CHAPTER 31

THREE CRUCIAL DIMENSIONS FOR STUDENTS WITH INTELLECTUAL GIFTS: IT IS TIME TO STOP TALKING AND START THINKING

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When the great psychometrician Louis L. Thurstone migrated from engineering to psychology, he noticed an important difference between psychologists and engineers. He observed that when engineers are confronted with a problem, they begin to think, whereas when psychologists are confronted with a problem, they begin to talk (Thurstone, 1952). Happily, over the past 3 decades, highly replicable empirical findings from multiple longitudinal studies on tens of thousands of participants have revealed important things to think about *and* talk about. These findings are critical for understanding educational, occupational, and creative outcomes among students who learn abstract/symbolic material at precocious rates.

Some of the most salient longitudinal advances in recent times involve intellectual abilities, the primary focus of this chapter. Arguably the two most important points uncovered by modern longitudinal research are (a) assessing intellectual abilities within the top 1% of ability and (b) doing so multidimensionally. For optimal practice and theorizing, both are essential. Because of the need to focus more systematically on objective assessments of intellectual capacities in the gifted field (Warne, 2016), this chapter focuses on recent advances based on objective assessments because these determinants identify populations that learn at precocious rates. Thus, these determinants are central. Yet, because the importance of intellectual abilities, commitment, interests, and opportunity are all needed to understand precocious intellectual development, a comprehensive model encompassing intellectual and motivational determinants is further recommended (Lubinski & Benbow, 2000, 2006). This model is, in turn, enriched by broader lifestyle determinants (Ferriman, Lubinski, & Benbow, 2009; Lubinski, Benbow, & Kell, 2014), which are crucial for understanding how outstanding educational, occupational, and creative accomplishments unfold over the lifespan among intellectually talented populations.

RELEVANT THEORY AND PRINCIPLES

Three Critical Specific Abilities

Just as Lewis Terman (1954) showed for the construct of general intelligence ("IQ"), and Julian C. Stanley (1996; Benbow & Lubinski, 2006) showed for mathematical and verbal reasoning abilities, the past 3 decades have solidified the importance of a third ability for students with intellectual gifts—spatial ability. Moreover, contemporary findings also reveal that it is suboptimal to assess these dimensions in isolation. They manifest important interrelationships for understanding individual differences in learning in school settings and performance in work settings; they operate as a collective. Each ability is conditional on the other two, and protracted longitudinal forecasts are more accurate when information about all three is used simultaneously (Humphreys, Lubinski, & Yao 1993; Kell, Lubinski, & Benbow, 2013; Kell, Lubinski, Benbow, & Steiger, 2013; Lubinski, 2004; Wai, Lubinski, & Benbow, 2009).

Organizing Intellectual Abilities

There is wide agreement that intellectual abilities are organized hierarchically (Carroll, 1993; Hunt,

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2011; Jensen, 1998; Snow, Corno, & Jackson, 1996). An efficient model for conceptualizing their structure is the radex (see Figure 31.1). A dominant dimension constitutes the center core; it is surrounded by three specific abilities, mathematical, spatial, and verbal reasoning, which covary in the .60 to .80 range. Their communality distills the construct of general intelligence (g). All measures of specific abilities have a large component of g, whereas all general ability measures consist primarily of g and contain a small number of content-specific ability components (cf. Lubinski, 2004, Figure 1, p. 99). But the specificity of specific abilities harbors important psychological significance (Kell, Lubinski, & Benbow, 2013; Kell, Lubinski, Benbow, & Steiger, 2013; Lubinski, 2004; Wai et al., 2009).

RESEARCH REVIEW

General ability level is important in life (Gottfredson, 1997). There is not a dimension of human individuality that has broader and deeper external relationships with important psychological phenomena. Individual differences in g index different rates of learning abstract/symbolic material among children in school, as well as the different rates of competency to which adults adjust to complexity in the world of work (Hunt, 2011; Jensen, 1998; Lubinski, 2004; F. L. Schmidt & Hunter, 1998). These findings are not only important for understanding individual differences in learning and work between individuals (F. L. Schmidt & Hunter, 2004; Wilk, Desmarais, & Sackett, 1995; Wilk & Sackett, 1996), but also between biologically related family members (Lubinski, 2004, 2009; Murray, 1998, 2002; Waller, 1971). Outside of learning and work environments, cognitive epidemiologists have shown connections with outcomes ranging from traffic accidents and mortality to behaviors engendering physical and psychological health, and a number of studies have provided compelling evidence for g, while controlling for socioeconomic status (Gottfredson, 2004; Lubinski, 2009; Lubinski & Humphreys, 1997). These relationships need to be assimilated before refinements offered by specific abilities can be evaluated for their added value (Warne, 2016). Although the common variance shared by the three specific abilities constitutes the most psychologically significant dimension of human individuality uncovered by psychological science, each specific ability has unique variance that is psychologically significant and that is critical to understanding all students (Humphreys et al., 1993; Lubinski, 2004; Wai et al., 2009).

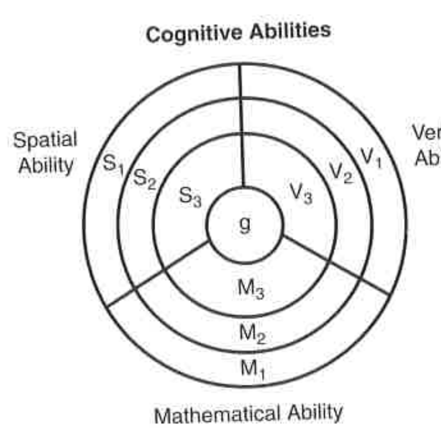

FIGURE 31.1. Cognitive abilities organized around mathematical, spatial, and verbal content domains. The higher order construct of general intelligence (g) at the center represents the communality shared by the three abilities. Adapted from "Spatial Ability for STEM Domains: Aligning Over 50 Years of Cumulative Psychological Knowledge Solidifies Its Importance," by J. Wai, D. Lubinski, and C. P. Benbow, 2009, *Journal of Educational Psychology, 101*, p. 821. Copyright 2009 by the American Psychological Association.

Ability Level

To help crystalize the importance of g for students with intellectual gifts, Figure 31.2 organizes longitudinal findings from the Study of Mathematically Precocious Youth (SMPY; Lubinski & Benbow, 2006). SMPY is a longitudinal study developed by Julian C. Stanley in 1971 at Johns Hopkins University; it is now codirected by Camilla P. Benbow and David Lubinski at Vanderbilt University (Lubinski & Benbow, 2006). SMPY consists largely of talent search participants identified through above-level testing during early adolescence using the Scholastic Aptitude Test (SAT). Research has shown that for high-ability students, the math and verbal composite score from the SAT is an excellent measure of g

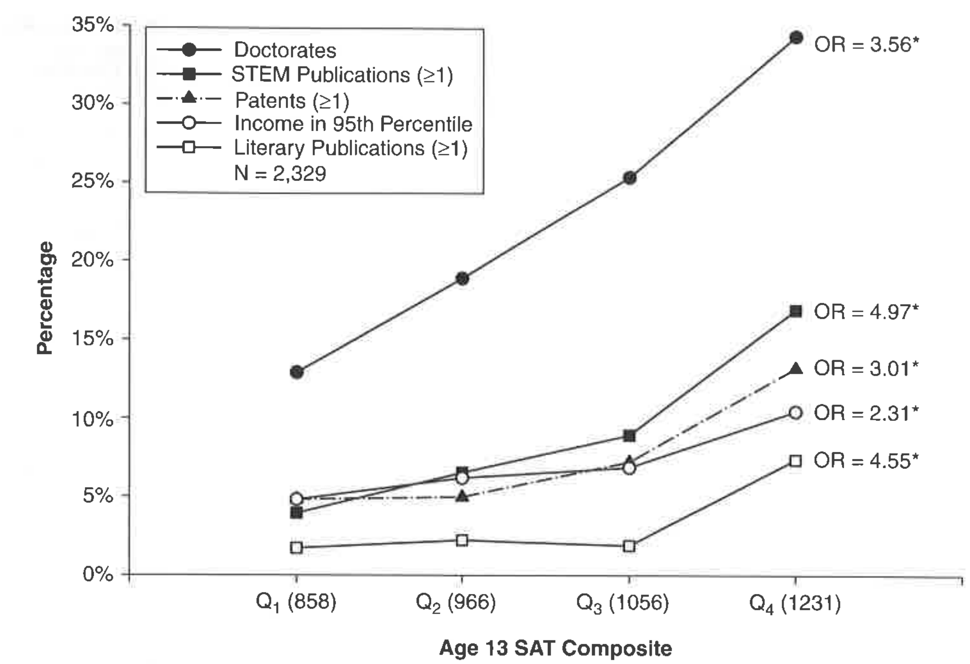

FIGURE 31.2. Accomplishments across individual differences within the top 1% of general cognitive ability 25+ years after being identified as such at age 13. Data are separated into quartiles based on participants' SAT-M (math) and SAT-V (verbal reasoning) composite score at age 13. The mean SAT composite score for each quartile is provided in parentheses along the x-axis. Odds ratios are provided comparing the likelihood of each outcome in the top (Q4) and bottom (Q1) quartiles. *95% confidence interval for the odds ratio did not include 1.0, meaning that the likelihood of the outcome in the top quartile was significantly greater than in the bottom quartile. From "Exceptional Cognitive Ability: The Phenotype," by D. Lubinski, 2009, *Behavior Genetics, 39*, p. 353. Copyright 2009 by Springer. Adapted with permission.

(Frey & Detterman, 2004). Combining these two indicators distills g for practical purposes. In Figure 31.2, the age 13 SAT composite scores of over 2,000 SMPY participants, all of whom were in the top 1% of ability, were divided into quartiles based on their composite scores from the SAT, which they completed at age 13. The mean SAT composite for each group is listed on the x-axis. After 25 years, information was collected on rare, socially valued outcomes: earning a doctorate, producing a science, technology, engineering, and mathematics (STEM) or arts/humanities publication, earning a patent, or having an income in the top 5% of the U.S. population.

