

# Insights From SMPY's Greatest Former Child Prodigies: Drs. Terence ("Terry") Tao and Lenhard ("Lenny") Ng Reflect on Their Talent Development

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## ABSTRACT

If the academic needs of the most profoundly gifted students can be met through the use of existing educational practices, specialists in gifted education can assume that the educational needs of less able, but still academically talented, students can also be met by using some combination of these strategies as well. This paper illustrates the feasibility and effectiveness of utilizing an individualized educational approach with gifted students by highlighting the unique educational paths taken by two of the very ablest math prodigies identified by Dr. Julian Stanley through the Study of Mathematically Precocious Youth (SMPY) since its founding in 1971. Interviews with Dr. Terence ("Terry") Tao and Dr. Lenhard ("Lenny") Ng, now both highly successful mathematicians, are presented in their entirety, demonstrating that even among the very ablest, strategies can be tailored effectively to the characteristics of each student through a combination of creative planning and the cooperation of parents, educators, and mentors.

Talent is a precious commodity. It is something that not only merits nurturance but also, indeed, *must* be nurtured if humanity is to transcend its own limitations. One needs only to imagine what the world would be like if brilliant minds such as Einstein's had never developed their talents nor had the opportunity to leave their priceless, paradigm-shifting marks on civilization. Without the innovations of passionate scientists like Marie Curie, the masterpieces of literary and artistic geniuses such as Ernest Hemingway and Leonardo da Vinci, and the vision of great leaders and peace-

## PUTTING THE RESEARCH TO USE

Given the wide-ranging differences in abilities, interests, personalities, life experiences, and culture that are evident among academically talented students, most specialists in gifted education would agree that a one-size-fits-all approach to educating the gifted is antithetical to the fundamental principles underpinning gifted education. As responsive as educators would like to be to the needs of their gifted students, they may be reluctant to individualize the curriculum for these students on the grounds that they lack sufficient resources to provide such a tailored approach. The information gleaned from the interviews with Drs. Terence Tao and Lenhard Ng should reassure primary and secondary school educators that they are not necessarily expected to provide a level of instruction for their gifted students that is beyond their grasp or training. Rather, through endorsing the use of alternative curricular options and resources that are available to academically talented youth, educators can actively assist the talent development of those future "movers and shakers" who have the potential to be extraordinarily productive, successful, and fulfilled in their adult lives. This article demonstrates that a willingness to provide support, flexibility, effective articulation of in-school with out-of-school learning, cooperation, and encouragement to seek special opportunities is arguably the greatest gift that educators can give their academically talented students.

makers like Mahatma Gandhi, not to mention the numerous innovations of other brilliant men and women in their respective fields, humankind would be far less advanced. The quality of life that so many people take for granted can be attributed largely to developed talent.

The development of a student's talent to its full potential is (or should be) the goal of all educators; however, there has been considerable disagreement within the field of gifted education regarding whether the emphasis should be placed on educational acceleration or enrichment as the primary vehicle through which this process occurs (Benbow & Stanley, 1996; Brody, 2004; Daurio, 1979; Schiever & Maker, 2003). While specialists in gifted education in both camps may remain staunchly committed to their own conceptions of how talent blossoms and of how best to facilitate this process, few would claim that there exists a single intervention strategy or curricular formula that works for all students.

Passow (1997) and Gross (2003) pointed out that many practices that might at first glance seem opposed may, in fact, if used in conjunction, provide a more comprehensive and richly textured approach to educating the gifted and talented. Passow suggested that rather than thinking in terms of "acceleration *versus* enrichment" (Daurio, 1979, p. 13), it may be more appropriate to think of acceleration *vis-à-vis* (face to face) with enrichment, noting the relationships between the two procedures rather than seeing them in opposition. Gross (2003) stated that in 19th-century England a *vis-à-vis* was a carriage in which the occupants sat facing each other. Although they were looking in opposite directions, their placement facilitated discussion during the journey.

The advantage of having access to what Stanley called a "smorgasbord" (Benbow, 1979; Stanley, 1991) of accelerative and enrichment options is that even the most remarkably talented individuals can tailor their educational programs to their unique needs and abilities. In theory at least, if even the most profoundly gifted students can find adequate challenges by using some combination of accelerative, enriching, and supplemental options, it seems safe to assume that through similar forms of synthesis the gifted education community can successfully devise educational programs to meet the needs of virtually all academically talented students, whatever their levels of ability. (Logicians call this an *a fortiori* argument.)

To illustrate the effectiveness of utilizing an individualized and flexible approach in educating profoundly gifted students and to identify other factors that are believed to promote not only talent development but also the overall well-being of brilliant students, this paper will present unique interviews with two of the world's most promis-

ing young mathematicians, Dr. Terence (Terry) Tao and Dr. Lenhard (Lenny) Ng. Both of these extraordinarily talented young men were involved in the groundbreaking Study of Mathematically Precocious Youth (SMPY) at Johns Hopkins University. The late Dr. Julian Stanley considered Terry and Lenny perhaps the two ablest math prodigies whom he had ever known, out of more than one million gifted young people tested by the Center for Talented Youth (CTY), although several others came very close. At the time of this article's publication, Terry had just been awarded the prestigious Fields Medal, the math world's equivalent of a Nobel Prize.

### From Sprinter to Marathon Runner: Terry Tao Goes the Distance

At the 2003 World Conference on Gifted Children in Adelaide, South Australia, Dr. Billy Tao spoke eloquently about his son's, Dr. Terry Tao's, remarkable journey from being a noted child prodigy to becoming one of the world's leading young mathematicians. Terry became a full professor of mathematics at a major American university at age 24. According to his father, by age 28, Terry had written or cowritten approximately 100 papers in seven areas of mathematics and had won several major prizes and awards in his field. Through the metaphor of distance running, Dr. Tao described how, from an early age, Terry tackled academic challenges like a sprinter but ultimately evolved into a marathon runner.

An early account by Dr. Miraca Gross (1986), published when Terry was 9 years old, detailed the astonishing development of Terry's academic talent. Like many other gifted children, he taught himself to read by watching *Sesame Street*; in Terry's case, however, this occurred before the age of 2. A few months after his second birthday, his parents found him using a portable typewriter that stood in Dr. Tao's office. He had copied a whole page of a children's book laboriously with one finger. By age 3, Terry had learned to read, write, type, and solve mathematical problems typical of 8-year-olds. Terry enrolled in elementary school at age 3 ½. This particular form of acceleration, however, did not meet his very great academic and intellectual needs. Intellectually, he was far in advance of the 5-year-olds in his class. Socially, however, he was not ready to spend extended periods of time with children 2 years older, and his teacher was uncertain of how to respond to his astonishing abilities. His parents withdrew him from

school after a few weeks and enrolled him in a neighborhood program with children of his own chronological age.

During this period, he attended weekend enrichment activities offered by the Gifted and Talented Children's Association of South Australia (GATCASA). Here, for the first time, he was able to work and socialize with other highly gifted children. Of course, he met no one sharing his own prodigious math ability; thus, even within the accelerated context of GATCASA programs, it was found necessary to accelerate Terry still further. During this period, Billy and Grace Tao investigated a number of local schools, seeking one that would have enough flexibility and open-mindedness to allow Terry to follow a highly individualized educational program. Shortly after his fifth birthday, the usual age for school enrollment in South Australia, he entered a primary school that proved willing to develop such a program. A few weeks after enrolling, he was placed in a split first- and second-grade class where he did most of his work with the second-grade students except for math, which he took with fifth-grade students.

