Introduction: Hans Eysenck and the study of intelligence

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In understanding Eysenck's contributions to this field, it may help to sketch some of the historical background into which he was first introduced as a student of psychology upon his arrival in London in 1935, and which, I believe, must have greatly influenced his subsequent career, especially as it involves the study of intelligence.

In a recent interview for a popular magazine, Eysenck stated that one of the first topics in psychology that interested him was intelligence. The reason he gave for this attraction was that intelligence was one of the first human traits for which psychologists could actually measure individual differences with some accuracy.

The idea that measurement, rather than subjective impressions, is a central requirement for the development of psychology as a branch of empirical natural science has been an abiding conviction of Eysenck's from the very beginning of his long and distinguished career. This value probably followed naturally from the fact that, as an émigré from Hitler's Germany, he had gone to the University of London hoping to major in physics. For certain technical reasons, however, he was not permitted to enroll as a major in that field. So, at that time, psychology was the only scientific subject open to him, and he had little option but to have that as his major, to scientific psychology's good fortune.

It remains uncertain whether Eysenck's deeply ingrained proclivity for measurement, quantitative analysis, and a wholly natural science approach to psychology, was innately intrinsic to his intellect and personality or was mainly imposed by his education in the German gymnasium, or later at University College, London. Most likely it was just a case of a genuine compatibility between Eysenck's scientific nature and the fortunate happenstance of the particular nurture afforded him by his initiation into a type of psychology that was known as "The London School."

The basic philosophy and quantitative technology of this school of psychology was characterized by its focus on the study of individual differences, also known as differential *psychology*, with its central purpose of discovering and objectively measuring all of the main mental and behavioral traits and capacities that showed individual differences among human beings. Also, it aimed to discover the causes of these measurable individual differences, causes attributable to differences in persons' heredity, biological structures, and life experiences. Differential psychology originated with the unique and powerful influence of Sir Francis Galton (1822–1911) in British psychology. A scientific genius, Galton was the father of psychometrics, behavioral genetics, and a number of basic concepts used in psychological statistics. Besides his own original contributions to behavioral science, Galton also promoted the biological and evolutionary thinking of Charles Darwin (who was Galton's half-cousin) and Herbert Spencer in psychology.

Historically, the founding fathers of the two main branches of psychology as an empirical science, distinct from philosophy, were Wilhelm Wundt (1832–1920) in Leipzig (experimental psychology) and Francis Galton in London (differential psychology). The oldest, most established universities of England—Oxford and Cambridge—followed mainly in the experimental tradition established by Wundt, while psychology in the University of London developed predominantly along Galtonian lines, even though, strangely enough, the psychology department's preeminent head, Charles Edward Spearman (1863–1945), was the only professor in Britain who received a Ph.D. under Wundt.

But Galton was really the father of mental measurement. He devised laboratory devices for the measurement of many psychological and anthropometric traits and calculated correlations between these two classes of variables. Although Galton never held any official academic position, he was instrumental in the founding of both the departments of psychology and genetics in the University of London, and he contributed various of his own "brass instrument" inventions for measuring human characteristics to the newly founded psychological laboratory in London's University College.

Galton's writings had considerable influence among the generation of students at the turn of the century who were just embarking on careers in academic psychology. The so-called "London School," to which Eysenck was introduced as a student majoring in psychology in 1935, is itself the product of nearly 50 years of domination of its Psychology Department by two of Britain's most eminent psychologists and ardent exponents of Galton. Both men had been strongly influenced by Galton's work and they promoted his ideas throughout their careers. Spearman, while a student under Wundt, read Galton's major works with much greater interest, he claimed, than he had found in any of Wundt's work. While he was still a doctoral student in Leipzig, two years before receiving his degree, he published (in *The American Journal of*

Psychology, 1904) a study that was most *un*Wundtian in its subject matter and its methodology, but strikingly Galtonian. Titled *General Intelligence, Objectively Determined and Measured*, it became widely recognized as a landmark in the history of psychometrics and differential psychology. Not only was it a pivotal contribution in its own right, but it laid out virtually all of the issues that, with further development, became Spearman's greatest contributions to psychology, including the discovery of *g*, the invention of factor analysis, and laying the foundation of what is now known as classical test theory.