Ability differences in the top 1%—IQs ranging from 137 to over 200—matter for real-world outcomes. Participants whose SAT scores placed them in the top quartile earn more doctorates, publish more articles, secure more patents, and earn higher incomes than participants in the other three quartiles. Although other factors (e.g., commitment, interests, opportunity) clearly matter, more ability is better. There is not a threshold effect for ability beyond which more ability doesn't matter. To observe this, however, requires measures capable of differentiating individual differences in the top 1% of ability and a variety of rare, low base-rate criteria (because there are many different kinds of outstanding intellectual accomplishments). The latter underscores why large sample sizes are needed for reliable statistical findings.

To place another lens on ability level, Figure 31.3 places the same group of SMPY participants into one of three groups on the basis of their highest terminal educational degree (i.e., bachelor's, master's, or doctorates); then into quartiles on the basis of their SAT scores in math (Park, Lubinski, & Benbow, 2008). Because SMPY is particularly interested in the development of talent in STEM, the psychological

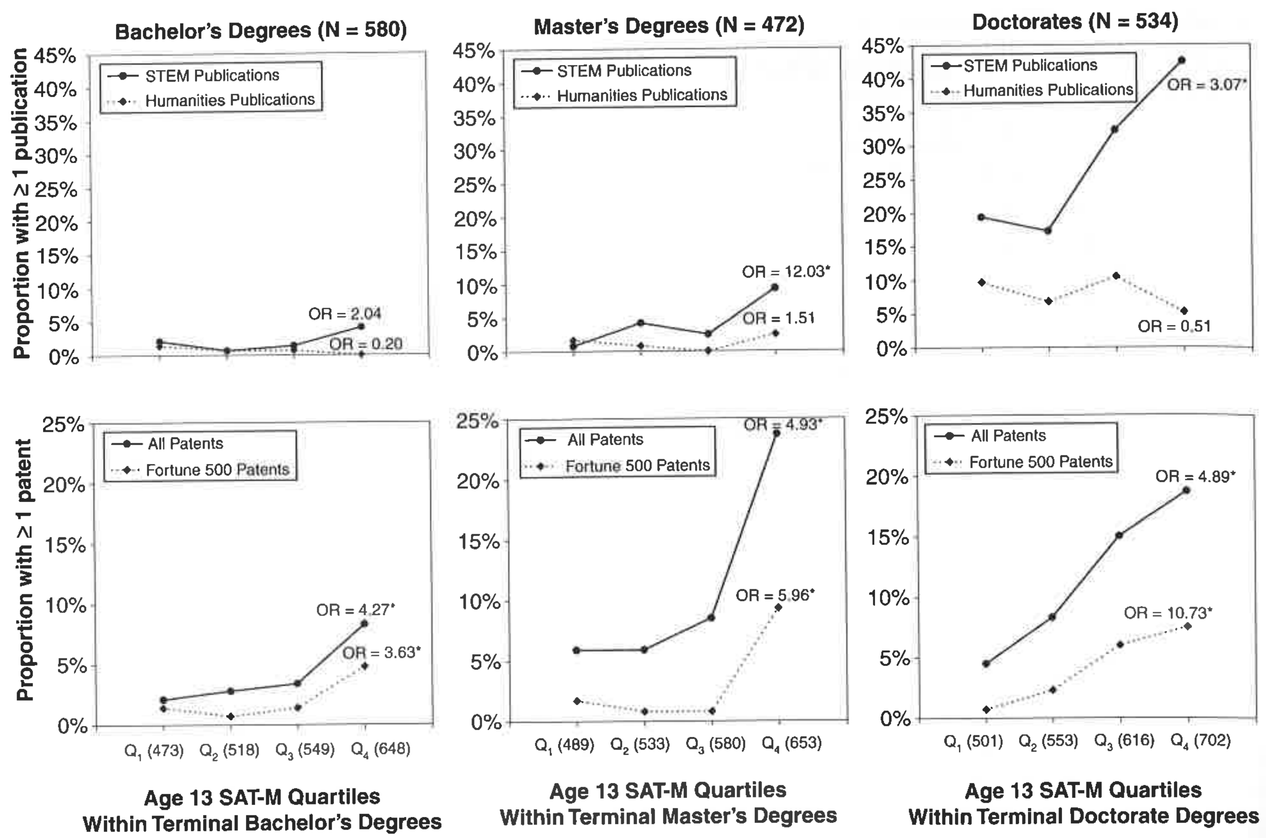

FIGURE 31.3. Participants with at least one peer-reviewed publication in either science, technology, engineering, and mathematics (STEM) or humanities (top row), and at least one patent or one Fortune 500 patent (bottom row). Data are grouped by highest degree earned by participants (i.e., bachelor's, master's, or doctorate). Within each degree group, participants were separated into quartiles based on their SAT-M (math) score at age 13. The mean SAT-M score for each group is provided in parentheses along the x-axis. Odds ratios are provided comparing the likelihood of each outcome in the top (Q4) and bottom (Q1) quartiles. *95% confidence interval for the odds ratio did not include 1.0, meaning that the likelihood of the outcome in the top quartile was significantly greater than in the bottom quartile. From "Ability Differences Among People Who Have Commensurate Degrees Matter for Scientific Creativity," by G. Park, D. Lubinski, and C. P. Benbow, 2008, *Psychological Science, 19*, p. 959. Copyright 2008 by Sage. Adapted with permission.

significance of individual differences within the top 1% on mathematical reasoning ability was examined. Notice how across all three panels, ability level increases as a function of more advanced educational credentials even though all participants rank in the top 1%. In addition, within each degree, differences on SAT assessments in math at age 13 mattered for refereed STEM publications and the likelihood of earning patents.

Initially, this study was submitted for publication containing only these 3 panels, but a peer reviewer pointed out that, perhaps, SAT scores in math were shared with participants' junior high and high school teachers, who, in turn, provided students with extraordinary learning experiences. These experiences could have resulted in outcomes and résumés that positioned them to secure admission to top universities, as well as other opportunities, which in turn enabled them to secure admission to top graduate schools. The peer reviewer wondered if their graduate school is what contributed to the differential outcomes (cf. Zuckerman, 1977). This is an astute observation and Park et al. (2008) took it seriously and responded with the analysis reported in Figure 31.4.

Participants who earned graduate degrees were placed into two groups: those who earned degrees from a graduate school ranked among the top

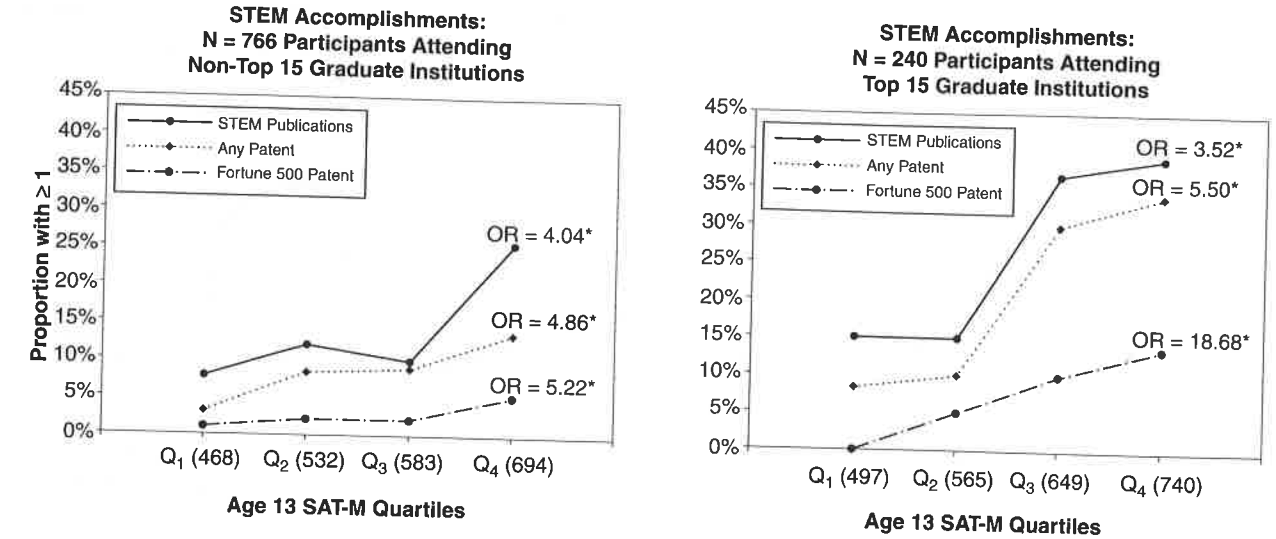

FIGURE 31.4. Science, technology, engineering, and mathematics (STEM) accomplishments of participants attending a top 15 graduate school versus participants attending a non–top 15 graduate school. Data include participants with a master's or doctorate degree who had a peer-reviewed STEM publication, a patent, or a Fortune 500 patent. Within each group, participants were separated into quartiles based on their SAT-M (math) score at age 13. The mean SAT-M score for each group is provided in parentheses along the x-axis. Odds ratios are provided comparing the likelihood of each outcome in the top (Q4) and bottom (Q1) quartiles. *95% confidence interval for the odds ratio did not include 1.0, meaning that the likelihood of the outcome in the top quartile was significantly greater than in the bottom quartile. From "Ability Differences Among People Who Have Commensurate Degrees Matter for Scientific Creativity," by G. Park, D. Lubinski, and C. P. Benbow, 2008, *Psychological Science, 19*, p. 960. Copyright 2008 by Sage. Adapted with permission.

15 graduate schools in the United States versus lower ranked universities. Then, participants' mean SAT scores in math were computed within each group and, finally, the percentage of participants earning STEM publications and patents were plotted as a function of these ability differences. Individual differences in mathematical reasoning assessed before age 13 mattered for both groups. The top quartiles differed significantly and substantively from the bottom quartiles. The mean SAT score in math for the top quartile of participants attending universities ranked in the top 15 graduate schools is 740. For these participants, the SAT math score is a compromised measure of their capability because of ceiling constraints. So, the assessment of the full scope of their mathematical reasoning acumen is compromised.

There is an old saying in applied psychology, "For a difference to be a difference it must make a difference." Clearly, these differences matter. To see these differences, however, they need to be measured. And there are other differences that matter, too.

