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Reverse engineering genius: historiometric studies of superlative talent

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Although genius has been defined in the dictionary as requiring an IQ above 140, this definition depends on an arbitrary methodological decision made by Lewis Terman for his longitudinal study of more than 1500 intellectually gifted children, a study that occupies four of the five volumes of *Genetic Studies of Genius*. Yet, only the second volume, by Catharine Cox, studied bona fide geniuses, by applying historiometric methods to 301 highly eminent creators and leaders. After defining historiometric research, I examine the difference between historical genius and intellectual giftedness with respect to heterogeneous intellects, personality differences, and early development and show that the actual relation between IQ and genius is small and heavily contingent on domain-specific assessment, the operation of traits like persistence and openness to experience, and the impact of diversifying experiences, including both developmental adversity and subclinical psychopathology. Hence, the dictionary definition of "genius" has minimal, if any, justification. If, using historiometric methods, one works backward from recognized geniuses, such as those studied by Cox, one might not obtain the kind of sample that Terman obtained for his longitudinal study. The two methods produce two distinct subgroups of the larger population.

Keywords: genius; talent; intelligence; personality; development; historiometrics

Introduction

One reputable dictionary defined genius as "a person who has an exceptionally high intelligence quotient, typically above 140."[1] It has become commonplace to conceive genius in terms of an extraordinarily high IQ score on a standardized test, albeit the specific threshold for receiving that status may vary. But where did this definition come from and how was the number 140 determined? It turns out that this concept emerged less than a century ago as a seemingly arbitrary methodological decision made in 1921 by Lewis M. Terman, when he initiated one of the most ambitious longitudinal studies in the history of psychology.[2] Having a few years earlier developed and standardized what came to be known as the Stanford–Binet Intelligence Scale, Terman wanted to show that children who scored sufficiently high on this new test would grow up to become extremely accomplished adults, even geniuses. The initial cutoff for inclusion in this elite sample was a score of 140, placing the resulting group in the top 1% of the school population. After selecting this criterion, he ended up with well more than 1000 extremely bright children who would be followed into adulthood, the study continuing even after Terman's death in 1956. Although Terman and his colleagues usually referred to these boys and girls as merely "gifted children," the set of five volumes that included the results was published with the title *Genetic Studies of Genius*, thus inadvertently establishing the IQ 140 definition of genius. Terman's methodological choice consequently entered the English language.

As is well known, few, if any, of these children grew up to become recognized geniuses.[3] For example, not one received a Nobel Prize. Ironically, in fact, two boys who were rejected from the sample—because they were deemed not intellectually gifted enough—much later won Nobel Prizes in physics, namely William Shockley and Walter Alvarez. Worse

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yet, although these gifted children differed greatly in adult success, those differences could not be attributed to corresponding contrasts in general intelligence.[4] Instead, other nonintellectual factors and developmental experiences had more discriminating power. Admittedly, the lack of intellectual contrasts might be ascribed to a restriction in range, given the highly selective nature of the sample. Yet that explanation does not suffice. Not only did the brightest and the least bright in the sample differ by more than four standard deviations on the Stanford–Binet scale, but the longitudinal research associated with the Study of Mathematically Precocious Youth has found substantial differences in performance outcomes in extremely exclusive samples.[5] Even the top 1 in 10,000 in mathematical precocity can be distinguished from those who are "merely" in the top 1%, as in Terman's gifted group. So the problem may reside with the real-world implications of IQ test performance per se.