In this school, with facilitative teachers and the ongoing support and guidance of his parents, Terry mastered course material from grades 1–7 in less than 3 years (from age 5 to 7) and was placed in 11th-grade mathematics when he was 7 years old. To accommodate his unique, albeit uneven, abilities in different content areas, Terry simultaneously took courses at various grade levels throughout his education: for example, attending courses at grade levels three, four, six, and seven during his second and final year of primary school. Later, as he rapidly exhausted his high school options in several content areas, Terry enrolled part-time in university courses. Dr. Julian Stanley, whom the Taos visited at Johns Hopkins when Terry was 9 years old, had advised them that, as radically accelerated as Terry was, they should monitor his progress most carefully and give him time to develop his verbal abilities and nurture his social and emotional development. Accordingly, they decided to delay his departure from high school and his matriculation into college as a full-time student.

Although Terry entered college on a part-time basis at the age of 9, at Flinders University in his home city of Adelaide, he did not formally enroll as a full-time student until he was 14. Terry spent a few more years at Flinders, earning his undergraduate degree at age 15, his Class 1 Honours degree at age 16, and his master's degree shortly after turning 17. A seasoned sprinter, Terry earned his Ph.D. in mathematics from Princeton University in 1996, shortly before turning 21. It was not until he reached a critical juncture in his life, during the period in his professional development when he was transitioning in his roles

from being a student to a professional, that he became a marathon runner. As his father explains in the following passage, by establishing a new pace and a new way of running the race, Terry seemed destined to become an eminent mathematician. According to Dr. Billy Tao,

Terry's transition from sprinter to marathon runner occurred when he was a graduate student [at Princeton University], between the age of 17 and 20. . . . The defining moment, I think, was at the "general," a time when Ph.D. candidates, before the completion of their studies, go through an oral exam with their supervisors and some invited professors . . . it was a harrowing experience, probably because it made him realize . . . that his background knowledge was not deep enough. I think that, from then onwards, he became a deep thinker, interested in seeking and then tackling difficult problems, which demanded great patience and perseverance. The progress [Terry made] from point A to point B could no longer be judged by speed, nor even distance covered, because here we are talking about a level of difficulty or profoundness that [could not] be measured horizontally. This surely is a very different landscape from the accelerated educational program Terry had experienced before the transition. (Tao, 2003, n.p.)

In an interview conducted in 2004 by e-mail, Dr. Terry Tao, reflected on his past experiences as a profoundly gifted and radically accelerated student, in addition to his current experiences as a highly celebrated young mathematician. Terry kindly agreed to respond in writing to the authors' questions, not only regarding his academic development, but also about his social and family experiences, which are inextricably related to his attainment of success.

Q: What are your earliest recollections of being more advanced intellectually than other children your age?

A: Well, I skipped grades starting from age 5. (When I was 3, my parents tried to place me at a primary [elementary] school, but after several weeks they pulled me out as I was clearly not ready.) So, pretty much for as long as I can remember I took my classes with people older than I (although we tried to stagger

the classes so that I would have at least one class with people reasonably close to my age).

Q: At a very young age, you received media attention due to your exceptional mathematical ability. As you recall, how did you handle that and how did you internalize that attention? What did your parents do to protect you from being sensationalized?

A: I think I was too young to really be affected by it; I was mostly interviewed as a child, before I had too much of a sense of self-consciousness or ego. I guess, to me, it was just another case of adults asking strange questions. Actually, there weren't that many such media interviews—two or three a year, perhaps—and they really didn't impact any other aspect of my life. I think there just wasn't a good enough story to sustain more interest; I wasn't facing any special difficulties or hardship at school, for instance, because of my grade placement.

Q: As you reflect on your career and personal development, how satisfied are you with your early educational experiences? If you could do it over again, would you accelerate more, the same amount, or less?

A: I'm pretty satisfied; I may not have gotten my life experiences at the same pace or order as most people, but I did end up with a well-rounded education and finally found my peer group in graduate school and beyond. Perhaps the one thing I regret is not taking enough humanities courses in high school and college, though I think at that age I would have been too immature to benefit from them anyway; they were certainly the courses I had the most difficulty with at the time. Unlike science and mathematics, it seems the humanities require some experience with life itself in order to truly appreciate the subject.

Q: What did you, your parents, and teachers do to create optimally challenging learning experiences for you as you were growing up?

A: There were two main things. One was to stagger the grades of the classes I took, so I would take math and science courses several years ahead of my other classes such as English and physical education. This meant also that I would take some classes at the local high school while I was primarily at elementary school, and take some classes at the local university while I was primarily at high school; this required a lot of

coordination and cooperation between my parents, teachers, and administrators at all these institutions! Also, my parents found a number of very good mentors (retired or active math professors, mainly) whom I could visit every weekend or so and talk with on a very informal level (say, over tea and cookies) concerning mathematics. I think that was very important for me, in getting a glimpse of how professional mathematicians view the subject and why they enjoy it (which is quite different from how I perceived mathematics at the high school and college levels, where it felt more like an abstract game).

Q: How did your involvement (and impressive accolades—e.g., International Mathematics Olympiad bronze, silver, and gold medals) in math competitions at very young ages enhance your educational experience and your socialization?

A: They were very enjoyable for me, possibly the first extended social experience I had away from my parents, and the first time I can really remember playing a tourist. The Math Olympiads do a good job of providing a lot of opportunities to socialize and basically have fun. From time to time, I find out that one of my colleagues participated in the Olympiads too, and sometimes even from the same year; this of course gives an opportunity to reminisce. From an educational perspective, the type of fast problem-solving skills one develops in the Olympiads turns out not to be really the skill needed for doing research mathematics—it seems one needs much more to learn a field broadly and develop some “big picture” intuition—but I still find the tricks I learned there to be handy from time to time. After one figures out the biggest obstacles to one's research problem, sometimes a number of “mini-problems” of much narrower scope remain, which are reminiscent of math competition questions (in fact, many such questions are found in this manner).

Q: In what other extracurricular activities did you participate? What importance did they have in your life and development?

A: Actually, as a student in Australia, I think my life pretty much revolved around math, science, and computer games; my parents encouraged me to take up some sports or musical instruments but I never really stuck [with] them for long. In graduate school, I started joining movie clubs, bridge clubs, anime clubs, and the like, but while I did make some very

good and lasting friends that way, I can't say that they otherwise had much influence on my life (other than enjoying myself while I was there).

Q: What were your social relationships like growing up? [Because] you simultaneously interacted with peers who varied in age, where and how did you find your social niche?

A: In primary and high school there were always people around my own age with whom I could play, even if in my math and science classes I would be around people 5 or more years older than I. I also had some neighborhood friends who would come over, and my two brothers of course. I only really started finding my peer group during and after graduate school, though; before then I think I was still primarily focused on mathematical-type pursuits.

Q: How would you describe your relationship with your parents growing up? What strategies did they use to help you remain grounded and develop emotionally and socially? How is your relationship with them today?

A: I think as a child one tends to take one's parents for granted; they did a lot behind the scenes to help my education and social development, but for me it was just part of life growing up to have these strange schedules and classes all the time. They did let me pursue my interests, and they kept my life as normal as possible otherwise. We still keep in touch, of course, especially now that I have a child of my own and can use all the advice I can get, but we live largely independent lives now.