Ability Pattern

The findings on the importance of assessing individual differences within the top 1% of high-ability students disproves the ability threshold hypothesis for real-world outcomes, which many observers saw coming for decades, based on individual differences in educational outcomes among students in the top 1% (Benbow, 1992). Assessing ability pattern within the top 1% is also relevant. Doing so is particularly relevant for insight into qualitative differences in learning preferences and long-term developmental trajectories. Figure 31.5 forms four Tukey plots (Park, Lubinski, & Benbow, 2007). The SAT composite scores of over 2,400 SMPY participants were plotted on the y-axis, and their math score minus their verbal score was plotted on the x-axis. This method results in two independent dimensions that assess ability level (y-axis) and pattern or "tilt" (x-axis). For the latter dimension, scores on the right of the x-axis indicate ability strength in mathematical relative to verbal reasoning ability; whereas the inverse is true for scores to the left. This two-dimensional

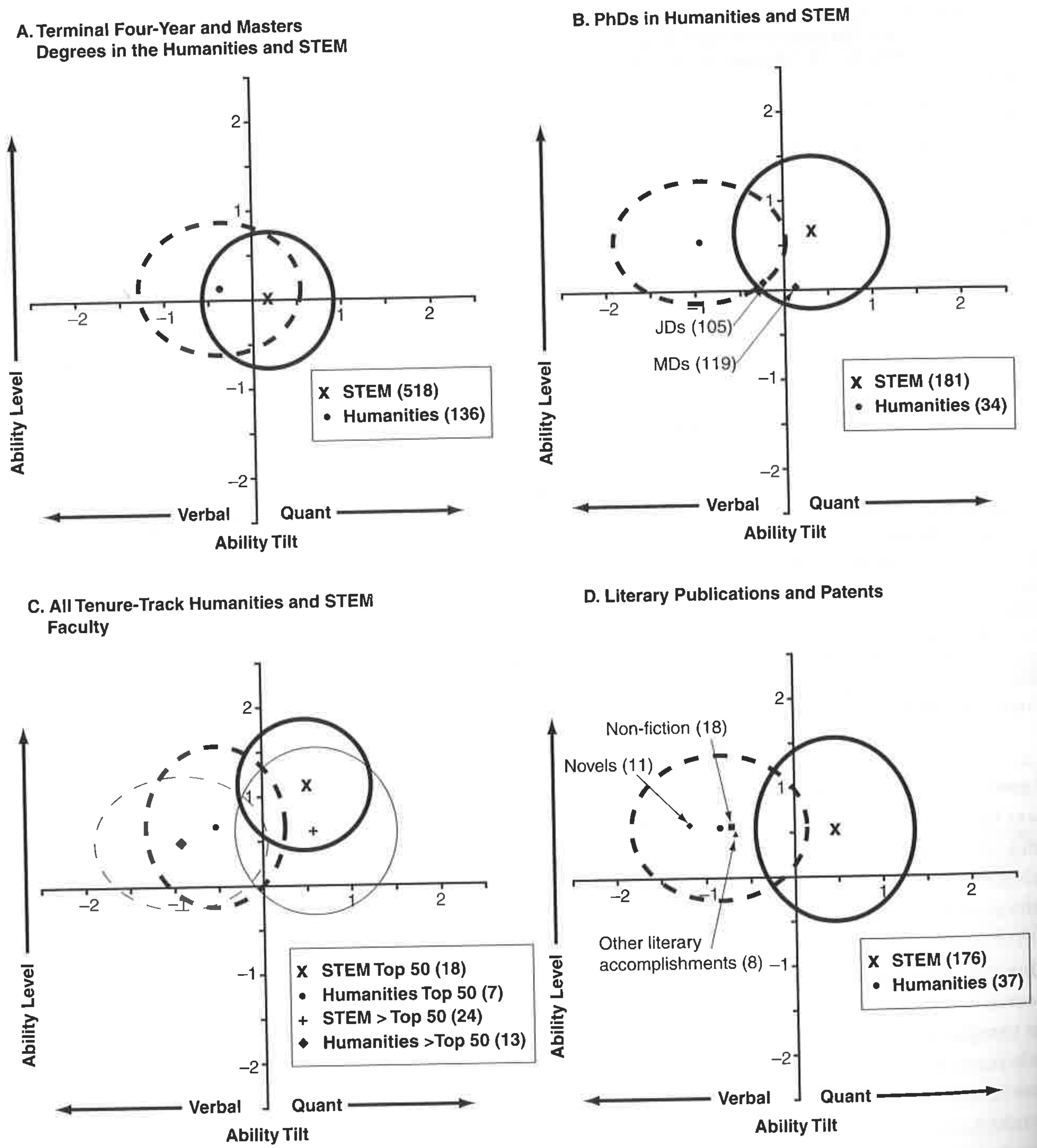

FIGURE 31.5. Participants' achievements as a function of ability tilt (SAT score in math minus SAT score in verbal reasoning) and ability level (sum of both SAT scores), in standard deviation units. The achievement categories included (A) completing a terminal bachelor's or master's degree, (B) completing a doctoral degree (means for MDs and JDs are also shown), (C) securing a tenure-track faculty position, and (D) publishing a literary work or securing a patent. In each graph, bivariate means are shown for achievements in humanities and in science, technology, engineering, and mathematics (STEM); the circle surrounding each mean indicates the space within 1 standard deviation on each dimension. The *n* for each group is indicated in parentheses. From "Contrasting Intellectual Patterns for Creativity in the Arts and Sciences: Tracking Intellectually Precocious Youth Over 25 Years," by G. Park, D. Lubinski, and C. P. Benbow, 2007, *Psychological Science, 18*, p. 950. Copyright 2007 by Sage. Adapted with permission.

representation shows a variety of educational, occupational, and creative outcomes accomplished by these participants over 25 years. Bivariate means in the humanities are surrounded by a dotted line and those for STEM are surrounded by a solid line, which are defined as ± 1 standard deviation on x and y, respectively, for members in each group.

In all panels, outcomes in the humanities and STEM are examined because they have large enough sample sizes to produce statistically stable results. Yet, bivariate points for other outcomes are also shown (e.g., MDs, JDs, novelists, & nonfiction writers). The ability-level increases and differential ability strength becomes more distinctive when looking from students with terminal bachelor's or master's degrees (panel A) to students with doctoral degrees (panel B). Tenured faculty at major universities (panel C) are particularly distinct, as are those with literary publications and patents (panel D). SMPY participants achieving these qualitatively different outcomes occupy different regions of the intellectual space as defined by these dimensions. These differences are detectable in early adolescence; however, they routinely go unnoticed because most of these students earn top scores on both SAT scales before they graduate high school (a ceiling problem). For this population, the SAT is no longer capable of distinguishing students with high ability from students with exceptionally high ability—differences that matter among intellectually precocious youth. The next longitudinal study reviewed underscores this idea with a group of 320 profoundly gifted participants (IQ ≥ 160).

Figure 31.6 graphs a 25-year longitudinal study of the creative outcomes of a group of SMPY participants (Kell, Lubinski, & Benbow, 2013) who scored at least 700 in math or at least 630 in verbal reasoning (or both) on the SAT before age 13 (i.e., the top 0.01% of students). In this graph, the SAT math score is on the x-axis and the SAT verbal reasoning score is on the y-axis. The smaller, dark gray ellipses represent ±1 standard error of the mean on the x-axis and the y-axis for participants within each major area, whereas the larger, light gray ellipses represent ±1 standard deviation. The profoundly gifted, like the gifted (Park et al., 2007) and typical college students (Gottfredson, 2003; Humphreys et al., 1993; Wai et al., 2009), tend to gravitate toward their ability strength. Essentially, all these students possess more mathematical and verbal reasoning ability than typical PhDs across all disciplines (Wai et al., 2009), yet they pursue learning, work, and creative endeavors in areas supportive of their greatest strength.

Moreover, the level of accomplishments among these profoundly gifted participants is astonishing (cf. Kell, Lubinski, & Benbow, 2013, Tables 1–3), including obtaining doctoral degrees (44% of participants), academic tenure at research universities (7.5% of participants), and patents (18% of participants). Several are vice presidents, partners, and department heads in the corporate sector, law, medicine, or information technology. These accomplishments far surpass midlife outcomes among students identified as in the top 1% of individuals with ability (Lubinski et al., 2014). Although these findings are clarifying with respect to ability level and pattern, adding a neglected dimension of intellectual functioning to mathematical and verbal reasoning provides even greater clarity and psychological insight.

Spatial Ability

In the late 1970s, because of his interest in identifying and developing scientific talent, Julian Stanley gave a group of 563 SMPY talent search participants, identified by their SAT scores at age 13, tests of spatial ability designed for high school seniors. He was unsure what these instruments would measure, but he wanted to find ways to better meet the gifted students' educational needs, and he thought these instruments might provide some clues. Stanley encouraged the students to do their best, and findings suggest they took this task seriously. Information about students' educational and occupational outcomes was collected at age 18 (after high school), age 23 (after college), and age 33 (early career; Shea, Lubinski, & Benbow, 2001). More recently, at age 48, information was collected about their creative accomplishments (Kell, Lubinski, Benbow, & Steiger, 2013). In both studies, three specific abilities—mathematical, verbal, and spatial reasoning—were found to have unique value for predicting meaningful outcomes, relative to the other two.