To be sure, the second volume in *Genetic Studies of Genius* would seem to support the IQ definition of genius.[6] Indeed, it is the only volume of the five to have "genius" in its title, rather than just "gifted." Called *The Early Mental Traits of Three Hundred Geniuses*, it is highly unique in four other ways as well. First, it is the only volume that does not include Terman as author or coauthor, but instead was solely authored by his graduate student, Catharine Cox, for her doctoral thesis.[7] Second, it was the sole volume that did not use the sample of intellectually gifted children, but instead collected a sample that included indubitable geniuses, such as Nicholas Copernicus, Charles Darwin, René Descartes, Galileo Galilei, Christian Huygens, Antoine Lavoisier, Justus von Liebig, Carolus Linnaeus, Isaac Newton, and James Watt (if these scientists and inventors cannot be considered geniuses, then the term has no meaning). Third, because these historical figures were deceased at the time of her investigation, they could not take the Stanford–Binet intelligence test that provided the ultimate basis for the other four volumes. Nevertheless, she estimated IQ scores for each but did so using retrospective methods. In particular, where volumes 1, 3, 4, and 5 used psychometric methods, embodied in the IQ test, Cox used historiometric methods based on biographical data.[8] Fourth and last, although the second volume was included in *Genetic Studies of Genius* because it was believed that its results corroborated the findings in the other volumes, her retrospective findings are not entirely consistent with the longitudinal findings, a point that will become apparent shortly.

Below, I first briefly discuss historiometric methods for studying genius, and then turn to an overview of the central results using these methods.

Historiometric research

In 1909, Frederick Woods, a behavioral geneticist, first defined *historiometry* as the technique where "the facts of history of a personal nature have been subjected to statistical analysis by some more or less objective method."[9] A couple of years later, Woods argued that this method was well suited for developing the "psychology of genius."[10] He then provided a bibliography of historiometric research published up to his time. Although the first historiometric studies date from the early 19th century,[11] the first monograph using the method did not appear until Francis Galton's 1869 *Hereditary Genius*.[12] Over a century later, historiometry was more formally defined as the scientific technique "in which nomothetic hypotheses about human behavior are tested by applying quantitative analyses to data concerning historical individuals."[13] In the specific case of the research that will be reviewed here, the scientific hypotheses concern the general psychological factors that underlie the development of talent into eminent achievement.

Although by no means a mainstream method for the scientific study of talent and giftedness, historiometry has attracted an impressive range of practitioners over the past century, including Terman himself, whose estimate of Galton's IQ provided the immediate inspiration for Cox's more extensive investigation.[14] The main appeal of historiometric research is its ability to directly investigate the most eminent figures of history, whether creators or leaders, using various at-a-distance quantitative methods, including computer content analysis of primary documents such as creative products or private correspondence.[15] Whatever might be lost in measurement reliability is presumed to be more than compensated for by measurement and sampling validity. If that compensation cannot be assumed, then the method's scientific justification is undermined.

Below, my main interest is in the historiometric results concerning heterogeneous intellects, personality differences, and early development.

Heterogeneous intellects

Cox's 1926 inquiry used a team of four independent raters—including Terman and herself—to rate her sample of 301 geniuses (just rounded off to 300 in the title).[6] These ratings were specified as IQ estimates using the same formula used in the Stanford–Binet test, namely IQ = 100 × MA/CA, where MA was the mental age and CA was the chronological age. IQ remained a literal quotient, with 100 indicating an average intelligence. Their ratings were based on biographical data organized into a precise chronology of intellectual development.

To illustrate, J. S. Mill began learning Greek at age 3; studied the Greek classics until he was 9 (having read Plato at 7); was sufficiently competent at age 5 to enter into a discussion with a certain "Lady Spencer" over the relative merit of the generals Marlborough and Wellington; composed a history of Rome at 6½; began studying geometry and algebra at 8, the same year he began Latin; and read Latin writers before he reached 9, the age at which he started studying conic sections, spherics, and Newton's arithmetic. By age 11, Mill was able to start calculus; then at 12, logic and philosophy; at 13, political economy; at 14, French writers (in French); and at 16, his law studies began. The four raters assessed Mill as having an IQ between 180 and 200. His mental age in his childhood and early teens was nearly twice his chronological age.