The second preeminent figure and Galton exponent to dominate the London School as Spearman's successor in 1932 was Professor Sir Cyril Burt (1883–1971). Burt had previously served for seven years as the professor of educational psychology in London University. Just three years after Burt assumed the Chair of Psychology, Eysenck enrolled in his department. Though officially retired, Spearman remained in the department, and Eysenck came to know the great man personally. I recall once hearing Eysenck contrast Spearman with Burt; he remarked that Spearman was not only a great psychologist, but also a nice fellow (presumably being unlike Burt in this respect).

The then well-established tradition of the London School was the basis of Eysenck's first view of psychology. And indeed, Burt's major research interest, like Spearman's, was in the theory and measurement of human mental abilities. It is noteworthy that Eysenck's first publication, in 1939 (a year before he received the Ph.D.), was a review of L. L. Thurstone's *Primary Mental Abilities*, in which Eysenck applied Burt's method of factor analysis to Thurstone's correlation matrix of 56 diverse tests and showed the existence of a large general factor, equivalent to Spearman's *g*, on which all of the tests were loaded and which accounted for more of the total variance than any of the primary factors identified by Thurstone's method of multiple factor analysis, which rotated the several primary factors to simple structure, a procedure that, of mathematical necessity, obliterated the general factor, creating the false impression that a general factor did not exist in the matrix. The method of factor analysis advocated by Burt (and used by Eysenck on Thurstone's correlation matrix) allowed the emergence of a large general factor, while also preserving each of Thurstone's primary factors, represented as first-order factors independent of the second-order factor, *g*.

Given this beginning and these influences, in addition to Eysenck's early recognized outstanding academic ability (Burt himself told me, in 1971, that he thought Eysenck was his "most brilliant and most industrious" student), it seemed inevitable that Eysenck was appointed Reader (1950) and then Professor of Psychology (1955) in the University of London, and headed the postgraduate Psychology Department in the Institute of Psychiatry. Nor is it surprising that Eysenck has long since rightfully earned a reputation as the leading contemporary exponent of the Galton tradition and the London School.

Probably because research on intelligence was so completely dominated by Burt during the early phase of Eysenck's career, and because during World War II he was appointed psychologist in London's Mill Hill Emergency Hospital, a psychiatric center in which the practice of clinical psychology predominated, he did not consider doing research on intelligence until many years later. Instead, he focused his research expertise in psychological measurement and factor analysis on a much less developed field—the scientific study of personality. He envisaged a major program of research in this new area similar to that conducted first by Spearman and later by Burt for the subject of mental abilities. His empirical studies on personality soon issued forth in several influential books, *Dimensions of Personality* (1947), *The Scientific Study of Personality* (1952), and *The Structure of Human Personality* (1953), and in countless journal articles. Research on the taxonomy, factor analysis, and causes of personality differences, including the well-known psychiatric syndromes, was the major effort of his newly organized Department of Psychology at the Institute of Psychiatry, a setting in which research on these topics was naturally most appropriate. The innovative methods advocated by Eysenck fortunately were favored and encouraged by the imposing medical head of the Institute of Psychiatry, Professor Sir Aubrey Lewis, one of Britain's eminent psychiatrists.

Although the bulk of Eysenck's research contributions have been in the personality field, he has also been remarkably prolific in his contributions to the literature of human intelligence. There were chapters related to intelligence in his first popular Penguin paperback, *Uses and Abuses of Psychology* (1953), but his first theoretically important essay in this field did not appear until 1967. (I will say more about it in my essay that follows.) Since then, Eysenck has published about 50 articles, six books, and numerous book reviews that all deal with human intelligence. Most of these items, up to 1985, are listed in the references of my chapter on Eysenck's contributions to the study of intelligence in *Hans Eysenck: Consensus and Controversy* edited by S. Modgil and C. Modgil (1986). (The same volume contains a detailed and purposely somewhat critical examination of Eysenck's theoretical approach to intelligence by J. S. Carlson and K. F. Widaman.)