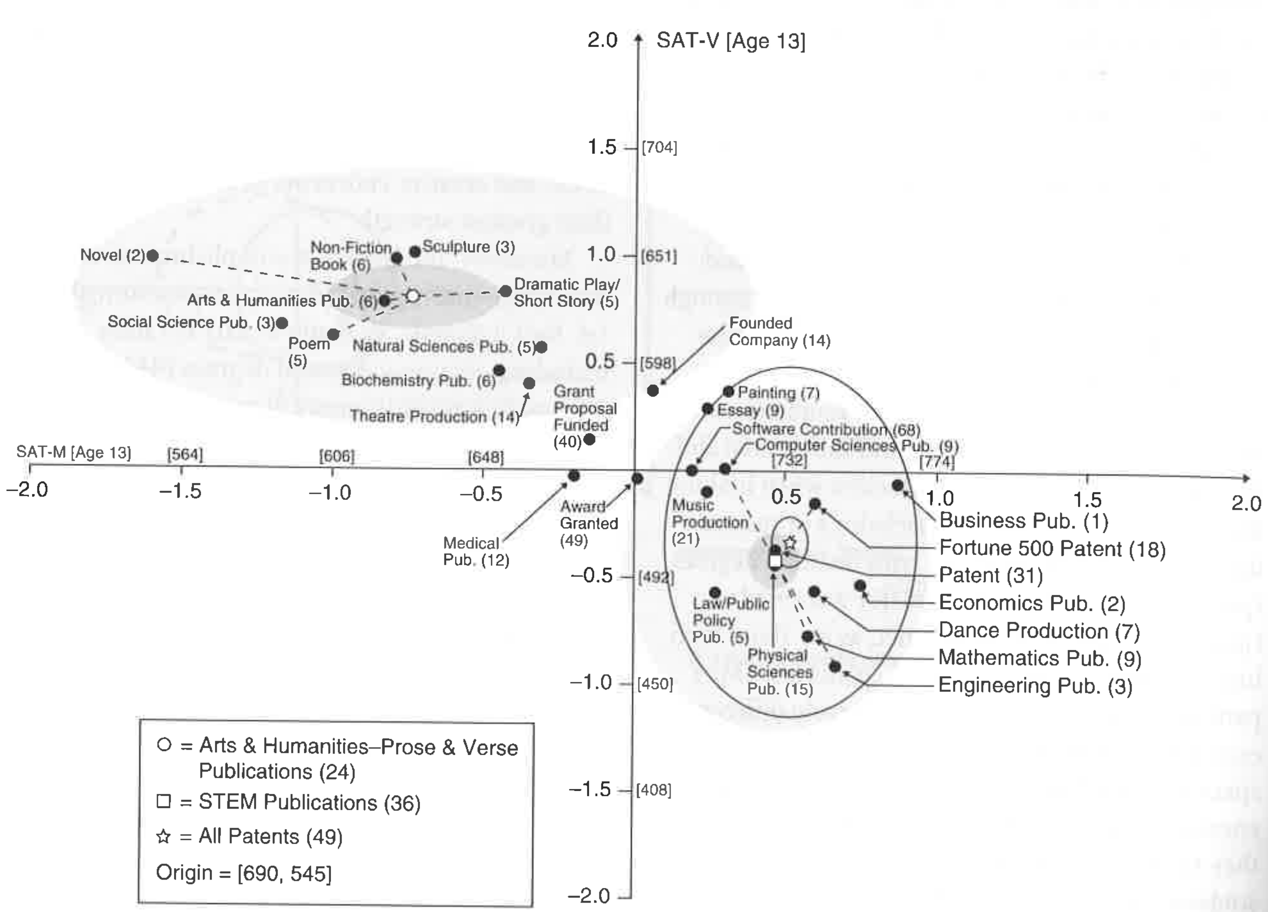

FIGURE 31.6. Bivariate means for scores on the SAT in math (SAT-M) and in verbal reasoning (SAT-V) at age 13 within creative-accomplishment category at age 38. Means for individual categories are represented by black circles; the sample sizes for these categories are in parentheses. White shapes (i.e., circle, star, square) represent rationally derived centroids (*ns* for these centroids are indicated in the key). The dashed lines emanating from a centroid indicate its constituents. Each centroid is surrounded by two elliptical tiers that highlight the concentration of points (gray shading or black outlines): an inner ellipse formed by the standard errors of the SAT-M and SAT-V means within that centroid (i.e., width and length = ±1 SEM for SAT-M and SAT-V, respectively) and an outer ellipse formed by the standard deviations of the SAT scores in that centroid (i.e., width and length = ±1 SD for SAT-M and SAT-V, respectively). Along the axes, unbracketed values are SAT-M and SAT-V scores in z-score units, and bracketed values are raw SAT scores. STEM = science, technology, engineering, and mathematics. From "Who Rises to the Top? Early Indicators," by H. J. Kell, D. Lubinski, and C. P. Benbow, 2013, *Psychological Science, 24,* p. 652. Copyright 2013 by Sage. Adapted with permission.

The three-dimensional plots in Figure 31.7 contain the educational outcomes of this sample at age 18 (panels A & B) and age 23 (panel C), and occupational outcomes at age 33 (panel D). In standard deviation units, the SAT math score is on the x-axis and the SAT verbal reasoning score is on the y-axis. The dots at the end of each arrow denote these bivariate points for each group of participants. Spatial ability is also scaled in standard deviation units using arrows: arrows to the right are positive values, and arrows to the left are negative values. Arrows showing positive values would be rotated up at a 90-degree angle from the x- and y-axes, and arrows showing negative values would be rotated down. The arrowheads constitute the location that these trivariate points occupy in three-dimensional space.

For this gifted sample (i.e., the top 1% of students), those who find humanities to be their favorite high

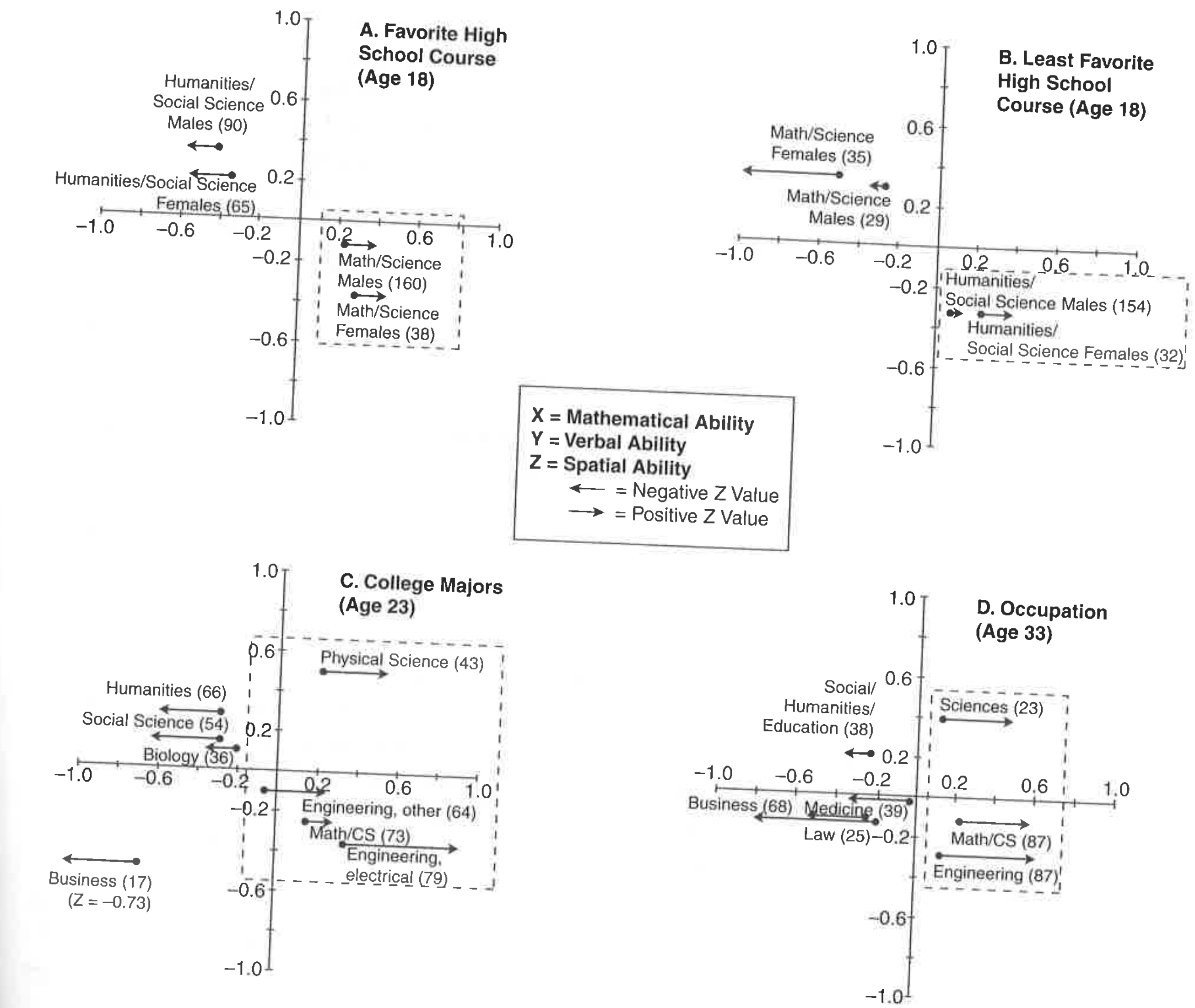

FIGURE 31.7. Shown are trivariate (*X/Y/Z* = mathematical/verbal/spatial) means for (A) favorite and (B) least favorite high school course at age 18, (C) college majors at age 23, and (D) occupation at age 33. Arrows to the right indicate a positive *z* value and arrows to the left indicate a negative *z* value. A and B are standardized within sex; C and D are standardized across sexes. Note that the length of the arrow for business in Panel C is actually $z = -0.73$. CS = computer science. Adapted from "Spatial Ability for STEM Domains: Aligning Over 50 Years of Cumulative Psychological Knowledge Solidifies Its Importance," by J. Wai, D. Lubinski, and C. P. Benbow, 2009, *Journal of Educational Psychology, 101,* pp. 820, 824. Copyright 2009 by the American Psychological Association.

school course tend to have an intellectual repertoire dominated by verbal ability relative to mathematical and spatial ability, whereas the inverse is true for students who prefer STEM courses. This is not only true for preferences for learning environments, but it also is true for occupations. Individuals with occupations in STEM possess salient mathematical and spatial abilities relative to their verbal ability. Statistical analyses revealed that each of these specific abilities provided incremental validity relative to the other two in the prediction of the location of these three groups in three-dimensional space; neglecting any one leaves a critical component missing. Doing so compromises a psychological understanding of intellectually precocious youth. This idea was reinforced 15 years later when data were collected about these participants' creative accomplishments (Kell, Lubinski, Benbow, & Steiger, 2013).

Kell, Lubinski, Benbow, and Steiger (2013) followed up with participants at age 48. They were interested in examining something that had not been studied before—does spatial ability add value for creative outcomes (creating knowledge)? Shea et al. (2001) and others (Humphreys et al., 1993; Wai et al., 2009; Webb, Lubinski, & Benbow, 2007), already established that spatial ability adds value to measures of mathematical and verbal reasoning ability in educational settings (assimilating knowledge) and in occupational settings (using knowledge). However, was Howard Gardner (1983) correct, "it is skill in spatial ability that will determine how far one will go in science" (p. 192)?