After checking the agreement among the separate ratings, which was quite high, Cox then combined them to produce a single composite assessment. More precisely, she produced four separate estimates, but we need not go into details because they correlated so highly as to essentially constitute a single measure. In fact, a linear composite of the four IQ measures has a coefficient alpha reliability of 0.93.[16] More important was her determination of two additional findings. First, her historic geniuses could boast very high estimated IQ scores, with an overall mean around a standard deviation above that for the gifted children in the Terman longitudinal sample. Second, an individual's IQ score correlated positively with his or her achieved eminence, as assessed by the amount of space received in several standard reference books according to Cattell's classic inquiry.[17] Taken together, it would seem that Cox's historiometric study endorses the fundamental hypothesis put forward by her mentor Terman. This apparent endorsement was reinforced by subsequent replication studies,[18] including one that focused just on minority-group members and used alternative operational definitions. [19]

That much admitted, the support for Terman's thesis is not as strong as it first appears. In the first place, despite the substantial range in calculated IQs—a full 100 points—the correlation between IQ and eminence is not very high. Cox first calculated the correlation as 0.25, but then obtained a correlation of 0.16 when the data were corrected for reliability.[6] Although the latter remains statistically significant, it can be reduced yet further by adding additional control variables.[20] Hence, the connection between estimated IQ and achieved eminence is precarious, perhaps too negligible to justify equating high IQ with genius. Certainly, the amount of variance shared between the two variables falls short of 10% and might even fall below 1%. Whatever it takes to display genius-level accomplishments, IQ must assume a minor role, as at least 90% of the variance in eminence remains unaccounted for. Genius *as achievement* is largely independent of genius as test-assessed intelligence.

Another more subtle problem should be noted: although Cox's historiometric IQ estimates are superficially comparable to Terman's psychometric IQ assessments, the actual differences are striking. On the one hand, Terman's measure was based on the Stanford–Binet test, a gauge of general intelligence, where "general" implicitly assumed that the resulting score is independent of the domain of achievement. Because test items assess general cognitive ability and knowledge, the children in his longitudinal study would have the same IQ regardless of whether they became artists or scientists, leaders or creators. On the other hand, Cox's measure was founded on a person's development with respect to a particular domain of achieved eminence. For instance, Mozart's IQ was based on his precocity in musical intelligence, whereas Pascal's IQ was based on his precocity in mathematical intelligence. Mozart likely would have gotten a low IQ score were he judged in mathematical development, just as Pascal likely would have received a low IQ score if evaluated in musical growth. Hence, rather than assessing general intelligence, Cox was evaluating domain-specific intelligence in a manner more consistent with Gardner's conception of multiple intelligences.[21] What this implies is that the only

way Cox could get intelligence to correlate with eminence was to make her measurement specific to the domain. Hypothetically, their actual scores on an IQ test designed to assess general intelligence would likely have been much lower and perhaps not even at genius level.

The above considerations lead to a very different concept of genius: domain-specific cognitive abilities replace general intelligence as the central correlate—Mozart had exceptional musical ability, Pascal mathematical ability, but unlikely (or infrequently) the twain shall meet. Mozart no more needed the capacity to write an original essay on projective geometry at age 16 than the 14-year-old Pascal required the capacity to write from memory the full score of Gregorio Allegri's complex *Miserere* after only hearing it twice in a Sistine Chapel performance. Both may have had genius-grade IQs, but their intelligences were incommensurate. Mozart was not a mathematical genius, nor was Pascal a musical genius.

