

# Exploring historically how intelligence has been defined, and why people have attempted to define it

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A lot of multidisciplinary individuals have contributed to the history of intelligence and helped in building its foundations, from Charles Darwin to Francis Galton to Alfred Binet. This paper explores how intelligence has been defined and measured, as well as the reason behind defining intelligence from the perspective of these multidisciplinary individuals. The aim is to explore the diversity of the opinions and thought that went into shaping the way we think about intelligence and its measurements today.

The early debates in understanding intelligence were to determine if it was hereditary or not. Charles Darwin's evolutionary theories were central to many arguments presented in the early intelligence theories. Darwin's and Wallace's theories provided an argument to begin the nurture versus nature debate. Barlow, Darwin's granddaughter, in her additions to 'The Autobiography of Charles Darwin', quotes Darwin, in one of his letters, as saying "I do not think that I owe much to him intellectually-nor to my four sisters... I am inclined to agree with Francis Galton in believing that education and environment produce only a small effect on the mind of any one, and that most of our qualities are innate" (Darwin, 'The autobiography of Charles Darwin', 43). Darwin's work inspired Francis Galton, who after the publication of Darwin's theories, went on to coin the terms 'eugenics' and 'nature versus nurture'. Darwin supported Galton's theories and in his letter began

to define what attributed intelligence. Darwin, as a naturalist, defined the attributes of intelligence to show that “there is no fundamental difference between man and the higher mammals in their mental faculties” (Darwin, ‘The Descent of Man’, 66).

Jean-Martin Charcot was the father of neurology. His theories attempted to link physiological and mental processes together, and were the foundations to show correlations between genetics, neurophysiology and intelligence. Charcot, similar to Darwin, also contributed to understanding the hereditary nature of intelligence by advocating and furthering the diathesis-stress model. The diathesis-stress model is one of the widely credited models that is used to explain the influence the environment has on genetics. His research on hysteric patients showed that most of the patients had a genetic predisposition to the disease, but the patient was more likely to get the disease after being exposed to certain environmental factors. This was slightly different to Darwin’s point of view, but the model still contributed to the idea that genetics were a contributing factor to diseases and other bodily developments. Charcot’s research stressed the importance of environmental factors (in conjunction to hereditary factors) more than his predecessors did, which was important as he showed it through conclusions made from his patients rather than from his past experiences. In addition, Charcot is also celebrated as the teacher for both Binet and Freud who also both went on to contribute to intelligence theories directly or indirectly.

Intelligence theory during that period revolved significantly around understanding how intelligence was passed on, rather than the measurement of it. Darwin, Charcot, and Galton, established the modern foundations for intelligence theory. The theories presented by each of them contributed to the nature versus nurture debate, which was central to the understanding of how intelligence was passed on. The definition and measurement of intelligence would be very different if intelligence was determined more by nurture than nature or if intelligence was not hereditary. At the time,

it was incredibly difficult to define intelligence as there were mixed theories on what contributed to intelligence, and the arguments presented by Darwin, Charcot, and Galton helped formulate a clearer understanding of its source.

Galton's contribution were incredibly important as he measured the inheritance of intelligence through data in his book 'Hereditary Genius'. In the book, Galton showed that "human mental abilities and personality traits, no less than the plant and animal traits described by Darwin, were essentially inherited" (Seligman, 54), and in his book he describes genius as "an ability that was exceptionally high and at the same time inborn" (Galton, Hereditary Genius, 6). The basis of his argument followed Darwin's argument where he claimed that nature always prevailed against nurture. In the book he examines data on "wrestlers of the North Country" (Galton, Hereditary Genius, 312), literary men, commanders, men of science, poets and musicians, using their heritage and accomplishments to show how individuals in each of these professions correlated to intelligence (statistical correlation being a concept he created). His work became important in the foundations of intelligence research, as it linked logic and deduction with statistical evidence. This was a shift in paradigm for the community around intelligence thinking as it was the first time someone had used numerical data to compare the intelligence of groups of people, and also based their theory on it.

In addition, it is also important to discuss the aims that Galton had to define intelligence. Through his work on looking at "wrestlers of the North Country", and Peerages of England, the last two chapters of his book were titled "The comparative worth of different races", and "Influences that affect the natural ability of nations". A large portion of his work is significant in intelligence theories, but his aims were not well-founded. Through his data he makes claims such as, "the number among the negroes of those whom we should call half-witted men, is very large"

(Galton, *Hereditary Genius*, 339), and “that the average ability of the Athenian race is, on the lowest possible estimate, very nearly two grades higher than our own (Galton, *Hereditary Genius*, 342). Throughout his book he develops this grading framework to be able to quickly pinpoint which civilization matches which grade depending on their accomplishments and intelligence levels. The framework he was developing for the measurement of intelligence was to comment and develop a theory about race superiority.