Q: How would you describe your relationship with your brothers growing up? How did your parents help to foster close and healthy relationships between you and each of them? Do you and your brothers have satisfying relationships today?

A: Well, we saw each other every day and were our primary playmates with each other growing up, so we were very close for a long time. At one point, we could even complete each other's sentences. Since we've grown up and moved to different places, we've become much more different, of course, but we still enjoy getting together when we have the chance.

Q: At a rather young age, you were most deservedly awarded a graduate fellowship in mathematics to

attend Princeton University. How was that experience? How did you adjust to being so far away from your family, friends, and home?

A: It did help that I spent some time away from home in previous years in Olympiads and summer schools, though of course I had far more supervision then. My dad came with me for the first few weeks to help me do such mundane activities as set up my first bank account and learn how to do my own laundry. Actually, almost all of the first-year mathematics graduate students stayed in the same college, and we helped each other out quite a bit. I flew back home every summer, and kept in touch by mail (and later, by e-mail), but I think I was kept busy enough with my new life not to get too homesick.

Q: You are an accomplished professor of mathematics at UCLA. Interestingly, many years ago at age 9, you anticipated that you would one day become a professor. Have you consistently held that ambition? If not, what other options did you consider? On a related note, did you consider a variety of options in terms of undergraduate and graduate institutions?

A: I think I had a rather naïve idea of what a career was as a child; actually, I remember dreading the time when I would finally leave school and have "responsibilities" and make my own decisions. Because of this, I remember thinking about taking a job whose description seemed completely understandable and required no responsibility—inventory-taking, for instance (a job I had temporarily at my high school). Of course, by the time I was finishing graduate school, the idea of an academic career had become quite natural to me. My parents chose my local university, Flinders University, because we already knew several of the faculty and it was very close to my high school (we were commuting between the two at the time). My undergraduate adviser strongly urged me to have some overseas experience in graduate school; I decided to go to the U.S. and eventually had the choice between MIT and Princeton. I chose Princeton in large part with the intention of working with Elias Stein (which I eventually did).

Q: Please tell us about the mentor relationships that were most instrumental in your talent development. Why

were they so effective/influential in guiding your development?

A: Before I went to the States, my two most influential mentors were Garth Gaudry (my undergraduate advisor) and Basil Rennie (an emeritus professor, now deceased). They helped me in very different ways; Garth got me interested in harmonic analysis (still one of my primary fields of research), and basically prepared me for the transition from recreational and undergraduate mathematics to professional mathematics. Basil came from a more applied background, and showed me how mathematics was relevant to the real world; he also was a great fan of recreational mathematics (he ran a small, friendly journal devoted to the subject), and kept me reminded that mathematics is not all seriousness and study.

Q: Some theorists in gifted education emphasize the role of chance factors in talent development. Did any chance factors, positive or negative, have an impact on your career?

A: I have felt very lucky in my own life, in finding good people to mentor me and with whom to work, though my parents did work very hard to look for such people, so it's hard to say how much of this is chance and how much of this is diligence on my parents' part.

Q: Now as a faculty member at UCLA, what are you currently working on? What are the most exciting/meaningful aspects of your work?

A: Too many projects to describe here! I tend to be interested in areas of mathematics that connect to many other areas of mathematics or other sciences. My research style is to roam broadly from one piece of interesting mathematics to another, learning as many branches of mathematics as I can, hoping eventually to bring some insight or idea from one field of research to another; I don't seem to have the patience for sticking with one field or problem for years and years. Right now I am interested in nonlinear wave and dispersive equations, and their connections with both geometry and integrable systems; in a geometric combinatorics problem called the Kakeya conjecture; and more recently in number theory, such as the distribution of the primes. But I get the feeling that I will be working on something rather different in, say, 5 years or so.

Q: Obviously, you have passion for math! Can you describe your emotional connection to math? What is the experience like for you when you are engaged in problem solving or problem finding?

A: It certainly is a pleasure to work something out in mathematics, even if it is something that has been done before; there is a certain satisfaction in having everything "click" and you see how something works, or when a concept [that] could be explained only unclearly and in a complicated manner can now be done in a clean and transparent manner. A large part of the task of problem solving in mathematics is simply to see things the right way, and to realize certain heuristics or insights, which are well worth learning in themselves and make you appreciate the field as a whole a lot better. I always feel that I'm learning something when I'm doing mathematics, and that's a good feeling.

Q: Now that you are a father, you will need to be an advocate for your child. How do you anticipate that you will respond to your son's educational needs? If he is mathematically and/or verbally precocious, what choices will you make to ensure his needs are met?

A: I think we will deal with that if and when the time comes; he is not even 2 years old right now, and it seems unrealistic right now to make plans to force an outcome that may not be natural or desirable. I don't think there is a one-size-fits-all approach to child rearing; there are guidelines, and good pieces of advice, to be sure, but one must also adapt to each child's own unique personality and traits.

Q: Have you been able to find balance in your life between work and personal/social relationships?

A: I think academic life is a little different from many occupations, in which there is a clear and rigid distinction between "work time" (from 9 a.m. to 5 p.m.) and "personal time" (from 5 p.m. to 9 a.m.). Instead, it is more evenly spread out, with a fair amount of work being done outside of regular office hours, and conversely a fair amount of socialization during office hours. On the other hand, we don't have as many deadlines and fixed schedules as in some other professions, so in most cases it is easy enough to arrange one's work around one's personal life rather than vice versa. There is a component to mathematical research that needs a certain uninterrupted and quiet block of

time, and the right motivation, in order to make any progress, and sometimes life gets too busy to attain that, but I still get more than enough of that kind of time to work on the projects that interest me most.

- Q: What is happiness to you—and have you found it?
- A: Tolstoy once said that happy families are all alike, but each unhappy family is unhappy in its own way. I think the most lasting type of happiness is not the one based on any sort of achievement, activity, or relationship, but simply the more mundane type of happiness that comes from *contentment*—the absence of stress, discord, misery, need, self-doubt, bitterness, anger, or other sources of unhappiness. Of course, if you do take pleasure in some achievement or relationship, then so much the better, but it should not define your happiness to the extent that any hitch in that achievement or relationship causes you undue grief. I'm quite content with my own life, and also have the luck to enjoy my work, my family, and the company of my friends, so I would consider myself very happy.
- Q: Of your many impressive accomplishments, which ones are most meaningful to you?
- A: The type of work I cherish the most is the type where, at the end of the project, not only have I understood some phenomenon or subject better, but can also present it in such a way that others also gain the same insight. I find this type of progress—the discovery and dissemination of insights—more satisfying, in fact, than solving a previously unsolved problem, though I find the two are often related. One usually does need to discover a new insight, or to understand an existing insight more fully, in order to make progress on a problem. This type of work isn't always a research paper; there are also some lecture notes for my graduate and undergraduate classes, for instance, that I am quite proud of, explaining quite standard material but with a spin on it, which gives it more meaning and relevance to the reader.
- Q: Having accomplished so much at such a young age, do you have a sense of important goals that you would still like to accomplish?
- A: Well, I never seem to run out of projects! There are always things that come up unexpectedly that attract my interest. And, there are certainly a lot of things I would like to work on—not just research, but also

in teaching—that I don't yet have the proper expertise for, but hope to in the future. There have been a couple times when I've put a project on hold for several years because I wasn't ready, but then returned to it with some fresh tools and ideas and finally made some progress. I guess I'm still experimenting with various activities and projects to see what I can be good at; right now, for instance, I am in the process of writing a graduate-level book for the first time.