Personality differences

Cox supplemented her extensive IQ study with an equally impressive assessment of personality characteristics.[6] Cox started with a subset of 100 geniuses for whom the biographical data were most reliable, and then had independent raters assess these individuals on 67 distinct traits. Although part of her interest in these assessments was to discern how personality varied across diverse domains of achievement, she was also concerned with how personality contributed to overall adult achievement. Her conclusions again weaken the notion that IQ is the primary determinant of genius. Of special importance was her inference "that high but not the highest intelligence, combined with the greatest degree of persistence, will achieve greater eminence than the highest degree of intelligence with somewhat less persistence." This persistence enables the young talent to persevere in the face of diverse obstacles that are often encountered in the path to exceptional achievement. This determination is comparable to the modern concept of "grit" that has received so much attention in recent research.[22] This personal factor also can be said to overlap another historiometric investigation that found that the eminence of 91 creators and leaders was strongly predicted by "aggressiveness," or what could be better called "assertiveness."[23]

Notwithstanding the assessment on 67 personality traits, Cox failed to assess the full range of traits that have subsequently been shown to relate to achieved eminence.[6] Most notably, her items could not adequately capture openness to experience, one of the Big Five personality factors.[24] Openness includes intellectual curiosity, preference for variety, aesthetic sensitivity, active imagination or fantasy, and attentiveness to inner feelings. Not only is openness a positive correlate of actual creative achievement,[25] but it also seems an important correlate of exceptional leadership.[26] Of particular interest is the positive correlation between the greatness ratings of U.S. presidents and the scores those presidents receive on traits associated with openness.[27] The greatest presidents tend to have wide interests and to be curious, inventive, artistic, sophisticated, complicated, insightful, and intelligent.[28] Indeed, this cluster of traits proves a better predictor of presidential leadership than does estimated IQ.[29] Openness has also proven a useful construct in single-case studies of various creative geniuses, such as the philosopher Jean-Jacques Rousseau,[30] the jazz saxophonist John William Coltrane,[24] and the psychologist B. F. Skinner.[31]

Motivational persistence and openness to experience are the two most consistent predictors of future genius regardless of the specific domain of achievement. Other personality traits, as Cox herself demonstrated, tend to vary greatly across domains. An especially controversial example concerns recent historiometric research on the so-called "mad genius."[32] Although these inquiries into the creativity–psychopathology question are plagued with numerous methodological problems and conceptual confusions,[33] it is clear that artistic and literary geniuses have a more conspicuous vulnerability to at least subclinical symptoms than do scientific geniuses.[34] The one intriguing exception to this generalization is that revolutionary scientists who overthrow traditional paradigms may prove more susceptible to mental illness than those scientists who work to preserve those paradigms.[35] Isaac Newton, who revolutionized physics, often suffered from severe psychopathological symptoms, whereas his contemporary, Gottfried Wilhelm von Leibniz, who endeavored to preserve the then-prevalent Cartesian paradigm, apparently enjoyed picture-perfect mental health. In terms of susceptibility to mental illness, the creative genius of scientific

revolutionaries falls somewhere between that of artistic geniuses and the genius of more conventional scientists.[36]

Early development

Because Cox's retrospective study was a solo venture, whereas Terman's longitudinal study involved collaborations with numerous graduate students and colleagues, Cox could not include developmental factors besides intelligence and personality.[6] This omission was unfortunate because it might have led her to conclusions contrary to what Terman had inferred from his high-IQ children. The latter had clearly come from relatively ideal family backgrounds.[2] Their parents could claim higher than average education, and the father of each was likely to be in a professional occupation requiring a higher degree. The homes were stable, even conventional, but also intellectually stimulating (e.g., containing lots of books). The children themselves were not just good students, but also contradicted the "nerd" stereotype by being unusually physically fit (with the exception of myopia). Not surprisingly, the gifted children themselves grew up to pretty much duplicate the lives of their parents, obtaining a better than average education, pursuing a profession, getting married and having children, and avoiding divorce and early death. The intellectually gifted girls departed from this overall picture only in their likelihood of becoming homemakers, an outcome consistent with expectation for young women growing up in the period between the two World Wars.[37] Only after their children left home were some able to pursue careers worthy of their talents.[38]