Similarly, about a hundred years before Galton, Samuel Morton made similar conclusions about race and their intellectual ability. Morton, a physician, in his work ‘*Crania Americana*’, claimed that you could measure the intellectual ability of a race by their skull capacity. Morton, similar to Galton, described the Caucasian as “distinguished by the facility with which it attains the highest intellectual endowments” (Morton, 2), and “the Negro” as “joyous, flexible, and indolent; while the many nations which compose this race present a singular diversity of intellectual character, of which the far extreme is the lowest grade of humanity” (Morton, 3). They were expressing their biased opinions on other races through ‘science’, but their use of statistics and intelligence theories made it more harmful as people perceived that they had data to support their views. Gould writes about Morton in ‘*The Mismeasure of Man*’ and describes Morton as having an unconscious bias (among other reasons) that supposed his prejudicial views. Among other reasons, the general acceptance of theories Darwin published in ‘*On the Origin of Species*’ disproved Morton’s work, and marked it as an origin of scientific racism.

Through the research, it can be seen that early intelligence research was biased as the theoretical framework of the researchers led them to use intelligence theories to show race superiority. Galton went on to write ‘*Inquiries into Human Faculty and its Development*’, which gave support to the eugenics movement. Arthur Jensen, in his book ‘*Galton’s legacy to research on intelli-*

gence', writes "it seemed obvious and even unarguable to Galton that, from a eugenic viewpoint, superior mental and behavioral capacities, as well as physical health, are advantageous, not only to an individual but for the well-being of society as a whole" (Jensen, 145), and "Galton's pioneer contributions to the science of mental ability became so amalgamated with his enthusiasm for eugenics as to have also contributed to the disfavor in which Galtonian research on human intelligence has been held in the latter half of the twentieth century" (Jensen, 145). Galton and Morton both thought they were scientifically correct, but "what seems not to have been sufficiently clear, even to Galton himself, yet needs to be emphasized, is this: prescriptive eugenics falls not in the purview of science, but in the province of moral philosophy" (Jensen, 150). The distinction that Jensen attempts to create is that there is a difference with what is, and what Galton and Morton thought should be. The eugenics movement clearly portrayed the aims of the early researchers in trying to define and measure intelligence. The study of intelligence gave them power and influence, as they were able to manipulate data to show put forth their views, however biased they were.

In addition, on the first page of Galton's book 'Hereditary Genius' he writes "I conclude that each generation has enormous power over the natural gifts of those that follow, and maintain that it is a duty that we owe to humanity to investigate the range of that power, and to exercise it in a way that, without being unwise towards ourselves, shall be most advantageous to future inhabitants of the earth" (Galton, Hereditary Genius, 1). This is a very powerful and encompassing statement that was influential to the views that many intelligence researchers had in that century. Furthermore, at this point in time, intelligence theories mostly consisted of psychologists, biologists, neurologists exploring differences between humans and comparing their intellectual abilities.

Influenced by the early research of Galton, Charcot, Darwin, and others, the field of intelligence theory was formally established by three key individuals: Wilhelm Wundt, James McKeen

Cattell, and Alfred Binet. Wilhelm Wundt was a Philosopher and is known to be the father of Experimental Psychology. Wundt began using psychological techniques in the laboratory, and through this theoretical framework and background in philosophy, he viewed the mind as an activity rather than a solid mass as biologists did, which in a way was similar to Freud. Wundt is indirectly influential in intelligence theories as he developed his theories in his book 'Principles of Physiological Psychology', which became the basis of many psychology labs, but was also instrumental in the establishment of the first intelligence test. His theory establishes the principle of recording mental activity based on reactions and measurable activity of the patients and objective knowledge. The development of modern psychology and experimental psychology was important for research around intelligence, as intelligence was not something that can be directly measured (even now).

James McKeen Cattell, a student of Wundt, worked along side of Wundt to help establish these correct practices, and helped establish the field of psychology. During the development of Wundt's framework, Cattell started to experiment with measuring reaction time rates of individuals based on different activities, and began to study the underlying differences they had based on their reaction times. Cattell is basically measuring different mental processes, such as reaction times of their memory, movement, and he also measured their sense of weights and if they could observe noticeable differences between different masses. In a lot of his research he believed that his experimentations were leading him to measure intelligence as he explored mental aptitude. His research on measuring intelligence was not successful, as we know, because he spent time doing experimentations on intelligence was linked to people's bodily features rather than doing written tests. In addition, Cattell was also a big supporter of eugenics. He went so far as to proposition his son/daughter with money if they were to marry a suitor of a high achieving background (such

as a professor or an academic). His aims on his research are not clear, but he was known to be pleased about his 'inherited ability', which for him meant that he had influence and could make a difference.