Kell, Lubinski, Benbow, and Steiger (2013) identified outcomes deemed genuinely creative for the 563 participants studied by Shea et al. (2001). The final groupings identified for analysis (with sample sizes in parentheses) were three types of academic publications—art–humanities–law–social sciences (27), biology–medicine (35), STEM (65)—and patents (33). These categories are mutually exclusive and exhaustive, because participants who earned patents and also had papers published are placed in the relevant publication category; the 33 individuals placed in the patent category did not have a publication at the time of follow up. Using a discriminant function analysis, participants' mathematical, spatial, and verbal ability assessments at age 13 were used to predict these outcomes at age 48. When only mathematical and verbal ability scores were used, they accounted for 10.5% of the variance in these group outcomes ($p < .01$); when spatial ability was also used, an additional 7.5% of the variance was accounted for ($p < .01$). Although it has been known for years that level and pattern of mathematical and verbal ability are important for forecasting the likelihood and nature of creative outcomes among intellectually precocious youth over multiple decades (Park et al., 2007, 2008; Wai, Lubinski, & Benbow 2005), this is the first demonstration that spatial ability adds additional value.

A trivariate (mathematical/spatial/verbal) three-dimensional plot of these findings is found in Figure 31.8. Each trivariate point is surrounded by ellipsoids, which represent three standard errors of each ability. The creative outcomes under analysis are supported by different configurations of intellectual talent. For example, among participants who secure patents, spatial ability is commensurate with those who publish in STEM, but the latter are more impressive in mathematical and verbal reasoning. Participants who publish in art–humanities–law–social sciences are the lowest of all in spatial ability. (The smallest ellipsoid constitutes the location of the remaining participants, those who did not secure one of these outcomes. Its small size is due to the large sample of participants that remained, which generates small standard errors.) This graph is psychologically informative. It represents the intellectual design space of creative thought.

Placing Ability Findings on the Gifted in a Broader Context

One attractive feature of these findings is that they are all in excellent accord with basic science findings within the psychological study of individual differences. When Shea et al. (2001) was in the review process, one of the referees, David Lohman, made the following observation. He pointed out that while findings were informative, he wondered how these three abilities would operate in less select populations, and particularly among students who were not involved in a "talent search." To address this question, we analyzed data from Project TALENT (Flanagan et al., 1962).

Project TALENT (Flanagan et al., 1962) is a stratified random sample of U.S. high schools. Because of its comprehensiveness and size, longitudinal findings from Project TALENT are compelling. They illustrate the role that specific abilities play in developing expertise in qualitatively different disciplines. Project TALENT's initial data collection occurred in 1960, and consisted of a stratified random sample of the U.S. high school population. Students in the ninth through 12th grades (50,000 boys and 50,000 girls from each grade; $N = 400{,}000$) were assessed, over a 1-week period, on a wide range of ability and information tests, interest and personality questionnaires, and an extensive 398-item biographical information form. Measures designed to assess general intelligence and specific abilities (mathematical, verbal, and spatial reasoning) were included. Project TALENT's follow ups were conducted at 1, 5, and 11 years after graduation from high school (Wise, McLaughlin, & Steel, 1979). Particular attention was devoted to educational and occupational accomplishments.

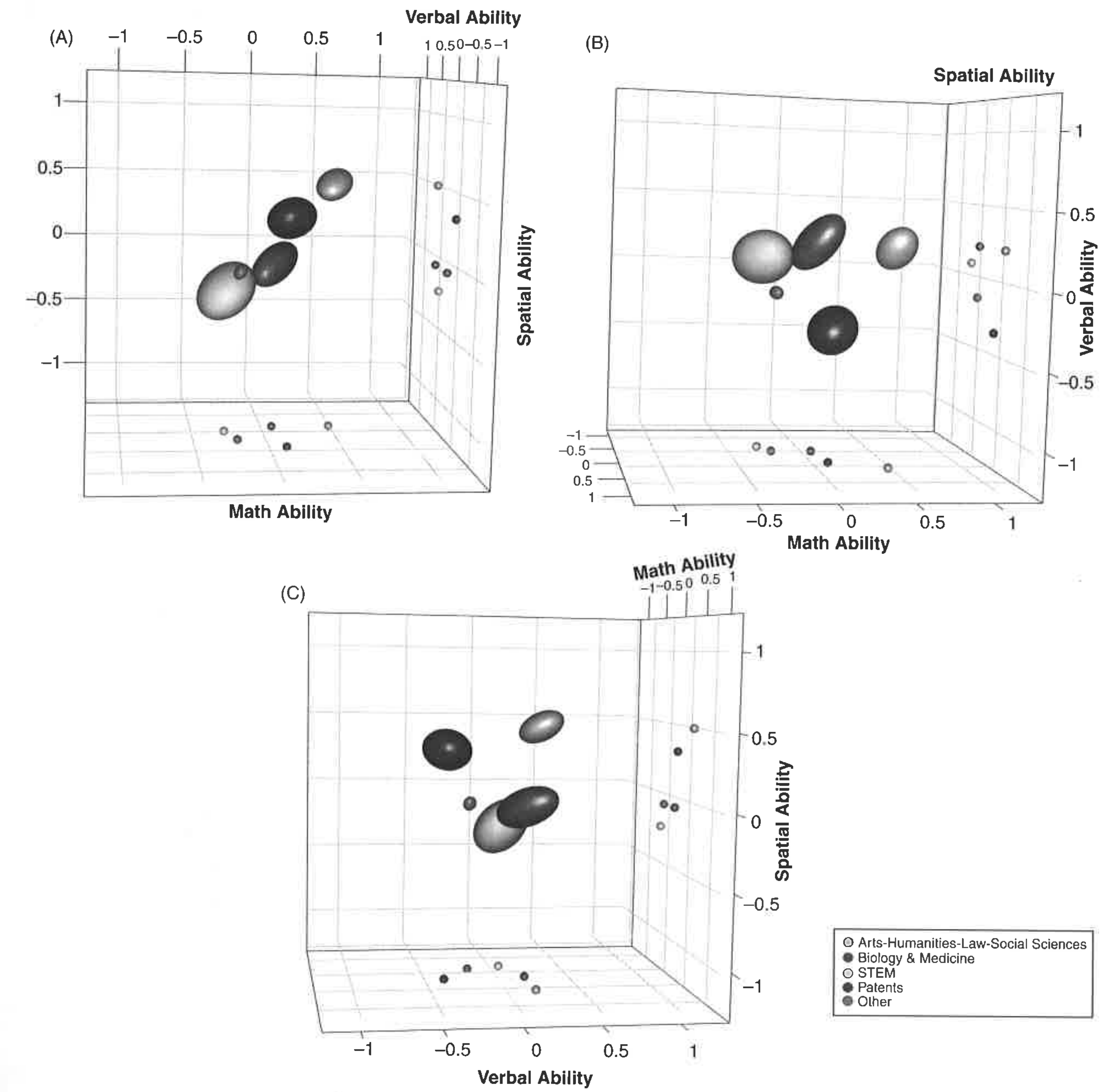

FIGURE 31.8. Confidence ellipsoids showing the locations of the four criterion groups in the three-dimensional space defined by scores for mathematical, verbal, and spatial reasoning ability. The data are rotated such that the graph in A shows mathematical ability on the x-axis, spatial ability on the y-axis, and verbal ability on the z-axis; the graph in B shows mathematical ability on the x-axis, verbal ability on the y-axis, and spatial ability on the z-axis; and the graph in C shows verbal ability on the x-axis, spatial ability on the y-axis, and mathematical ability on the z-axis. The ellipsoids are scaled so that each semiprincipal axis is approximately equal in length to the standard error of the corresponding principal component. Each ellipsoid is centered on the trivariate mean (centroid), and bivariate means are plotted on the bordering grids. The criterion groups were defined as participants with a peer-reviewed publication in the arts, humanities, law, or social sciences; a peer-reviewed publication in biology or medicine; a peer-reviewed publication in science, technology, engineering, or mathematics (STEM); or a patent. In addition, an ellipsoid is shown for participants with none of these creative accomplishments ("other"). From "Creativity and Technical Innovation: Spatial Ability's Unique Role," by H. J. Kell, D. Lubinski, C. P. Benbow, and J. H. Steiger, 2013, *Psychological Science, 24,* p. 1834. Copyright 2013 by H. J. Kell, D. Lubinski, C. P. Benbow, and J. H. Steiger. Reprinted with permission.

Figure 31.9 graphs the general and specific ability profiles of students earning terminal degrees in nine disciplines. Because highly congruent findings were observed across ninth through 12th grades, the cohort's standardized z scores are averaged. An equally weighted composite of the three specific abilities (designed to measure *g*) is plotted on the x-axis in z-score units. The z scores for each specific ability are plotted on the y-axis.

The intellectual hierarchy revealed on the x-axis has been observed for decades (Humphreys et al., 1993; Lubinski, 2010; Wai et al., 2009). Students in the STEM disciplines typically possess higher levels of general intelligence relative to students in other disciplines. But critically, there is another major difference between students who secure advanced degrees in STEM and students in other disciplines: For all STEM educational groupings found in Figure 31.9 (and the advanced degrees within these groupings), spatial ability is greater than verbal ability; whereas, for the other six disciplines (from education to biology), spatial ability is less than verbal ability (except bachelor's degrees in business). Adolescents who earned advanced educational credentials in STEM manifested a spatial/verbal ability pattern opposite that of students who earned educational credentials in other areas.

These findings highlight different intellectual architectures for learning and work. People pursuing STEM disciplines have a different intellectual orientation to problem solving, and they approach learning, work, and novel problems with a different set of relative strengths. The results in Figure 31.9 complement evidence showing that contrasting correlational profiles of specific abilities (mathematical, spatial, and verbal) are associated with different configurations of educational/occupational interests and values (Ackerman, 1996; Ackerman & Heggestad, 1997; D. B. Schmidt, Lubinski, & Benbow, 1998). Together, these findings suggest a psychological basis for not only different approaches to learning and work but also life in general (Lubinski, 1996, 2000, 2004). For understanding intellectually precocious students (and indeed all students), understanding the psychological significance of these dimensions of human individuality is critical. Regardless of whether specific abilities are measured or not, they will structure important aspects of learning and psychological development. This is something with which Thurstone's (1952) experiences and observations would resonate.