- Q: Would you like to offer any words of wisdom to young academically talented students?
- A: Well, don't be afraid to explore, and be prepared to learn new things continually and to evolve your appreciation of your subject. I remember in high school thinking that I understood what mathematics and physics were all about, only to discover so many wonderful things about these subjects in college that I had no idea existed at high school. This happened similarly when I was a graduate student, or a postdoc, or even now (or especially now!). Most parts of my subject, mathematics, have some sort of point, have some interesting motivation, and have some underlying intuition that is quite natural, even if the way the subject is presented can sometimes obscure these basic facts from view, so if something doesn't quite make sense or seems rather arbitrary, don't be afraid to track it down, either by working it out by yourself, doing some library research, or asking people. I think this type of questioning spirit is very important to really deepen both one's understanding of a subject and one's appreciation of it.

### *Comments by Dr. Stanley*

I first heard of Terry via newspaper publicity when he was, at age 8, already an acclaimed prodigy in Australia. I contacted his parents by mail and sent them a copy of the College Board's Scholastic Aptitude Test (SAT). Terry scored 760 on the math part. His SAT verbal score was much lower then but during the next few years rapidly climbed into the 700s.

Terry and his parents visited my wife and me for several days and nights when he was 9 years old. At that time, Terry's father seemed to aspire to Terry's getting his Ph.D. degree in mathematics when as young as possible. He is, however, a very bright, sensible pediatrician who cared deeply for his son's educational and personal development, so, on the advice of my wife, Barbara, and me, he modified Terry's educational progression in ways

Terry outlined above. The fortunate outcome of such careful planning is obvious in Terry's highly insightful comments.

### *Comments by Dr. Miraca U. M. Gross*

As mentioned in a previous publication (Gross, 1986), I recall informally assessing Terry's ability for placement in math enrichment workshops when he was very young. At just under 4, he was multiplying two-digit numbers by two-digit numbers in his head. Shortly before his fifth birthday, working with a GATCASA group of mathematically talented 7- through 9-year-olds, Terry was asked to find the next four numbers in the sequence 9182736. He thought briefly and responded "4554." He was correct! The number sequence consists of consecutive multiples of nine.

### *Comments by Dr. Billy Tao, Terry's Father*

I think Terry has had a successful educational experience because of three factors. The first is his intellectual capacity. Much has been said about it in this paper, so I am not going to repeat that.

The second is his friendly personality. He is at once helpful, natural, and modest. When he was little, he was liked by his classmates and teachers, and now he is equally liked by his colleagues, peers, and students. Things seemed to have always moved smoothly for him both in the educational and career sense, but beneath the success, his lovely personality is an important key.

The third is his chance meetings with many kind and helpful people. When he started primary school at the age of 5, the principal quickly agreed to accelerate him radically. His high school principal interviewed and then agreed to take him when he was 7, and put him straight into an 11th-grade class—something unheard of in Australia at that time. The head of the math department, who bumped into him at a university corridor when he was 9, asked him curiously, "Young lad, what are you doing here?" He later contacted us personally, and became first his math supervisor and then a life-long friend. Terry met Julian Stanley, who [had] given us much inspiration on the future direction of his education, in 1985. He also has met many famous mathematicians (some of whom are Fields Medalists) from the time he was 9 years old, and all of them have helped him develop in one way or another.

## **The Boy Who Kept Hitting the Ceiling: The Lenhard ("Lenny") Ng Story**

When juniors or seniors in high school earn perfect scores (800) on either portion of the SAT-I, it is considered a remarkable achievement. When a 10-year-old earns a perfect score on the SAT mathematics or SAT verbal, it is nothing short of astounding. Having earned a perfect score of 800 on the math portion of the SAT-I not only once, but twice at this extremely young age, Lenny was once thought to be the "smartest kid in America" (Fischer, 1990, p. 1E). Through his participation in SMPY, he was estimated to be the top one in approximately one million of his age-mates.

Scoring at the absolute maximum on standardized tests became a common occurrence for Lenny. Aside from being the youngest person we've ever known to earn a perfect score on the SAT-M on the first try, Lenny was able to repeat his performance on a subsequent SAT exam, earn a perfect score on the College Board Test of Standard Written English at age 11, and earn an unprecedented perfect score on the American High School Mathematics Examination in all 4 years of high school. He repeatedly competed in the International Math Olympiads (IMO) during his high school years and, not surprisingly, was a gold medalist twice and a silver medalist once. Moreover, in 1994, Lenny coached, through the Math Olympiad Program (MOP), the United States team that earned an unprecedented perfect score in the IMO. Throughout his undergraduate years at Harvard University, Lenny earned the rare distinction of becoming a Putnam Fellow, and prior to entering graduate school at the Massachusetts Institute of Technology (MIT), earned perfect scores on all three parts of the Graduate Record Exam (GRE) and also on the GRE subject test in mathematics. (Given Lenny's impeccable record, one naturally wonders what his true scores would have been on the various standardized tests if their ceilings had been even higher.)

Considering that Lenny repeatedly bumped his head on the ceilings of these exams, which were by most standards regarded as rigorous, one might assume that he followed an educational path similar to the one that Terry Tao pursued. Not so. While Lenny did take some courses simultaneously at different levels depending on his skill and content knowledge in the subject areas, he skipped only one whole grade (grade 3). His parents deliberately discouraged him from moving forward too quickly in order to ensure that his social and emotional development remained on track. Thus, although he accelerated in certain subject areas and eventually, while still in high school,



completed a number of university courses at the University of North Carolina at Chapel Hill, where his father is a renowned physics professor, Lenny retained his high school enrollment and graduated with the 12th graders. Lenny earned his undergraduate degree from Harvard in 1996 (the same year as Terry earned his Ph.D.) and his Ph.D. from MIT in 2001. In contrast to Terry, who “sprinted” through his educational program, Lenny may have envisioned himself as a marathon runner from the very beginning.

Lenny did not view learning as something that occurred only within the parameters of the courses he took at school. The notion of the classroom was broadened for Lenny, as it had been for Terry, to include academic competitions and summer programs. Aside from distinguishing himself as the top performer in numerous national and international math competitions, he also earned recognition in other national events: for example, the National Spelling Bee and the Westinghouse science competition. He was also chosen to be on the USA Today All-Academic team.

As mentioned before, Lenny enrolled in academic summer programs. They afforded him opportunities to hone his writing skills and study number theory. Furthermore, during the summer of his eighth-grade year, Lenny earned the honor of attending the Research Science Institute (RSI), which is considered the most prestigious and competitive academic summer science program in the nation. This was quite an extraordinary accomplishment when one considers that the program is designed for rising high school seniors. Interestingly, Lenny had the opportunity to meet Terry Tao for the first time at RSI, which was then held on the campus of George Washington University. Upon completing this intense program, the boys reportedly corresponded, “sometimes sending joke math problems through the mail” (Fischer, 1990, p. 2E).