Alfred Binet was a psychologist who was the inventor of the first used intelligence test. Binet began researching alongside Charcot in Charcot's laboratory. Binet was able to learn a lot from the experimental nature of the laboratory, and a lot from the views that Charcot had on hypnotism. Later, it was shown that Charcot's hypothesis were incorrect, and Binet began to shift his work to differential, experimental, and many other types of psychology theories. His view of intelligence theories shifted from attempting to understand intellectual ability to understanding intellectual development and its relations to attention span and a person's receptiveness. His view started shifted after his daughters were born as he begun doing intelligence testing on them, and started giving them tests. This was a large shift as it concentrated on understanding how intelligence in a person developed rather than examining how intellectual a person was in a short period of time.

Furthermore, Binet began working with the French government on the education of retarded children. A part of this project was to develop methodology to identify the particular student who needed to be a part of this group. Over a couple years, Theodore Simon, a colleague of Binet's, and Binet started to devise questions that separated the children. They asked the children to name body parts or count coins, solve patterns, and the questions got progressively harder. They devised 30 questions, and the first set of questions were questions that all children could answer (regardless of however challenged they were). He found that intellectual ability developed in children in variable rates, which had to be accounted for, and he stressed the study of intelligence to be qualitative rather than through quantitative measures. Binet and Simon in regards to intelligence write, "it seems to us that in intelligence there is a fundamental faculty, the alteration or the lack of which, is

of the utmost importance for practical life. This faculty is judgment, otherwise called good sense, practical sense, initiative, the faculty of adapting one's self to circumstances. A person may be a moron or an imbecile if he is lacking in judgment; but with good judgment he can never be either. Indeed the rest of the intellectual faculties seem of little importance in comparison with judgment" (Binet and Simon, 42).

Simon and Binet developed this measure of intelligence for social good. Their intentions seemed to be very positive, but they both disagreed with a lot of the research that came out of their experimentation and research. He condemned the research that happened at Stanford and the development of his research that viewed intelligence as a being one-dimensional or having one aspect to it. Meanwhile, in the U.S., in 1908, H.H. Goddard translated Simon and Binet's intelligence test into English, and began distributing it to the academic audience. Goddard also went on to further it in his books 'Standard method for giving the Binet test', 'Feeble-Mindedness: Its Causes and Consequences', 'School Training of Defective Children', and many more. Historically, this is an important contribution as it further accelerated and captured the interests of psychologists, mathematicians, and a lot more people around the world. Goddard, pre-1908, was becoming a huge advocate for institutions (such as a hospital, school, legal system, etc.) to begin using intelligence testing. One of his largest accomplishments was requiring deaf, blind, and mentally retarded students to get special education, and also introducing into law that criminals with subpar intelligence should limit their criminal responsibility. Even though he also advocated for eugenics, he was able to utilize this measure to bring some social good for the years to follow.

Around the same time as Simon and Binet, Charles Spearman published his own theory of intelligence, which was also influenced by the performance of children, in his paper 'General Intelligence, "Objectively Determined and Measured"'. Spearman observed in the scores of grade-



school children, that the performance of students across different subjects, even if the subjects were totally unrelated, was consistent. He believed and put forth the idea that there was a single quality that made someone intelligent. Spearman named it, 'g', for general factor. In addition, Spearman writes in regards to "estimating 'Intelligence', the guiding principle has been not to make any a priori assumptions as to what kind of mental activity may be thus termed with greatest propriety. Provisionally, at any rate, the aim was empirically to examine all the various abilities having any prima facie claims to such title, ascertaining their relations to one another and to other functions" (Spearman, 249-250). This definition of the measurement or estimation of intelligence is key to understand the theory behind the 'g' factor, and this definition is also important as he calls it an estimation rather than a measurement.

Moreover, Spearman also pioneered a technique called factor analysis, which he used in his work to show the correlation between intelligence tests, and their consistencies. His work on factor analysis was groundbreaking, and hugely important in today's intelligence testing. Furthermore, his work in showing that there can be a general factor for intelligence was revolutionary as he was able to use his knowledge of statistical analysis and correlations to prove it. This is different to his predecessors as even though they strongly believed it, they were never able to show it. Spearman was also a passionate eugenicist, and after publishing his theory he advocated to restrict people with a 'g' lower than a certain standard to not be allowed to vote, and be able to have offspring. He was driven by a lot of the same ideology as his predecessors.