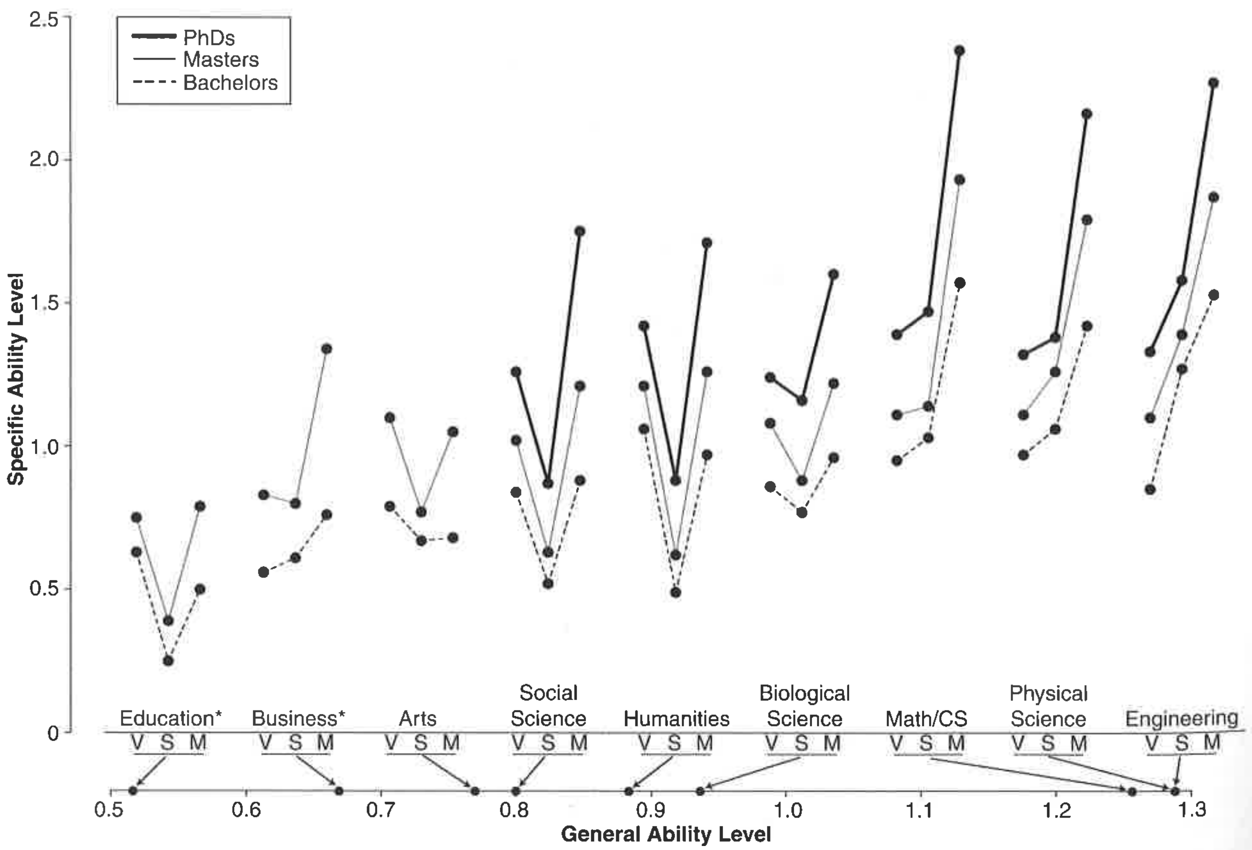

FIGURE 31.9. Average *z* scores of participants on verbal, spatial, and mathematical ability for terminal bachelor's degrees, terminal master's degrees, and doctoral degrees are plotted by field. The groups are plotted in rank order of their normative standing on *g* (verbal [V] + spatial [S] + mathematical [M]) along the x-axis, and the lines with arrows from each field indicate where these disciplines average in general mental ability in *z*-score units. This figure is standardized in relation to all participants with complete ability data at the time of initial testing. *For education and business, master's and doctoral degrees were combined because the doctorate samples for these groups were too small to obtain stability (n < 30). From "Spatial Ability for STEM Domains: Aligning Over 50 Years of Cumulative Psychological Knowledge Solidifies Its Importance," by J. Wai, D. Lubinski, and C. P. Benbow, 2009, *Journal of Educational Psychology, 101*, p. 834. Copyright 2009 by the American Psychological Association.

PRACTICE AND POLICY ISSUES

Level and Pattern of Abilities and Criteria

We know enough now to say that information about individual differences in level and pattern of mathematical, spatial, and verbal reasoning abilities enhances applied and basic science research. The optimal development of talent among intellectually precocious youth requires a more comprehensive characterization of their intellectual architecture with measures that have sufficiently high ceilings. For best practices, all three abilities should be assessed simultaneously to help students and clients understand their strengths and relative weaknesses, and to add precision to longitudinal forecasts about development. To ascertain valid support for this idea, attention needs to be devoted to the level and pattern of criterion outcomes as well, for validating procedures. Different patterns of precocious intellectual talent respond to contrasting opportunities for learning and work in different ways, and the criterion space needs to accommodate a diversity of qualitatively different outcomes to capture differential development.

For example, vast amounts of resources are now being devoted to the development of STEM talent, and for good reasons. STEM innovation drives modern economies. But there are huge differences in the outcomes needed to examine procedures designed to enhance STEM literacy, STEM competence, STEM expertise, and the kind of STEM talent needed for genuine innovation. All these outcomes are important. The public needs to be STEM literate to make informed decisions about whether evolution should be taught in our schools and to make informed decisions about climate change. However, procedures that foster such broad-spectrum development are quite different than identifying the kind of STEM talent, commitment, and opportunities that are needed to genuinely advance STEM innovation. Procedures aimed at the former are similar to individuals consulting health care professionals about an optimal diet and exercise plan, whereas procedures aimed at the latter are more similar to individuals training for the Olympics.[1]

Of the 2,409 intellectually precocious SMPY participants (Figure 31.5), 18 ultimately secured tenure at a top 50 U.S. university in a STEM discipline—a modest, albeit meaningful, criterion for intellectual leadership in STEM innovation. For these 18 participants, their mean SAT score in math before age 13 was 697, and the lowest SAT score in math was 580 (which constitutes the top 60% of the top 1% of high-ability students). This underscores the mathematical reasoning capability of world-class STEM innovators, which is supported by other literature (Friedman, 2007). Furthermore, although criterion level is important, so are different criterion qualities. Figure 31.6, for example, organized creative criterion outcomes for profoundly gifted participants. These participants possess more mathematical and verbal ability than the typical PhD recipient in any discipline (Wai et al., 2009). Yet, a diversity of criterion outcomes needs to be assembled to capture the breadth of their accomplishments. These considerations have a bearing on educationally efficacious interventions designed to enhance cognitive abilities.

[1]Readers interested in educationally efficacious interventions designed for intellectually talented students on the basis of SMPY research findings are referred to Bleske-Rechek, Lubinski, and Benbow (2004), Park, Lubinski, and Benbow (2013), and Wai, Lubinski, Benbow, and Steiger (2010); SMPY's overarching educational philosophy is described in Benbow and Stanley (1996) and Stanley (1996, 2000).

Enhancing Cognitive Ability

Interventions designed to enhance a specific ability (Robinson, Abbott, Berninger, Busse, & Mukhopadhyay, 1997; Uttal et al., 2013) need to consider not only initial ability level but also ability pattern and adjust ultimate outcome expectations accordingly. Ability level structures the magnitude of achievement, whereas ability pattern moderates the nature of development. Evaluations that neglect to measure multiple abilities (with high ceilings) and multiple outcomes (with low base rates) could generate findings that are unjustifiably harsh for validating their procedures. Just as multiple abilities are needed to assess human potential fully, multiple criteria are needed to evaluate the educational efficacy of contrasting interventions. Although enhancing cognitive performance is possible (Robinson et al., 1997; Uttal et al., 2013), markedly changing the developmental trajectories of individuals with salient differences in intellectual strengths and relative weaknesses is a different matter. This idea is reinforced by well-documented findings that nonintellectual educational/occupational interests covary in different ways with measures of mathematical, spatial, and verbal reasoning. Appreciable intraindividual differences in cognitive abilities reflect motivational differences for gravitating toward contrasting opportunities in educational and occupational settings (Ackerman, 1996; Ackerman & Heggestad, 1997). Collectively, these ability/motivational amalgams signal contrasting orientations to learning and work (Lubinski, 1996, 2000), which jointly structure development down different paths.

Spatial Ability: A Neglected Talent

When the senior author of this chapter was a postdoctoral fellow with Lloyd G. Humphreys (1987–1990), working on problems associated with spatial ability's unique role in understanding educational and occupational phenomena relative to mathematical and verbal reasoning abilities (Humphreys & Lubinski, 1996; Humphreys et al., 1993; Lubinski & Humphreys, 1990a, 1990b), Humphreys sent a letter to Julian C. Stanley. Humphreys was complimentary of Stanley's work, showing the importance of going beyond IQ for identifying students with intellectual gifts, and the value added by mathematical reasoning measures for engineering and the physical sciences in particular. There was always a "but" with Humphreys, however, and this letter was no exception.

Humphreys went on to say that what Stanley had done for mathematical ability also could be done with spatial ability. This would identify another population of students with a distinct set of intellectual gifts for nonverbal ideation; they would have somewhat different educational needs, and they would have differential promise for contrasting outcomes in the world of work and for creative expression. In Stanley's brief response, he was appreciative, noted that Humphreys was likely correct about spatial ability, and added that carrying out his proposal would involve another career. (Stanley had just retired.)