By regulating the pace of Lenny’s educational progress and by taking advantage of the smorgasbord of curricular and supplemental options that Benbow and Stanley endorsed (Benbow, 1979; Stanley, 1991), Lenny’s parents implemented an educational program for him that allowed enough time and flexibility for him to explore his nonacademic interests. From a very young age, Lenny was exposed to stimulating extracurricular activities. For example, Lenny started taking piano and violin lessons when he was 4 years old. One year later, he began composing music. Not surprisingly, as a boy who loved to compete, Lenny eventually performed in violin and piano competitions and earned honors for his musical ability. He also enjoyed participating in several sports (e.g., basketball, tennis, swimming, and track) and, as a boy, was a

member of a championship little-league basketball team. Throughout the years, he has maintained his musical and athletic interests.

As involved as Lenny was in nonacademic activities, he never lost sight of his academic goals. He always distinguished himself as a stellar young scholar. In fact, Linda Paras, the President and cofounder of the New-Jersey-based Scholarship Foundation that awarded Lenny a merit scholarship, which was applied to his Harvard tuition, commented on Lenny’s academic prowess:

If Leonardo da Vinci walked in with the “Mona Lisa” under one arm and the “Last Supper” under the other, he would not get a scholarship to a top school; 96.5 percent of scholarships are given on the basis of need . . . we give these students awards to give them recognition. A student like [Lenny] is a role model for the country. (Broili, 1994, p. 1)

In an e-mail interview conducted in 2004 while in the process of completing a prestigious American Institute of Mathematics Five-Year Fellowship at Stanford University, Dr. Lenny Ng shared his reactions to the early academic, social, and family experiences that shaped his development. He also commented on his life as a successful mathematician who seems to be well on his way to eminence:

- Q: What are your earliest recollections of being more advanced intellectually than other children your age?
- A: I have vague memories (corroborated by my parents) of learning the multiplication table (up to  $10 \times 10$ ) when I was 3. Certainly by the time I enrolled in kindergarten, I was studying more advanced material mathematically than my classmates. It didn’t seem like anything exceptional at the time, though.
- Q: At a very young age, you received media attention due to your exceptional mathematical ability. As you recall, how did you handle that and how did you internalize that attention? What did your parents do to protect you from being sensationalized?
- A: I think the first media attention arrived when I was 10, after I first took the SATs. It was flattering but not too big of a deal. I remember that the first newspaper article was mainly about how I would rather play than study. Fairly early on I was able, through math competitions and spelling bees, to meet many extremely

talented kids nationwide. I think that helped to ground me. What I'd done was really nothing so extraordinary in the grand scheme of things. (In particular, when I was 12, I met Terry Tao, whom I'm convinced operates on a higher plane of existence.) The media attention was fine, and definitely pleased my relatives (especially my grandparents), but I think it didn't really affect me. My parents did a great job of insisting that I experience as "normal" [of] a childhood as possible, and as a result my friends didn't see me as being terribly different from them.

Q: Although you certainly had the intellectual ability and academic talent to "sprint" through school, your parents opted not to have you skip more than one grade or leave your peer group too early. As you reflect on your career and personal development, how satisfied are you with your early educational experiences? If you could do it over again, would you accelerate more, the same amount, or less?

A: I'm quite pleased with the level of acceleration that my parents found for me. I definitely think that I would have been much less happy if I'd had to leave my peer group. It seems to me that my parents struck a good balance between keeping me challenged and allowing me to progress as a normal kid. The only grade I skipped was the third. I believe I was getting a bit bored by the end of second grade, so the school allowed me to jump ahead. But, I think the cost of omitting further grades wouldn't have been worth the marginal benefit of taking more advanced classes, especially [because] I was able to take higher level classes in math and some other subjects.

Q: What did you, your parents, and teachers do to create optimally challenging learning experiences for you as you were growing up?

A: My teachers and schools were very accommodating of my needs. As early as second grade I was allowed to sit aside from the rest of the class during math lessons and to learn at my own pace. When I entered junior high school, [Professor] Stanley was instrumental in persuading my school to allow me to take math classes at the local high school. I ended up having a great deal of flexibility in which classes I was able to attend. This was true in subjects other than math as well; for instance, when I was in eighth grade, I was taking AP Math and AP Chemistry in high school. When I was in high school, I was allowed to take a number

of courses at the University of North Carolina (many in math, but also physics, computer science, and history); I was in an English class one grade ahead of me; and I was taking other courses along with the students in my grade.

So, I was very fortunate to enjoy such a level of flexibility. By contrast, I have a friend who's now a tenured math professor at Princeton [who] says that until he went to college, he had barely any experience in math outside of the usual high school curriculum. The subject came easily to him, but he had no idea how much mathematics is out there, or that anyone else might find it interesting. Obviously, this lack of exposure didn't really hurt him, but who knows how many promising students *were* turned off of math because their interest wasn't fostered! I have known of several elite high schools where students are discouraged from taking classes beyond calculus, and where an extracurricular math club (or other enrichment activity) would be viewed as a waste of time.

On another note, I read a lot when I was growing up—novels and other things, such as recreational math books—and my parents encouraged this. I also enjoyed creative activities such as composing music. My parents say that when I was young, whenever I'd done something bad, I would change the subject by sitting down at the piano and announce that I was "composing." A hush would fall over the house to let me concentrate, and that would be that.

Q: Math competitions seemed to play an integral role in your talent development. How did your involvement and unprecedented achievements in these competitions (e.g., a perfect score four times on the American High School Math Exam [AHSME] and two gold medals and a silver medal in the International Math Olympiad) enhance your education and your socialization?

A: It was the competitions that really introduced the fun side of math to me. Somehow, tackling math problems was quite enjoyable. I was once given a photo of me at a state math contest when I was 11 or so, and I'm curled up at a desk, bent over a sheet of paper, with a goofy grin on my face. So, the main academic significance of the competitions was that they motivated me to learn more. Sometimes the problems would be connected to areas of math that I knew nothing about, and would pique my curiosity.

The competitions also contributed quite a bit to my social life. Starting after seventh grade, I spent sig-

nificant portions of each summer at math programs, especially the Math Olympiad Program, which served as an enrichment program, as well as a training program for the International Math Olympiad. This was great because I could hang out with kids with similar interests. I still keep in touch with a lot of the people I met this way. The competitions were also a great opportunity for me to go traveling, whether within the country or outside (thanks to the Olympiad, I enjoyed free trips to Sweden, Russia, and Turkey).

Q: In what other extracurricular activities did you participate? What importance did they have in your life and development?

A: I played a fair bit of sports when I was younger, mainly tennis and basketball, and enjoyed them quite a bit. My main nonmath extracurricular was music. I started playing (classical) piano and violin when I was 4 and kept them up through college (can't seem to find the time now); I already mentioned the music compositions. When I was in grad[uate] school, I realized that I really liked singing, and I was fortunate enough to be invited to join the Tanglewood Festival Chorus, which sings with the Boston Symphony Orchestra. This was an unbelievable thrill. In general, the math-music cliché was really valid in my case. Playing music, or composing, or singing, gave me a great nonacademic outlet, and a nonmathematical direction to develop. I used to listen to the local classical radio station obsessively—there was so much great music out there! Even now, I find it easier to work with music in the background (not the bland stuff that permeates many classical radio stations these days, but symphonies, concerti, operas, etc.) than without. This perplexes my fiancée to no end. [They are now married.]

Q: How were your social relationships growing up? Where did you find your social niche?

