" are usually former math prodigies who are now in college or graduate school.

GCT: You rely on the students' ability to learn well chiefly on their own?

JCS: Yes. They have instructional materials to use that provide an introduction to the different types of problems. For example, one of the hardest problem types for them at first is if AB over CD equals EF over GH, then solve for G. We show the students in detail how to do that type of problem and why it is done that way. We give them a series of examples until they have mastered the principles involved in solving a particular type of problem. Another example: If they don't know that dividing by zero is an impermissible mathematical operation, they can readily learn this.

GCT: I don't mean this as an insult, but it sounds like programming a computer. A computer is told that certain operations are done under certain conditions and that certain operations are impermissible, and this information is forever stored in its memory banks.

JCS: They learn an algorithm quickly and remember it well. The average student learns it but may get confused and forgets it, doesn't apply it correctly, or doesn't learn when to apply it. Much of elementary math is not problem solving as much as choosing to use an algorithm under appropriate circumstances. SMPY students come to us with excellent mathematical and analytical reasoning ability, since they have done so well on SAT-M. When we first started our fast-paced biology class, in 1982 (see Stanley & Stanley, 1986), we used a 100-item College Board achievement test in biology that is pretty tough. The students took the test; then we did an item analysis of their answers to see which problems they tended to get right and which items they tended to miss. We discovered something that's just the opposite of what many gifted child specialists might expect. The students were almost infallible on the reasoning items if only a little knowledge was required. The typical high school senior can't reason very well and therefore tends to get those items wrong. But if the item depended on knowledge of specific facts in biology such as the distinction between RNA and DNA, many of the young SMPY students got it wrong. We realized that we had to make sure the students acquired a lot of well-organized facts in a hurry, but the instructor didn't have to worry about their ability to reason with the facts. We didn't have to help them develop their reasoning ability. When people criticize us for not teaching thinking skills largely divorced from subject matter, we reply that the SMPY students already have excellent thinking skills to refine in the context of a given subject. I think there is misplaced emphasis in gifted-education efforts to develop reasoning skills "in a subject-matter vacuum," rather than developing them in conjunction with course content.

GCT: Much of the emphasis on developing reasoning skills comes from educators working with minority students. For a variety of reasons, Hispanic, native American, and black students tend to be weaker in analytic thinking skills than white and Asian students. Work with gifted and talented students who are weak in analytic thinking has been focused on teaching them to analyze problems so that learned strategies can be applied. When young gifted and talented minority students are taught thinking skills, they improve their test performance.

JCS: Some developmental work done with students to improve their aptitude is well-conceived. We take only those students who already have high quantitative reasoning ability.

GCT: What is the distinction between students who already achieve well in mathematics and students who have great "potential" for learning mathematics and related subjects in the physical sciences?

JCS: SMPY students don't necessarily know a lot of mathematics. They can do well on elementary math material having a strong reasoning component, but a student with a score of 500 on the SAT-M at age 12 will not necessarily do well on an Algebra I test without prior exposure to algebra. The student has the potential to do well, given the proper instruction.

There is an argument in the literature about aptitude and achievement that highlights a false distinction. Some people say there is no real difference between aptitude and achievement. The correlation between aptitude in a particular area and achievement in the same area may be high enough for us to predict who will achieve well if we know the aptitude scores, but we can't predict environmental opportunities to learn. Suppose we have two groups of students matched on initial aptitude. Only one of the two groups takes a chemistry course. There will be a nice correlation between initial aptitude and achievement as measured on the chemistry final exam for those students who take the course. The other group won't show a good correlation because they won't be able to answer most of the questions on the chemistry final. Having great aptitude for learning chemistry doesn't make a student already know chemistry itself.

GCT: What factors contribute to the success of a fast-paced class?

JCS: First, pick students for the class who are highly able and well motivated to do well in the class. Beyond that, it comes down to the instructor's skill in using the curriculum materials without lecturing at the blackboard to everybody in the class. The fast-paced class cannot be treated as a regular class. There have to be incentives for students to move ahead quickly. As soon as they feel ready, students take a standardized test. If they score at the 90th percentile of national norms or higher, they receive credit for the level on which they are working. If, for example, this is Algebra I, they move to Algebra II. They also compete somewhat with each other. If one student thinks another student is moving ahead at a fast rate, he or she may push to catch up.

GCT: A good instructor manages the competition, delivers the material quickly, watches for problem areas . . .

JCS: Not lecturing. S/he's alert and on his or her feet all the time, looking to see who is having difficulty and ready to help. S/he must also prevent the lazy student from becoming dependent on the instructor's help in solving problems. We try to help students become good independent learners. We don't want to hold their hands and show them how to do everything. They need to do most of the work by themselves, learn how to learn.

GCT: Is it possible to have a fast-paced class at the local school level?

JCS: When we describe our fast-paced summer-school format to math teachers in the public schools, it may sound preposterous to them. Students work 6 hours a day, 5 days a week, for 3 weeks on one subject. Most teachers don't believe their students would be willing to do something like that. If they have enough talented students, schools are more willing just to have Algebra I available earlier than normal, perhaps offering it in the seventh grade to a highly selected group. To make it more fast-paced, they can double up the curriculum and have Algebra I and II in one year. After all, the first part of many Algebra II courses is mostly a repetition of Algebra I.

GCT: How do students describe the experience of taking a fast-paced class?

JCS: They are eager to learn more math. They may feel daunted by how able some of the other students are, but they start to feel comfortable pretty quickly. They can get up to go to the bathroom without asking permission and soon realize that there aren't the constraints of a regular class in regular school. Since they live together in a dormitory for 3 weeks in the summer, the atmosphere is almost like camp. In fact, the dormitory counselors have a tendency to make the situation too social, letting students get away with not doing their homework. Sometimes in class the students will stop working and start talking with each other about social things. There must be at least one good manager in the classroom to keep everyone focused on the subject matter most of the time. The main instructor has to manage both the class and the teaching assistants. The usual ratio is one instructor and two teaching assistants to 15-20 students.

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This interview will be continued in the September/October 1992 issue of *The Gifted Child Today.*