This idea was based on Humphreys (1962) extensive experience, using measures of spatial ability to classify military personal throughout the 1950s, and Humphreys provided compelling empirical support for his ideas about the spatially gifted a few years after writing to Stanley (Gohm, Humphreys, & Yao, 1998). Humphreys showed that intellectually talented students whose intellectual strength was in spatial ability were at risk for underachievement educationally and underemployment occupationally. The following year, R. E. Snow (1999), perhaps the leading authority at the time on the educational significance of spatial ability, had this to say:

> There is good evidence that [visual-spatial reasoning] relates to specialized achievements in fields such as architecture, dentistry, engineering, and medicine . . . Given this plus the longstanding anecdotal evidence on the role of visualization in scientific discovery . . . it is incredible that there has been so little programmatic research on admissions testing in this domain. (p. 136)

The reason for detailing this history is not to appeal to authority but, rather, to document what leading scientific authorities routinely observe from consistent and powerful longitudinal findings on the basis of huge samples. Furthermore, *most of the findings involving spatial ability reported in this chapter came subsequent to their remarks.* With the replication crises ever present in the psychological sciences (Open Science Collaboration, 2015), we not only need to ask why human cognitive abilities with powerful effects are not being measured with appropriate ceilings, but why spatial ability is being neglected altogether (Lubinski, 2010). Estimates that modern talent searches miss over half of the top 1% of students in spatial ability are available (Wai et al., 2009). This is the largest untapped source of human talent that we know of, and it is critical for the technical professions.

Given that spatial ability adds value as a function of its conditional relationships with mathematical and verbal reasoning (Kell, Lubinski, Benbow, & Steiger, 2013; Wai et al., 2009), spatial ability is also important to fully understanding the learning needs and potential of all students. Examining Figure 31.9 places this idea in an especially clear light for typical college students, and Figures 31.6 and 31.8 do the same for students with intellectual gifts. Moreover, given the proportion of students in the top 1% on spatial visualization, but who are relatively unimpressive in mathematical or verbal reasoning (Gohm et al., 1998; Humphreys & Lubinski, 1996; Humphreys et al., 1993), a critical source of human capital for advanced technical professions (e.g., master carpenters, master electricians, master plumbers) is readily identifiable. These, among other critical occupations for supporting our infrastructure, are professions that cannot be outsourced, and they are deeply needed. With so many calls to reconceptualize intelligence, and concerns about psychological findings replicating, we need to ask ourselves why we are neglecting these important and robust findings.

CONCLUSION

Fifty years ago, E. G. Williamson (1965) published an important scholarly treatment of the empirical findings, history, and philosophy of educational and vocational counseling from an individual differences point of view; Williamson (1965) should be required reading for educational and career counselors. Among other things, he expressed concern about the extent to which psychologists relied too heavily on subjective assessment tools (questionnaires and self-reports) for educational and vocational counseling, and the neglect of objective appraisals of capability. Williamson's (1965) concern has intensified over time (Lubinski, 2010). Williamson (1965) stressed that assessing feelings and thinking were critical and merit commensurate attention. Given the 50 years of longitudinal findings on the importance of level and pattern of mathematical, spatial, and verbal abilities, a firm scientific edifice of human intellectual capability is available from which to build.[2] This is true for intellectually talented students, as well as all students. What better way to mark the 50-year anniversary of Williamson (1965) than to reinstate his call to avoid a "truncated form of vocational assessment" (p. 140). Doing so not only underscores an important exception to the short half-life of psychological findings (Cronbach, 1975) but, quite likely, Thurstone (1952) would find this worthy of talking about.

References

Ackerman, P. L. (1996). A theory of adult intellectual development: Process, personality, interests, and knowledge. *Intelligence*, *22*, 227–257. http://dx.doi.org/10.1016/S0160-2896(96)90016-1

Ackerman, P. L., & Heggestad, E. D. (1997). Intelligence, personality, and interests: Evidence for overlapping traits. *Psychological Bulletin*, *121*, 219–245. http://dx.doi.org/10.1037/0033-2909.121.2.219

Benbow, C. P. (1992). Academic achievement in mathematics and science of students between ages 13 and 23: Are there differences among students in the in the top one percent of mathematical ability? *Journal of Educational Psychology*, *84*, 51–61. http://dx.doi.org/10.1037/0022-0663.84.1.51

Benbow, C. P., & Lubinski, D. (2006). Julian C. Stanley, Jr. (1918–2005). *American Psychologist*, *61*, 251–252. http://dx.doi.org/10.1037/0003-066X.61.3.251

Benbow, C. P., & Stanley, J. C. (1996). Inequity in equity: How "equity" can lead to inequity for high-potential students. *Psychology, Public Policy, and Law*, 2, 249–292. http://dx.doi.org/10.1037/1076-8971.2.2.249

Bleske-Rechek, A., Lubinski, D., & Benbow, C. P. (2004). Meeting the educational needs of special populations. *Psychological Science*, *15*, 217–224. http://dx.doi.org/10.1111/j.0956-7976.2004.00655.x

[2]While this chapter was in production, three articles appeared that reinforce the scientific significance of these conclusions (Clynes, 2016; Lubinski, 2016; Makel, Kell, Lubinski, Putallaz, & Benbow, 2016).

Carroll, J. B. (1993). *Human cognitive abilities: A survey of factor analytic studies*. http://dx.doi.org/10.1017/CBO9780511571312

Clynes, T. (2016). How to raise a genius: Lessons from a 45-year study of super-smart children. *Nature, 537*, 152–155. http://dx.doi.org/10.1038/537152a

Cronbach, L. J. (1975). Beyond the two disciplines of scientific psychology. *American Psychologist, 30*, 116–127. http://dx.doi.org/10.1037/h0076829

Ferriman, K., Lubinski, D., & Benbow, C. P. (2009). Work preferences, life values, and personal views of top math/science graduate students and the profoundly gifted: Developmental changes and gender differences during emerging adulthood and parenthood. *Journal of Personality and Social Psychology, 97*, 517–532. http://dx.doi.org/10.1037/a0016030

Flanagan, J. C., Dailey, J. T., Shaycoft, M. F., Gorman, W. A., Orr, D. B., & Goldberg, I. (1962). *Design for a study of American youth*. Boston, MA: Houghton Mifflin.

Frey, M. C., & Detterman, D. K. (2004). Scholastic assessment or *g*? The relationship between the Scholastic Assessment Test and general cognitive ability. *Psychological Science, 15*, 373–378. http://dx.doi.org/10.1111/j.0956-7976.2004.00687.x

Friedman, T. L. (2007). *The world is flat: A brief history of the 21st century* (3rd ed.). New York, NY: Farrar, Straus & Giroux.

Gardner, H. (1983). *Frames of mind*. New York, NY: Basic Books.

Gohm, C. L., Humphreys, L. G., & Yao, G. (1998). Underachievement among spatially gifted students. *American Educational Research Journal, 35*, 515–531. http://dx.doi.org/10.3102/00028312035003515

Gottfredson, L. S. (1997). Foreword to "Intelligence and social policy." *Intelligence, 24*, 1–12. http://dx.doi.org/10.1016/S0160-2896(97)90010-6

Gottfredson, L. S. (2003). The challenge and promise of cognitive career assessment. *Journal of Career Assessment, 11*, 115–135. http://dx.doi.org/10.1177/1069072703011002001

Gottfredson, L. S. (2004). Intelligence: Is it the epidemiologists' elusive "fundamental cause" of social class inequalities in health? *Journal of Personality and Social Psychology, 86*, 174–199. http://dx.doi.org/10.1037/0022-3514.86.1.174

Humphreys, L. G. (1962). The organization of human abilities. *American Psychologist, 17*, 475–483.

Humphreys, L. G., & Lubinski, D. (1996). Brief history and psychological significance of assessing spatial visualization. In C. P. Benbow & D. Lubinski (Eds.), *Intellectual talent: Psychometric and social issues* (pp. 116–140). Baltimore, MD: Johns Hopkins University Press.

Humphreys, L. G., Lubinski, D., & Yao, G. (1993). Utility of predicting group membership and the role of spatial visualization in becoming an engineer, physical scientist, or artist. *Journal of Applied Psychology, 78*, 250–261. http://dx.doi.org/10.1037/0021-9010.78.2.250

Hunt, E. (2011). *Human intelligence*. Cambridge, England: Cambridge University Press.

Jensen, A. R. (1998). *The g factor*. Westport, CT: Praeger.

Kell, H. J., Lubinski, D., & Benbow, C. P. (2013). Who rises to the top? Early indicators. *Psychological Science, 24*, 648–659. http://dx.doi.org/10.1177/0956797612457784

Kell, H. J., Lubinski, D., Benbow, C. P., & Steiger, J. H. (2013). Creativity and technical innovation: Spatial ability's unique role. *Psychological Science, 24*, 1831–1836. http://dx.doi.org/10.1177/0956797613478615

Lubinski, D. (1996). Applied individual differences research and its quantitative methods. *Psychology, Public Policy, and Law, 2*, 187–203. http://dx.doi.org/10.1037/1076-8971.2.2.187

Lubinski, D. (2000). Scientific and social significance of assessing individual differences: "Sinking shafts at a few critical points." *Annual Review of Psychology, 51*, 405–444. http://dx.doi.org/10.1146/annurev.psych.51.1.405

Lubinski, D. (2004). Introduction to the special section on cognitive abilities: 100 years after Spearman's (1904) "'General intelligence,' objectively determined and measured." *Journal of Personality and Social Psychology, 86*, 96–111. http://dx.doi.org/10.1037/0022-3514.86.1.96

Lubinski, D. (2009). Exceptional cognitive ability: The phenotype. *Behavior Genetics, 39*, 350–358. http://dx.doi.org/10.1007/s10519-009-9273-0

Lubinski, D. (2010). Neglected aspects and truncated appraisals in vocational counseling: Interpreting the interest-efficacy association from a broader perspective: Comment on Armstrong and Vogel (2009). *Journal of Counseling Psychology, 57*, 226–238. http://dx.doi.org/10.1037/a0019163

Lubinski, D. (2016). From Terman to today: A century of findings on intellectual precocity. *Review of Educational Research, 86*, 900–944. http://dx.doi.org/10.3102/0034654316675476

Lubinski, D., & Benbow, C. P. (2000). States of excellence. *American Psychologist, 55*, 137–150. http://dx.doi.org/10.1037/0003-066X.55.1.137

Lubinski, D., & Benbow, C. P. (2006). Study of Mathematically Precocious Youth after 35 years: Uncovering antecedents for the development of math-science expertise. *Perspectives on Psychological Science, 1*, 316–345. http://dx.doi.org/10.1111/j.1745-6916.2006.00019.x

Lubinski, D., Benbow, C. P., & Kell, H. J. (2014). Life paths and accomplishments of mathematically precocious males and females four decades later. *Psychological Science, 25*, 2217–2232. http://dx.doi.org/10.1177/0956797614551371

Lubinski, D., & Humphreys, L. G. (1990a). Assessing spurious "moderator effects": Illustrated substantively with the hypothesized ("synergistic") relation between spatial and mathematical ability. *Psychological Bulletin, 107*, 385–393. http://dx.doi.org/10.1037/0033-2909.107.3.385

Lubinski, D., & Humphreys, L. G. (1990b). A broadly based analysis of mathematical giftedness. *Intelligence, 14*, 327–355. http://dx.doi.org/10.1016/0160-2896(90)90022-L

Lubinski, D., & Humphreys, L. G. (1997). Incorporating general intelligence into epidemiology and the social sciences. *Intelligence, 24*, 159–201. http://dx.doi.org/10.1016/S0160-2896(97)90016-7

Makel, M. C., Kell, H. J., Lubinski, D., Putallaz, M., & Benbow, C. P. (2016). When lightning strikes twice: Profoundly gifted, profoundly accomplished. *Psychological Science, 27*, 1004–1018. http://dx.doi.org/10.1177/0956797616644735

Murray, C. (1998). *Income, inequality, and IQ*. Washington, DC: AEI Press.