A: I guess I had three groups of friends. There were the friends with whom I grew up, who were my age, and with whom I'd play sports and the like. There were the friends with whom I took classes, who tended to be a couple of years older. And, there were the friends whom I met through competitions, whom I usually saw only in the summers. That's not to say that I had a particularly active social life, but maybe I had a wider range of socialization than some other people. Fortunately all of these groups accepted me

pretty well, I think. On the flip side, though, I didn't get to know any of them as well as I would have if I'd spent time with just one set of people.

Q: How would you describe your relationship with your parents growing up? What strategies did they use to help you remain grounded and develop emotionally and socially? How is your relationship with them today?

A: I have always been quite close with my parents, and they have always been very interested in what I'm doing. When I was growing up, they went to great lengths to make sure that I had any opportunity that I wanted. My mother especially made a lot of sacrifices for me—for instance, she'd drive me each day from the junior high school to the high school, or from the high school to the university—otherwise I couldn't have taken concurrent classes in two places. I know there's this cliché of the overbearing parents who push their unwilling children in unhealthy directions—actually, in my experience, there are quite a few parents like this—but mine weren't. They were never pushy (except, I suppose, when I was a small kid and wanted to play instead of take music lessons, but I'm glad that they made me persevere).

Q: How would you describe your relationship with your brother growing up? How did your parents help to foster a close and healthy relationship between you and your brother? Do you and your brother have a satisfying relationship today?

A: I was always very fond of my brother. When he was born, my parents were worried that I'd be jealous of the newcomer, and they offered to buy me the present of my choosing; I apparently told them that my brother was a good enough present. We're separated by 4 ½ years, which basically eliminated the rivalry component and, I think, allowed us to get along well. My parents took pains to make sure that we didn't feel like we were in direct competition with each other, and fortunately his interests are sufficiently different from mine that he doesn't feel that he's in my shadow. (At least I think this is the case, most of the time.) My brother and I talk a lot these days, though I can't seem to beat him at basketball any more.

Q: How did your undergraduate education at Harvard and graduate studies at MIT shape your academic, social, and emotional development?

A: College was the first time I was always surrounded by people with similar interests—it was like my summers during high school, but year round. So, it was an exciting time and helped to confirm my interests. The diversity I found in college also allowed me to branch out a bit in extracurriculars; I played in an orchestra for the first time, learned a bit of ballroom dance, and played in a number of intramural sports. Another big chance for me was living in a city—I love Boston and was delighted to have access to the cultural side of a city (concerts, plays, museums, etc.). Emotionally, I'd guess that I matured like any college student (who led a generally tame and studious life!). In graduate school, I was more narrowly focused on my studies. This was probably the first time I had to provide my own motivation for studying, without the benefit or distraction of deadlines or even any concrete goals. I guess grad[uate] students are self-selected to be motivated from within; I was quite impressed with how hard my fellow students worked, and how deeply they loved their subject matter. When one participates in a lot of competitions, sometimes it's easy to forget that what really matters in an academic career is your level of motivation and understanding, rather than how quickly or cleverly you can solve problems or the like. In any case, I was very inspired by my peers, and I think they helped me to progress in my mathematical "maturity" (whatever that means). I tried at the same time to maintain my balance and participate in extracurriculars—this is when I discovered that I liked singing in choruses.

Q: Were you always clear about your educational/career path? Did you consider a variety of options regarding undergraduate and graduate institutions, academic majors, and career focus?

A: When I was young, I thought I'd like to work in some sort of science. I knew I wanted to attend a good college, because I'd most likely [be able] to find people with similar interests and level of studiousness there. In college, I majored in math almost by default, but added a second major in physics when I decided that it was pretty interesting. After taking a number of classes in both disciplines, though, I realized that physics wasn't for me. If things hadn't gone so well for me in math, I might have considered other dis-

ciplines as well—I really liked biology, for instance. But, I was very happy in math. I discovered in college that I enjoyed the academic life and had a temperament much more suited for academe than industry. I underwent the obligatory suffering in grad[uate] school and found that I did really want to stay in a university setting. All in all, I guess I've had a pretty set idea of my career path since I was relatively young, and didn't really go through any prolonged periods of doubt.

Q: Which mentor relationships were most instrumental in your talent development? Why were they so effective/influential in guiding your development?

A: I've had a number of excellent mentors starting, I'd say, with [Professor] Stanley, and moving through professors who served as my advisors in high school, college, and grad school. [Professor] Stanley was extremely helpful in sharing his experience with gifted education. My other mentors served in a narrower academic role; they suggested mathematical topics for me to explore. I guess this is pretty normal for someone in an academic career path, though I probably started a bit earlier than most. I've had the good luck that my mentors and advisors were all patient and gracious with their time, and their encouragement gave me the confidence I needed to progress.

Q: Some theorists in gifted education emphasize the role of chance factors in talent development. Did any chance factors, positive or negative, have an impact on your career?

A: I'd say I was lucky that my teachers in junior high and high school were as accommodating of my needs as they were—everything seemed to work out for me. I'm of course very fortunate to have been raised in the environment I was. The glut of opportunities I enjoyed—certainly not everyone has them, and I was very fortunate in this regard.

Q: Now as a postdoctoral fellow at Stanford, what are you currently working on? What are the most exciting/meaningful aspects of your work?

A: I'm conducting research in geometry and topology. Probably the most accessible part of my research has to do with knot theory, the study of knots (i.e., how to tell when two knots are the same). What I really

like doing is finding connections between disparate areas of mathematics. I've been applying techniques from an area in geometry called symplectic geometry, which is pretty hot these days, to knot theory, and coming up with new results in knot theory this way. [At the time of publication, Lenny will be starting his new faculty position as assistant professor of mathematics at Duke University.]

- Q: Like Terry, you obviously have passion for math! Can you describe your emotional connection to math? What is the experience like for you when you are engaged in problem solving or problem finding?
- A: What drew me into mathematics, when I was involved in competitions and the like, was the "eureka" moment when I'd been working on a difficult problem and suddenly I saw how to solve it. Almost any problem that has a reasonably nice answer can be solved in an elegant way, and I was attracted to the elegance, the act of finding patterns and coming up with a simple and insightful solution. To me, this is still the best thing about mathematics: the fact that one begins with a pure and abstract construct, that one can really use one's imagination [because] one isn't tied to experiment, and that one can create such order and beauty from first principles.
- Q: You alluded to having a fiancée. What is your personal situation?
- A: I'm engaged to a wonderful woman I met in grad school (she was also in math but decided that mathematical research wasn't for her). Astrid and I will be married this summer. [As noted earlier in this article, they were married.]
- Q: Have you been able to find balance in your life between work and personal/social relationships?
- A: I think so. I'd say the two most important things for me are my work and my relationship with Astrid. Now that I'm a postdoc, I have an increasingly limited amount of time to socialize, but I find that spending time with Astrid is really sufficient for me, for the most part. (Of course, I still see and talk to my other friends, but not as much as before.) The one thing I miss right now is music; I'd like to join a singing group, or maybe get a piano, as soon as things settle down.
- Q: What is happiness to you—and have you found it?
- A: I don't know exactly what "finding happiness" means to me. I'm certainly very happy with my life, and as I mentioned above, the two most valuable things to me (my work and relationship with Astrid) are both going very well. I feel like I've lived a charmed life so far.
- Q: Of your many impressive accomplishments, which ones are most meaningful to you?
- A: Probably my current research is the most meaningful. Competitions and such are nice, but somehow one needs a different kind of talent, not to mention maturity, to conduct good academic research. I spent graduate school mainly learning about the ideas and techniques of others, and I'm finally starting to discover my own ideas. ("Research" from high school and college don't really count.) It's very gratifying to me when my work is interesting to other people.
- Q: Having accomplished so much at such a young age, do you have a sense of important goals that you would still like to accomplish?
- A: I don't really feel like I've accomplished that much yet. I would really like to have a successful academic career and contribute something meaningful to mathematics. It's such a beautiful subject and I'd like to add my part to it. It won't be easy but I'm working on it.
- Q: Would you like to offer any words of wisdom to young academically talented students?
- A: I would say indulge your curiosity and creativity. Don't let others circumscribe what you can do. Read, learn, [and] find a community of your peers. Don't be discouraged by teachers who might neglect your needs because you're gifted. Seize every opportunity to broaden your horizons, and know that there's so much out there for you to discover. This is not very original, but I think it's easy for talented kids to get untracked if circumstances aren't just right, and that's a terrible shame.
- Q: Thank you Lenny! Your comments will be helpful to specialists [in gifted education] and other educators.