Lewis Terman published his paper 'Stanford Revision of the Binet-Simon Scale' in 1916 after being inspired by H.H. Goddard's translation. Terman was a psychologist. Stern was an active researcher in the philosophy of herd behavior and group psychology. William Stern was a philosopher during the time that the translation came out. Terman was an active researcher, and he worked

with gifted children to measure, understand, and discover the general signs of what made the gifted children. Initially, Terman published his theory without Stern's collaboration, which is known as the "Stanford-Binet" test. The paper Terman published consisted of five large areas or factors of intelligence were: fluid and quantitative reasoning, working memory, knowledge, and visual processing. In the 1905 paper, Terman proposed testing which measured if an individual could recognize food properly, verbally know and make sense of pictures, and 28 other tests. Stern then published some additional suggestions to his original paper. Both Terman and Stern worked on adapting the system of measuring intelligence for the general adult population, and later adapted it to a general audience. After making their generalization, they published the intelligence quotient, a term which was coined by Stern. Stern proposed comparing the score of a child to his/her age, which created a ratio that showed their mental progress, which was denoted by their IQ.

The largest push for the mass adoption for intelligence testing came about when Yerkes, an army major and a psychologist, assembled 40 psychologists (Terman included) to develop an intelligence test for the army. This test would be given to a very large audience, and the psychologists were given certain constraints and had to measure numerical ability, knowledge, ability to follow instructions, and verbal ability. They were constrained because the military was divided into either immigrants and non-educated people or semi or highly educated people. The group managed to develop two different tests for the separate groups: the Army Beta test, which was for non english speakers and illiterate individuals, and the Army Alpha test, which was for the rest. Each candidate would take the test and get a grade between an A and a E, which would decide their post. The psychologists managed to test their hypothesis on a large scale, and manage to see how the graded candidates did at their assigned posts.

The next critical breakthrough happened in the 20th century with the mass adoption of intelli-

gence testing for universities, high-schools, middle-schools, and pre-schools. The testing started both in universities and pre-schools at the same time, where for universities they were looking at high-school graduates and their SAT score to determine if they would be accepted to a university, and for pre-schools they were looking at children would needed extra help or support. The SAT was developed by a Princeton psychologist called Carl Brigham, who also previously helped develop the Army Alpha and Beta tests alongside Terman. The constraints for the SAT were different to the military, but the ideal principle was the same: regardless of their socioeconomic ability or cultural privilege, they should be able to work on the same positions given the right training. This was supposed to reduce the biases that existed in the previous testing methodology, and this is a central reason to why there was a boom in the colleges or institutions that used intelligence testing as a methodology to select individuals.

Jeff Hawkins, a well known technologist, develops his theory, from the background of a Electrical Engineer turned Biophysicist turned self-taught Neuroscientist, in his book 'On Intelligence'. Hawkins' aim to measure and quantify intelligence is to be able to re-build it in the form of an Artificially Intelligent agent. This is fundamentally different from the aims of many other researchers seeking to define and measure intelligence. The distinction is important as most researchers seek to explore or quantify intelligence for philosophical or experimentation purposes, but Hawkins seeks to go a step further and make attempts to build it. In addition, the theoretical framework or worldview of being able to build an intelligent machine only became possible after the formation of machines and the fields of Artificial Intelligence and Computer Science.

Hawkins' theory is solidified on the idea that intelligence is just learning to see repetitions in patterns, and does not constitute of the ability to do any specific tasks. Hawkins writes "the intelligent machine must learn via observation of its world, including input from an instructor when

necessary. Once our intelligent machine has created a model of its world, it can then see analogies to past experiences, make predictions of future events, propose solutions to new problems, and make this knowledge available to us” (Hawkins, 2009). Hawkins believes that the different areas of your brain that learn (i.e. eyes for learning to see), do so in the exact same way. This means that there is potential to find an algorithm that is able to represent the foundations of learning, and by extension his view and definition of intelligence summarizes to this one-learning algorithm.

In conclusion, many different individuals have studied intelligence in a lot of different ways and aspects, and for a multitude of different applications. Understanding human intelligence, what it means, and how to measure it has been a central problem in the past, and there is still active research on understanding it now. Throughout the last few centuries, the focus has shifted multiple times, from understanding how intelligence is passed on, to understanding the components that form intelligence, to applying intelligence testing to determine social/political structures, to now being able to create these machines which build on our principles of intelligence. In the present day, our lives are constantly impacted and guided by these intelligence testing measures such as the SAT, the IQ, the Turing test, and many more. It becomes important to think about these intelligent measures, and how they are going to further impact the social structures of our world.

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