Murray, C. (2002). IQ and income inequality in a sample of sibling pairs from advantaged family backgrounds. *American Economic Review, 92*, 339–343. http://dx.doi.org/10.1257/000282802320191570

Open Science Collaboration. (2015). Estimating the reproducibility of psychological science. *Science, 349*, aac4716. http://dx.doi.org/10.1126/science.aac4716

Park, G., Lubinski, D., & Benbow, C. P. (2007). Contrasting intellectual patterns predict creativity in the arts and sciences: Tracking intellectually precocious youth over 25 years. *Psychological Science, 18*, 948–952. http://dx.doi.org/10.1111/j.1467-9280.2007.02007.x

Park, G., Lubinski, D., & Benbow, C. P. (2008). Ability differences among people who have commensurate degrees matter for scientific creativity. *Psychological Science, 19*, 957–961. http://dx.doi.org/10.1111/j.1467-9280.2008.02182.x

Park, G., Lubinski, D., & Benbow, C. P. (2013). When less is more: Effects of grade skipping on adult STEM productivity among mathematically precocious adolescents. *Journal of Educational Psychology, 105*, 176–198. http://dx.doi.org/10.1037/a0029481

Robinson, N. M., Abbott, R. D., Berninger, V. W., Busse, J., & Mukhopadhyay, S. (1997). Developmental changes in mathematically precocious young children. *Gifted Child Quarterly, 41*, 145–158. http://dx.doi.org/10.1177/001698629704100404

Schmidt, D. B., Lubinski, D., & Benbow, C. P. (1998). Validity of assessing educational-vocational preference dimensions among intellectually talented 13-year-olds. *Journal of Counseling Psychology, 45*, 436–453. http://dx.doi.org/10.1037/0022-0167.45.4.436

Schmidt, F. L., & Hunter, J. (2004). General mental ability in the world of work: Occupational attainment and job performance. *Journal of Personality and Social Psychology, 86*, 162–173. http://dx.doi.org/10.1037/0022-3514.86.1.162

Schmidt, F. L., & Hunter, J. E. (1998). The validity and utility of selection methods in personnel psychology: Practical and theoretical implications of 85 years of research findings. *Psychological Bulletin, 124*, 262–274. http://dx.doi.org/10.1037/0033-2909.124.2.262

Shea, D. L., Lubinski, D., & Benbow, C. P. (2001). Importance of assessing spatial ability in intellectually talented young adolescents: A 20-year longitudinal study. *Journal of Educational Psychology, 93*, 604–614. http://dx.doi.org/10.1037/0022-0663.93.3.604

Snow, R. E. (1999). Commentary: Expanding the breadth and depth of admissions testing. In S. Messick (Ed.), *Assessment in higher education: Issues of access, quality, student development, and public policy* (pp. 133–140). Hillsdale, NJ: Erlbaum.

Snow, R. E., Corno, L., & Jackson, D., III. (1996). Individual differences in affective and conative functions. In D. C. Berliner & R. C. Calfee (Eds.), *Handbook of educational psychology* (pp. 243–310). New York, NY: Macmillan.

Stanley, J. C. (1996). SMPY in the beginning. In C. P. Benbow & D. Lubinski (Eds.), *Intellectual talent: Psychometric and social issues* (pp. 225–235). Baltimore, MD: Johns Hopkins University Press.

Stanley, J. C. (2000). Helping students learn only what they don't already know. *Psychology, Public Policy, and Law, 6*, 216–222. http://dx.doi.org/10.1037/1076-8971.6.1.216

Terman, L. M. (1954). The discovery and encouragement of exceptional talent. *American Psychologist, 9*, 221–230. http://dx.doi.org/10.1037/h0060516

Thurstone, L. L. (1952). Autobiography. In E. G. Boring, H. S. Langfeld, H. Werner, & R. M. Yerkes (Eds.), *A history of psychology in autobiography* (Vol. 4, pp. 295–321). Englewood Cliffs, NJ: Prentice Hall.

Uttal, D. H., Meadow, N. G., Tipton, E., Hand, L. L., Alden, A. R., Warren, C., & Newcombe, N. S. (2013). The malleability of spatial skills: A meta-analysis of training studies. *Psychological Bulletin, 139*, 352–402. http://dx.doi.org/10.1037/a0028446

Wai, J., Lubinski, D., & Benbow, C. P. (2005). Creativity and occupational accomplishments among intellectually precocious youth: An age 13 to age 33 longitudinal study. *Journal of Educational Psychology*, *97*, 484–492. http://dx.doi.org/10.1037/0022-0663.97.3.484

Wai, J., Lubinski, D., & Benbow, C. P. (2009). Spatial ability for STEM domains: Aligning over 50 years of cumulative psychological knowledge solidifies its importance. *Journal of Educational Psychology*, *101*, 817–835. http://dx.doi.org/10.1037/a0016127

Wai, J., Lubinski, D., Benbow, C. P., & Steiger, J. H. (2010). Accomplishment in science, technology, engineering, and mathematics (STEM) and its relation to STEM educational dose: A 25-year longitudinal study. *Journal of Educational Psychology*, *102*, 860–871. http://dx.doi.org/10.1037/a0019454

Waller, J. H. (1971). Achievement and social mobility: Relationships among IQ score, education, and occupation in two generations. *Biodemography and Social Biology*, *18*, 252–259. http://dx.doi.org/10.1080/19485565.1971.9987927

Warne, R. T. (2016). Five reasons to put the g back into giftedness: An argument for applying the Cattell–Horn–Carroll theory of intelligence to gifted education research and practice. *Gifted Child Quarterly*. Advance online publication.

Webb, R. M., Lubinski, D., & Benbow, C. P. (2007). Spatial ability: A neglected dimension in talent searches for intellectually precocious youth. *Journal of Educational Psychology*, *99*, 397–420. http://dx.doi.org/10.1037/0022-0663.99.2.397

Wilk, S. L., Desmarais, L. B., & Sackett, P. R. (1995). Gravitation to jobs commensurate with ability: Longitudinal and cross-sectional tests. *Journal of Applied Psychology*, *80*, 79–85. http://dx.doi.org/10.1037/0021-9010.80.1.79

Wilk, S. L., & Sackett, P. R. (1996). Longitudinal analysis of ability–job complexity fit and job change. *Personnel Psychology*, *49*, 937–967. http://dx.doi.org/10.1111/j.1744-6570.1996.tb02455.x

Williamson, E. G. (1965). *Vocational counseling: Some historical, philosophical, and theoretical perspectives*. New York, NY: McGraw-Hill.

Wise, L. L., McLaughlin, D. H., & Steel, L. (1979). *The Project TALENT data bank*. Palo Alto, CA: American Institutes for Research.

Zuckerman, H. (1977). *Scientific elite*. New York, NY: Free Press.

Chapter 32

PSYCHOLOGICAL ISSUES UNIQUE TO THE GIFTED STUDENT

Maureen Neihart and Lay See Yeo

There is a long history of interest in the adjustment of gifted children. Generally, two views have prevailed. The first view is that gifted children as a group are better adjusted than their typically developing peers, because they are capable of greater understanding of self and others. Therefore, they cope better with stress and conflicts. Many empirical studies support this view (Neihart, Pfeiffer, & Cross, 2015). The second view is that gifted children are more at-risk for psychological problems, particularly during adolescence and adulthood, because they are more sensitive to interpersonal conflicts and experience greater degrees of alienation and stress (Silverman, 2012). There is some evidence to support this idea (e.g., Gross, 1993, 2006). Gifted children do have unique psychological issues, but these do not arise from giftedness itself. Rather, giftedness seems to add complexity to an individual that can either enhance or interfere with healthy adjustment, depending on several factors. The aim of this chapter is to summarize the research on these factors and describe practical implications that have an evidence base.

IMPORTANCE OF THE TOPIC

Understanding the psychological functioning of gifted children often has been driven by a desire to improve achievement outcomes, especially academic ones. Adults are keen to know what can be done to help talented young people realize their potential. In developing or emerging countries, there is often an interest in making the most of the nation's talent to further development of the country (Chan, 2010, 2012; Chua, 2014; Garces-Bacsal, 2013). Another reason for investigating the psychological functioning of gifted children has been to support positive adjustment. There has been growing awareness since the 1980s that some adolescents with the highest abilities struggle socially and emotionally as they navigate the developmental trajectory from ability to achievement and from high achievement to elite performance. Psychological needs are the foundation for well-being and achievement, and it is possible to systematically strengthen the mental and emotional competencies necessary for both through targeted supports and intervention (Chua, 2014; Ericsson, Charness, Feltovich, & Hoffman, 2006; Neihart, 2015).

Differences in Global Perspectives

The values and priorities of various cultures are reflected in conceptions of ability, self, well-being, and achievement. Because many of the variables of interest in psychology are social constructions, it is not surprising that conceptions of ability, self, well-being, parenting, teaching, and achievement vary across cultures around the world. Children's development must be understood in its cultural context. A thorough discussion of global perspectives is not possible here but two illustrations of well-known cultural differences in perspectives on ability and on well-being are offered to demonstrate the wide variations that can exist.

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APA Handbook of Giftedness and Talent, S. I. Pfeiffer (Editor-in-Chief)