### Comments by Dr. Stanley

Lenny graduated in 3 years, *summa cum laude* in mathematics, from Harvard at age 19. He could have completed his baccalaureate faster at the University of North Carolina because of courses he took there (and excelled in) while still in high school. Wisely, his parents supported him for a “normal” residential experience at the country’s most highly selective, oldest college, Harvard. There, from the first, he studied mathematics at the graduate level.

### Comments by Dr. Jack Ng, Lenny’s Father

In hindsight, Lenny did show signs of precocity at a rather young age. But, it did not dawn on my wife and me until relatively late that we were blessed with a gifted child. Our emphasis was for Lenny to have a balanced development both intellectually and socially. Above all, we wanted him to have a happy childhood. Still, we and his primary school teachers noticed that Lenny had an unusual capability for grasping new ideas. So, we did our best in accelerating his education despite strong and persistent discouragement from the school principal. For me, that meant taking over as his mathematics teacher. At the repeated urging of his teacher in his class for gifted children, we allowed Lenny to take the SAT at age 10. (Initially we worried that he might be demoralized by the result.) His perfect score in the mathematics portion caught the attention of [Professor] Stanley, who quickly became his strongest advocate and a patient advisor. Together we adopted an accelerating but balanced approach for Lenny’s “precollege” education. But, even with [Professor] Stanley on our side, we still had our critics, in fact from both sides. We were criticized by some for pushing Lenny too fast, and by others for holding Lenny back (purportedly to break records in mathematics competitions). Eventually Lenny and we agreed that he should go to Harvard at the age of 16. We were relieved and felt vindicated when Lenny, after one month at Harvard, thanked us for keeping him at home until then, when he was intellectually and emotionally ripe for college. And, Harvard was indeed the right place for him, offering him the right amount of challenge and stimulation.

As a theoretical physicist, I was keenly aware of the symbiotic relationship between mathematics and physics. So, I tried my best to encourage Lenny to broaden his interest to include physics. To my delight, he added physics as his second major and even took the advanced graduate course on quantum field theory at Harvard (and went

on to win first place in the Boston Area Undergraduate Physics Competition, which has since gone nationwide). Furthermore, at graduate school, he chose the field of geometry and topology, which provides the conceptual underpinning for fundamental physics. Therefore, perhaps he will be able to contribute to both mathematics and physics in the future. As a researcher, I know only too well that research is a long-term activity, and may have unintentionally imbued in Lenny the vision of a marathon runner. I am glad that he took up the challenge of tackling a profound and difficult problem in geometry in his first 2 years in graduate school. Though he did not succeed in solving the problem, I am convinced that this experience served him well, giving him an appreciation for the hardship of research and the perseverance necessary for this immensely rewarding endeavor.

### Discussion

As marathon runners, both Dr. Terry Tao and Dr. Lenny Ng seem to possess the intrinsic qualities that will lead them onwards to even greater eminence, providing, of course, that no as yet unforeseen obstacles or uncontrollable factors mar their progress. Both young men appear committed to run the distance. Unequivocally, they are highly motivated, focused, and passionate about their work. Certainly, people with lesser abilities have been known to possess these qualities. Perhaps what distinguishes these two extraordinary men is their unique capacity to be “paradigm shifters.” Like other great thinkers and creative artists who have left their stamp of originality on their work and introduced novel ways of thinking about or viewing phenomena, Drs. Tao and Ng, inspired by their facilities for creative synthesis, have the ability to juxtapose ideas from disparate areas to create radically new ideas.

Theories of giftedness and talent that focus on the translation of high potential into high performance—for example, the models developed by Tannenbaum (1983, 2003) and Gagné (1985, 2003)—emphasize the catalytic effect of both personality and environment on talent development. Longitudinal studies of profoundly gifted young people (e.g., Bloom, 1985; Brody & Benbow, 1987; Brody, Lupkowski, & Stanley, 1988; Brody & Stanley, 1991; Gross, 2004; Hollingworth, 1942) have traced the positive and negative outcomes, for social and emotional development, of various educational interventions. Unfortunately, though very few in number, anecdotal accounts of negative outcomes have eclipsed the many success stories that have much to teach us about nurturing talent effectively. The

heartbreaking and highly publicized story in the early days of the past century about radically accelerated child math prodigy William James Sidis, who ostensibly “burned out” at a young age and settled for mediocrity at best in his professional life, has certainly fueled the myth of *early ripe, early rot* (Wallace, 1986). Although it is widely known within the gifted education community that Sidis’ problems stemmed largely *not* from his radical acceleration, but instead from being raised in an emotionally painful environment, the public persists in believing that radical or alternative educational interventions, such as academic acceleration, are negatively linked to poor social and emotional outcomes. For counterexamples, see Weiner (1953, 1956); George, Cohn, and Stanley (1979); and Stanley, George, and Solano (1977). To combat this destructive, persistent myth, leaders in the field of gifted education have joined together to produce the two-volume Templeton National Report on Acceleration (Colangelo, Assouline, & Gross, 2004) to set the record straight about acceleration in its many forms.

Without question, educational interventions should be assessed continually to ensure they are being used efficaciously and in appropriate combinations that meet the unique needs of any given child at any given point in his or her development. A constellation of other factors should, however, also be under scrutiny when assessing outcomes. Norbert Weiner, another famous child math prodigy, who became a pioneer in information theory (and coined the word *cybernetics*) after earning his Ph.D. from Harvard University at age 18 (Weiner, 1953, 1956), cautioned Americans to emulate European education by allowing “brilliant children . . . to blossom early and inconspicuously, well out of the public eye” (Wallace, 1986, p. 285). Exploitation by the press or even by well-intentioned parents, poor parenting, family issues, socioeconomic factors, and many other negative environmental factors can impede the academic, social, and emotional development of a child regardless of ability level. Although much can be gained by retrospectively examining *what went wrong* in cases producing negative outcomes, arguably more can be gained by studying *what went right* in the development of brilliant and highly successful people and how they coped with impediments.

Because both Terry and Lenny have been successful thus far in fulfilling their potential and using their remarkable intellectual gifts to advance knowledge in various fields of mathematics while maintaining satisfying social and personal lives, it seems important to understand the factors, both personal and environmental, that have aided their development. Because academics, educators, and parents of gifted children stand to benefit from learning how they can exert a positive influence on the

talent development and overall adjustment of academically talented individuals, it seems especially important to focus this discussion on the environmental factors that positively affected Terry’s and Lenny’s development.