Since I have already written at length about Eysenck's theory of intelligence in the Modgil and Modgil (1986) volume, I will here only characterize his contributions in broad outline and leave it up to the other contributors in this part to discuss the specifics. As I have pointed out, Eysenck's approach to intelligence can be characterized in general by the terms objective, quantitative, analytical, and biological.

The first empirical research on human intelligence that I am aware of in Eysenck's career, done in collaboration with one of his colleagues at the Institute, Desmond Furneaux, conceived of "splitting" Spearman's *g* into three psychologically distinct components: mental speed, error checking, and

persistence. With a grant from the Nuffield Foundation, Furneaux developed an individual test, which he called the Nufferno Test, based on number series (which Spearman and others had found to be highly *g*-loaded). The testee was closely observed while taking the test and the solution time for each single item (each presented on a separate card) was individually measured. This permitted separate scores to be derived for each of the components—speed, error checking, and persistence (measured on the more difficult problems). Furneaux proposed a theory to explain individual differences in the speed score, based on the speed of a hypothetical neural scanning mechanism in the brain. The other two components, however, appeared not to be cognitive variables but really belong in the personality domain. What had actually been "split" by Furneaux's method was not *g* per se, but the particular measure of *g* obtained with the Nufferno test. This is an important point from a psychometric standpoint, because the particular mechanics and item content of any test of homogeneous item content always results in the test scores containing other components of variance besides *g*. The Nufferno test separated out at least two of these non-*g* factors as distinct scores. Cognitive tests with other properties would contain other non-*g* factors. In a factor analysis of a great many diverse tests, as both Spearman and Burt had shown, *g* could be separated from all of the non-*g* group factors and test specificity. But no systematic effort was ever made to demonstrate the relationship of the Nufferno's measures of error checking and persistence to other *g*-loaded tests, and the Nufferno test had little subsequent influence on intelligence theory or research. What persisted as central in Eysenck's thinking, however, was the hypothesis of individual differences in mental speed as the basis of *g*.

Similarly, Raymond B. Cattell's claim to have split Spearman's *g* into fluid (Gf) and crystallized (Gc) components by means of hierarchical factor analysis appears to be attributable to the limited variety of tests entered into the factor analyses that show this split. Gf and Gc are themselves highly correlated in most populations and if the hierarchical factor analysis is not truncated at the level of second-order factors but a third-order factor is extracted, it turns out to be Spearman's solitary *g*. Recent hierarchical factor analyses show that the larger and the more diverse the battery of tests that is factor analyzed, the greater the similarity between Cattell's second-order Gf factor and the third-order *g* factor. In fact, when a large enough number of highly diverse tests are included in the factor analysis, Spearman's *g* and Cattell's fluid Gf become one and the same general factor, or *g*. Gf disappears as a second-order factor, being absorbed into, and identical with, the higher order *g* at the third stratum, or apex, of the hierarchical factor structure. Gc, however, remains as a rather minor second-order factor, loaded mainly in various tests of scholastic and cultural achievements. It now seems a safe generalization that the *g* that emerges from the factor analysis of complex psychometric tests, such as those

used in the factor-analytic work of Spearman, Burt, and Cattell, has not yielded to being "split" by any means available at the psychometric and factor analytic level of analysis.