In contrast, if Cox had studied the early biographies of her 301 geniuses, she might have spotted a more complex picture: unstable, diverse, or unconventional homes; traumatic events in childhood or adolescence; physical or cognitive disabilities; minority or multicultural status; and often uneven scholastic performance—what have been collectively called "diversifying experiences."[39] These are events or conditions "that help weaken the constraints imposed by conventional socialization"[40] so that the children do not become "normal" adults. For example, the parents might come from different geographic, religious, or ethnic backgrounds, and one or both parents might have died while the child still lived in the home. Some laboratory experiments have even simulated the impact that diversifying experiences might have on creative development.[41]

To be more precise, the role that diversifying experiences might play in the emergence of genius varies according to the domain of achievement.[39] Indeed, the observed pattern closely reflects what was earlier stated with respect to any tendencies toward psychopathology. To be specific, the frequency and intensity of such developmental events and conditions are higher for literary and artistic geniuses than for scientific geniuses. This difference is seen among Nobel laureates: the rates of parental loss among recipients of the literature prize are eight times higher than for the winners in physics.[42] The latter tend to come from homes more similar to those of Terman's intellectually gifted children.

Nor is the domain of achievement the only complication in describing the relation between diversifying experiences and the development of genius. To begin with, it is possible to have "too much of a good thing." Excessive traumatic events in childhood or adolescence can induce abnormality rather than just the lack of normality. Hence, the relation is best described by a curvilinear inverted U suggesting a "sweet spot" for optimal talent development.[39] Minority status can prove a developmental asset only if it is not associated with pronounced discrimination or oppression. Although the number of European Jews among Nobel laureates exceeds statistical expectation by a factor of 10 or more, that disproportional representation is contingent on national origins, for example Swiss Jews are 83 times more likely to earn a Nobel Prize in science than are Russian Jews, on a per capita basis.[42] Among other things, Jews in Switzerland have faced much less anti-Semitism than those in Russia.

In addition, the psychopathological tendencies mentioned earlier seem to function in much the same way as diversifying experiences.[39] This suggests that they may enter into some trade-off interaction: the more of one, the less of the other. Put differently, diversifying experiences might be split into two categories of variables: psychopathological inclinations and developmental adversity. This possibility was tested in a recent study of 291 eminent African Americans, a group that tended to experience far more developmental adversity than would be expected among eminent achievers in the majority culture.[43] Although the distribution of

psychopathology across the domains followed the expected pattern—especially the contrast between artistic and scientific geniuses—the overall level of mental illness was much lower than predicted. Most strikingly, there were no suicides, not even among the literary creators! The poet Maya Angelou, for example, despite experiencing horrific adversity in childhood and adolescence, passed away while still actively working on major projects at age 86. In comparison, the poet Sylvia Plath, a near contemporary, experienced seemingly far less developmental adversity (notwithstanding her father's death when she was 8 years old), but committed suicide at age 30.[44]

It is worth contemplating that Terman's longitudinal sample, despite its impressive size, contained very few minority group members. No one in the sample grew up to become a highly eminent artist, either.

Conclusions

Although research has produced an extensive body of empirical findings, we are still a long way from knowing everything about how exceptional talent converts into overt genius.[45] Nevertheless, the historiometric research reviewed thus far has demonstrated that IQ plays a very minor role. Not only do differences in general intelligence explain little variance in achieved eminence, but the explanatory power of intelligence is apparently also contingent on having intelligence defined in more domain-specific terms. In essence, intellectual giftedness must be reconceived as the degree of acceleration in expertise acquisition within an individually chosen domain.[46] Furthermore, personality differences and early developmental experiences have an even bigger part to play in the emergence of genius, although these influential factors must also be tailored to the specific domain of achievement. The one-size-fits-all conception of genius that Terman introduced with his influential IQ 140 criterion just does not work. Indeed and in conclusion, "reverse engineering" genius on the basis of historiometic methods would very unlikely result in a group of children with high IQ as determined by Terman in his longitudinal study.

Conflicts of interest

The author declares no conflict of interest.

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