Question of intelligence: How much can we attribute to our genes?

Exactly what constitutes intelligence, and to what extent it is genetic, are some of the most controversial questions in science. But now a new study of nearly 80,000 people, published in Nature Genetics, has managed to identify a number of genes that seem to be involved in intelligence.

According to a dictionary definition, intelligence is “the ability to learn, understand or deal with new situations” or “the ability to apply knowledge to manipulate one’s environment or to think abstractly”.

This is obviously quite broad. Indeed, even animals display a number of different forms of intelligence, typically critical for survival. These range from reaching or gathering sources of food and escaping predators to the sharing of duties within a group (such as in ant communities). Elephants or monkeys also possess forms of empathy and care, which strengthen their relationships and chances to survive.

Human intelligence started out as “reactive”, enabling us to find solutions to the challenges of nature. But it later became “proactive”, so that we could use the resources of nature to develop preventive measures aimed at solving problems. Ultimately, what makes human intelligence different from that of other animals is our ability to shape the environment, for example through farming. This became possible as we developed communities and started delegating tasks on the basis of talents. When the acute problem of survival was controlled, we could dedicate our intelligence to the development of arts or other higher skills.

There are many factors that enable us to shape and nurture our intelligence – ranging from access to resources and information to skills acquired through experience and repetition. But, like with most human traits, there is also a genetic basis.

The experiment

The method used to measure intelligence in the new study was the so-called “g-factor” – a measure of analytical intelligence. Although it might appear reductive to catalogue all types of intelligence through a single test, the g-factor is often used in scientific research as being among the most unbiased methods. The authors looked at such scores in 78,000 people of European descent to search for genetic factors ı intelligence.

They carried out a genome-wide association study (GWAS).

This assesses connections between a trait and a multitude of DNA markers called single-nucleotide

polymorphisms, or SNPs, which might determine an individual's likelihood to develop a specific trait. The test enabled the researchers to identify 336 significant SNPs.

Generally, the vast majority of significant SNPs that result in this way fall in non-coding regions of the DNA. In other words, they indicate portions of the DNA that may regulate gene expression even though the actual regulated gene is unknown. This makes the SNPs from GWAS hard to interpret. So the authors then complemented their analysis with a so called genome-wide gene association analysis (or GWGAS), which calculates the effect of multiple SNPs within genes and can identify actual associated genes. They then combined both kinds of study to strengthen their confidence in naming the genes associated with intelligence.

This work led to isolating 52 candidate genes linked to intelligence. Although 12 of these had been previously associated with "intelligence", the study needs to be replicated in future studies.

What do we gather?

The researchers discovered that the genes that were the strongest linked to intelligence are ones involved in pathways that play a part in the regulation of the nervous system's development and apoptosis (a normal form of cell death that is needed in development). The most significant SNP was found within *FOXO3*, a gene involved in insulin signalling that might trigger apoptosis. The strongest associated gene was *CSE1L*, a gene involved in apoptosis and cell proliferation.

Does this all mean that intelligence in humans depends on the molecular mechanisms that support the development and preservation of the nervous system throughout an person's lifespan? It's possible.

And is it possible to explain intelligence through genetics? This paper suggests it is. Nevertheless, it might be warranted to consider that intelligence is a very complex trait and even if genetics did play a role, environmental factors such as education, healthy living, access to higher education, exposure to stimulating circumstances or environments might play an equally or even stronger role in nurturing and shaping intelligence.

It is also worth considering that the meaning of "intelligence" rather falls within a grey area. There might be different types of intelligence or even intelligence might be interpreted differently: in which category would for example a genius physicist – unable to remember their way home (Albert Einstein) – fall? Selective intelligence? Mozart nearly failed his admission tests to Philharmonic Academy in Bologna because his genius was too wide and innovative to be assessed by rigid tests. Is that another form of selective intelligence? And if so, what's the genetic basis of this kind of intelligence?

Studies like this are extremely interesting and they do show we are starting to scratch the surface of what the biological basis of intelligence really is.

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