Eysenck realized that to pursue the analysis of *g* any further would require that the cognitive measurements be obtained at a different, more elementary, level of information processing than is possible for conventional psychometric tests. The greater complexity of mental processes that conventional test items call upon for solution (or for initially having been consolidated in long-term memory) rendered conventional tests unamenable to further analysis beyond the item level. Eysenck was one of the earliest to see the necessity for going beyond the factor analysis of ordinary psychometric tests, and in 1967 he spelled out his ideas for a new, more analytic, approach to intelligence research ("Intelligence assessment: A theoretical and experimental approach." *British Journal of Educational Psychology, 37*, 81–98). In this innovative article, and even more so in many subsequent works, Eysenck put forth compelling arguments from the philosophy of science aimed at making sense (and countering the prevalent nonsense) on the topic of intelligence, which, outside the range of influence of the London School, was encumbered with disgracefully unscientific and muddled misconceptions, some unfortunately still blighting modern psychology textbooks. Eysenck's writings in this field showed him, above all, to be a wonderfully clear thinker in a field that most needed clear thinking. This was probably the chief source of his appeal to those reading him for the first time. Whatever else may be said about Eysenck, his core values, never ideological or dogmatic, have always embraced an uncompromising empirical science approach to any and all psychological phenomena. This does not insure always being right in every hypothesis or every conclusion, of course, but it certainly does keep investigation on the right track, and on that score Eysenck has pursued an unwavering course. His explicit insistence on psychology as natural science is absolute. Given this philosophy, inevitably the scientific truth will out.

Eysenck's suggested approach to research on intelligence was at first actually more Galtonian than Spearmanian, both in its harkening back to Galton's idea of mental speed as the basis of individual differences in general ability (which is itself a Galtonian concept) and its advocacy of various forms of reaction time (RT) as a tool for the measurement and analysis of individual differences. (A then recent study by Roth [1964], published in Germany, had shown a substantial correlation between RT and a conventional measure of *g*.)

RT in elementary cognitive processes soon became a lively area of research in differential psychology and when the relationship between RT and intelligence (as presaged by Galton but incapable of demonstration by his relatively primitive methodology 100 years earlier) became clearly evident in the burgeoning research literature on RT, Eysenck made the next logical step—taking up the measurement of the one physiological variable already

shown to be correlated with IQ, the brain's electrical activity in response to an external stimulus, measured as the averaged evoked potential, or AEP. The discovery of a physiological basis of *g* was not only implicit in the work of Galton, but was explicit in Spearman's major work, *The Abilities of Man* (1927), in which he expressed the hope that a neurological explanation of *g* would be discovered—"whereby physiology will achieve the greatest of all its triumphs" (p. 407).

But the technical means for direct physiological research on *g*, instead of merely theoretical speculation about brain processes, only became available in the 1960s. In the following decade, Eysenck began promoting such research in his laboratory, measuring the AEP and nerve conduction velocity and correlating these variables with IQ, and contributing many theoretical and substantive articles and influential book chapters in this line, often in collaboration with his students and colleagues (such as Elaine and Alan Hendrickson and Paul Barrett) who had become expert in electrophysiological methods. Indeed, it might be said that a major step toward Spearman's expressed wish occurred when Eysenck and co-workers demonstrated that the column of correlation coefficients showing the degree to which each of the 11 subtests of the Wechsler Adult Intelligence Scale (WAIS) is correlated with the complexity of the waveform of the AEP was directly proportional to the corresponding column of each of the 11 subtest's loadings on the *g* factor. The rank-order correlation between the two columns was +0.95! Later that same year (1985), and independently of Eysenck's report, a pioneer of AEP research, E.W.P. Schafer, using the WAIS and the same method as described above but based on a different AEP measure (the habituation of the amplitude of the AEP), showed a rank-order correlation of +0.92, very similar to that reported by Eysenck. In brief, there is an intimate relation between Spearman's *g* as reflected in psychometric tests and the complexity and amplitude of brain waves in response to external stimuli.

Thus, it appears clear to me that Eysenck has cast a greater influence than any other contemporary psychologist in advancing what certainly must be referred to henceforth as the Galton–Spearman–Eysenck school of research on human mental ability.