Primarily, it appears that these young men’s intelligent, well-educated parents played very active roles in their lives. In both cases, the parents responded to their sons’ needs for a differentiated and accelerated curriculum and advocated vigorously for their sons. Although the Taos moved Terry ahead in various grade placements much faster than the Ngs chose to move Lenny, both young men appear to be satisfied overall with the pace and the structure of their early educational programs. The crucial point is that each set of parents was attuned to the different personal needs of their exceptionally gifted sons, which enabled them to determine an appropriate pace of instruction for the boys. Each boy experienced both acceleration and enrichment, but the blend was different.

Interestingly, although Lenny and Terry grew up halfway around the world from each other, their actual hometown educational and cultural opportunities were probably not nearly as different as the geographical distance might suggest. Likewise, both had similar ethnic backgrounds within a cultural tradition that prizes intellectual striving and a love of learning. Unquestionably, the cooperation of some school personnel and their willingness to accommodate the boys’ academic needs by allowing them as much flexibility as they could tolerate in their schedules seemed to be an important factor in promoting the development of their talent. An individualized plan, no matter how appropriate it may seem, is not workable if it cannot be implemented due to the recalcitrance and skepticism of teachers and school administrators. Fortunately, both Terry and Lenny had positive educational experiences because the schools and universities adapted to their needs rather than expecting the young men to conform to traditional pathways through the educational system. On a related note, both Terry and Lenny had the advantage of living in geographical proximity to important educational resources, which made it logistically possible for such flexible programs to be implemented. Due to the willingness of their mothers, who chauffeured them to different schools (e.g., high school and a local university), they were able to attend courses at different grade levels simultaneously. Consistent with earlier research findings (e.g., Arnold & Subotnik, 1995; Casey & Shore, 2000; Clasen & Clasen, 2003), mentors also played an important role in their success.

**Table 1**  
*Key Factors Contributing to Success*

<b>Abilities/Personal Qualities</b>	<b>Terence</b>	<b>Lenhard</b>
Astonishing mathematical and verbal reasoning abilities	X	X
Facility for creative synthesis	X	X
High level of intrinsic motivation, focus, task commitment, perseverance, self-discipline, and the like	X	X
Strong interpersonal and communication skills: ability to collaborate on projects, work well with others	X	X
<b>Family Background/Experiences</b>		
Highly intelligent, well-educated parents who were attuned to the unique educational needs of their sons	X	X
High level of parental involvement in education/ongoing advocacy	X	X
Supportive and nurturing family environment	X	X
Availability of parent(s) to drive Terry/Lenny to different schools and activities and accommodate flexible schedule	X	X
Parents' effort to maintain as much normalcy as possible in Terry's/Lenny's life during childhood years	X	X
<b>Educational Programming</b>		
Extreme flexibility in course scheduling	X	X
Cooperation of school personnel (student-centered approach)	X	X
Radical whole-grade acceleration	X	
Minimal use of whole-grade acceleration		X
Subject acceleration (radical in areas of strength)	X	X
<b>Outside-of-School Educational Opportunities</b>		
Heavy involvement in math competitions (international level)	X	X
Involvement in other high level academic competitions (e.g., Intel/Westinghouse)		X
Participation in academic summer programs	X	X
Development of relationships with mentors	X	X
<b>Extracurricular Involvement</b>		
Participation in sports		X
Participation in music competitions		X
<b>Early Socialization</b>		
Played with congenial sibling(s)	X	X
Played with age peers	X	X

*Note.* The key factors contributing to success listed in this table are not in order of importance.

As outlined earlier and as shown in Table 1, although they shared similar advantages in many respects (e.g., cooperative schools, a flexible curriculum, actively involved parents, involvement in math competitions, and access to mentors), Terry and Lenny traversed somewhat different paths educationally, reflecting their individual differences and needs (see Table 2). If education is to be truly effective, it must be tailored to the needs of the individual student. Terry and Lenny are two prime examples of profoundly gifted individuals who, despite sharing some similarities, are different. They are both remarkable human beings who have the intellectual ability to continue to make significant contributions to their respective fields and to be “movers and shakers” in the intellectual realm. Appropriately, however, as children they were on different developmental and educational trajectories (see Table 2). Although both developed a deep reverence for and emotional connection

to mathematics at a young age, they had differing needs because they were unique individuals with their own personalities, temperaments, likes, and dislikes.

## Conclusion

Although it would certainly be inappropriate to make sweeping generalizations about the needs of academically talented students from the two remarkable case studies presented above, the information gleaned from the histories of, and interviews with, Dr. Terry Tao and Dr. Lenny Ng, and the comments by their fathers, may be of assistance to educators of the gifted and talented. While very few academically talented students possess the astonishing abilities of Terry and Lenny, and while few become paradigm shifters who rise to eminence and



**Table 2**  
*Summary of Backgrounds*

Factor/Dimension	Terence Tao	Lenhard Ng
Birth Date	July 17, 1975	December 8, 1976
Ethnic Background	Chinese-Australian	Chinese-American
SAT-M Score (SMPY)	760, 8 years old	800, 10 years old (twice)
Age of Entry Into College Part-time	9 years old	12 years old
Age of Entry Into College Full-time	14 years old	16 years old
Educational Degrees	B.Sc. Class 1 Honors degree in mathematics—Flinders University, 1991 M.Sc. in mathematics—Flinders University, 1992 Ph.D. in mathematics—Princeton University, 1996	B.A. in mathematics/physics—Harvard University, 1996, <i>summa cum laude</i> Ph.D. in mathematics—Massachusetts Institute of Technology (MIT), 2001
Current Position	Professor at University of California Los Angeles (UCLA)	Assistant professor at Duke University
Father's Education/Occupation	M.B.B.S. (equivalent to M.D.), University of Hong Kong; Pediatrician, Adelaide, Australia	Ph.D. in physics, Harvard University; Professor of physics, University of North Carolina Chapel Hill
Mother's Education/Occupation	B.Sc. Class 1 Honors degree in physics/math, University of Hong Kong; homemaker/ former high school math teacher	B.A. in environmental design, University of California Berkeley; homemaker
Sibling(s)	Two younger brothers	One younger brother
Personal Status	Married, one young child	Married

revolutionize their respective fields, much can be learned from their experiences. As stated earlier, if teachers and schools can find ways to foster and challenge the very ablest, then surely we should be able to provide more moderately gifted students with opportunities inside and outside the classroom that will nourish their intellectual hunger without resorting merely to their skipping many school grades.

As alluded to earlier, we would be remiss if we did not acknowledge factors that could prevent students from finding these resources—economic disadvantages, family conflicts or crises, geographic isolation, lack of suitable mentors, the “times” not being favorable, and health or personal issues, to name a few. Nevertheless, with the smorgasbord of curricular and extracurricular opportunities available to gifted youth today (and we have not mentioned the 34 Advanced Placement program courses available), academically talented students of all levels of ability should, with some creative strategizing and with the help and cooperation of their schools and their parents, be able to develop a workable educational plan that will augment their development rather than hinder it. Thoughtful,

energetic parenting and teaching can help intellectually talented boys and girls capitalize on the *zeitgeist*, serendipity, and available resources. These, plus some good luck, can produce independent adults who enjoy using their talents for their own and society's benefit.

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