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Discoveries Regarding the Genetic Determinism of Cognitive Processes and Human Behavior

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Abstract: The paper presents the importance of the discoveries of behavioral genetics at the time and in the way of learning, growth, and development. Hereditary character transmission and the molecular mechanism of gene transmission are the main research topics of genetics in the 21st century, but modern genetics wants to further study the function and behavior of genes. Behavioral genetics studies the heritability of behavioral traits, a concept that summarizes how much of the variation of a trait is due to the variation of genetic factors. The research seeks to identify issues related to the expression of genetic material at the level of IQ, as well as the extent to which the environment and education have a role in defining behavioral traits, theories known in the scientific community since the last century. However, the latest research focuses on the results of new, DNA-based research rather than traditional studies of twins and families. From these results, it was concluded that this provides some support for the idea that the phenotypic structure of intelligence is due in part to genetic effects acting on a general factor of intelligence and also to more specific cognitive levels.

Keywords: genetics; intelligence; heritability; behavior; DNA

1. Preliminary Consideration

Genetics appeared at the beginning of the last century and in just a few decades it has become one of the most fascinating realities of our world. This new branch of biology has revolutionized vast areas of science and tends to give new dimensions to the humanities, ethics, sociology, and philosophy. The decipherment of any biological process, starting from the origin of life and biological evolution, reaching the morphological, physiological, and biochemical characteristics of organisms, and ending with human thinking and behavior, can be achieved only if the hereditary component is allowed in the system of defining elements.

We know that the genetics of human behavior is a scientific discipline that deals with the study of the influence of genetic makeup on behavior and the interaction between inheritance and the environment insofar as they affect behavior.

Genetics (from ancient Greek: γενετικός genetikos, genitive, and γένεσις genesis, origin) is a branch of biology that studies the phenomena and laws of heredity and variability of organisms. Even though heredity is a concept that was observed millennia ago, the scientist Gregor Mendel was the first to start studying it from a scientific perspective. He studied how the traits are transmitted and how they affect the phenotyping of the offspring, performing various experiments on the pea plant[2].

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[2] https://ro.wikipedia.org/wiki/Genetics.

Hereditary transmission of the character and molecular mechanism of gene transmission is the main research topic of genetics in the 21st century, but modern genetics wants to further study the functions and behavior of genes.

Behavioral genetics studied the heritability of behavioral traits and overlaps with genetics, psychology, and ethology (the scientific study of human and animal behavior). Genetics plays an important role in the timing and way in which learning, growth, and development take place.

Heritability is a concept that summarizes how much of the variation in a trait is due to variation in genetic factors. This term is often used to refer to the resemblance between parents and their offspring. In this context, high heritability implies a strong resemblance between parents and follows in terms of a specific trait, while low heritability implies a low level of similarity.

Heredity is not a genetic inheritance or a share of the percentage of genetic factors, but a statistical coefficient. It can be differentially attributed to genetics between individuals and can be estimated from correlations between relatives of the same degree.

The estimation of heritability in a population depends on the division of the observed variation into components that reflect genetic and environmental factors. It is not the proportion of a phenotype, but rather the proportion of phenotypic variation that is due to genetic factors. It is a parameter of the population and therefore depends on population-specific factors.

Heritability, in a general sense, is the ratio between the variation due to differences between genotypes and the variation of the total phenomenon for a character or trait in a population.

The concept is usually applied in behavioral genetics and quantitative genetics. It is commonly used in studies of twins in the field of behavioral genetics.

A trait can have complete heritability and yet be drastically altered by environmental changes. This can be seen in certain genetic disorders of metabolism.

One of the most used methods to assess the heritability of intelligence is the study of identical twins who were separated at an early age and raised separately. Studies on twins provide strong evidence for the heredity of intelligence, with scores on identical twins being closely correlated. Also, the scores of adopted children are highly correlated with their biological parents and not with the adoptive parents.

2. The Role of Genetics in Determining Cognitive Processes

In general, studies of cognitive abilities are concerned with the differential perspective. A major concern of researchers is to establish those individual differences determined mainly biologically (genetically) and through natural maturation processes, to the detriment of those determined by individual experiences, through education and training.

The debate between Hans J. Eysenck and Leon Kamin, the so-called intelligence controversy, is well known, in which Eysenk stated that intelligence can be determined by 80% genetic factors, while Kamin considers that the role and contribution of genetic factors tend to zero.

These theories refer to the genetic factor of intelligence g, measured by standardized intelligence tests, and do not consider the possibility that specific cognitive abilities may differ in terms of genetic determination. Some evidence in this regard was provided by J.C. DeFries, S.G. Vandenberg, and G.E. McClearn, in 1976, indicating that almost all known cognitive abilities have some genetic determinants.

General cognitive ability is one of the most studied fields in behavioral genetics. Almost all of this genetic research is based on a model, called the psychometric model, which considers cognitive skills to be organized hierarchically (Carroll, 1993) from specific tests to main (general) factors and hence to general cognitive ability, often called g.

Is intelligence an expression of genetic material? What makes us smart? What makes us smarter than others? Be its genetic material, the environment we come from, or education?

The answer to these questions cannot be definitive, because intelligence presented a complex concept and at the same time difficult to define. For this reason, the quantification of intelligence is done through a general operational process, expressed by an IQ, IQ.

It is unanimously accepted that intelligence is linked to the personality and development of these individual old parks. It is also known that both genetic components and biological factors, which are extremely numerous and diverse, are involved in determining intelligence. What, however, cannot be definitively expressed is the weight of these factors. Which factor prevails over the other and how much of the intelligence is written in the genes?

Another theory, which argued for the importance of cultural, educational factors, stated that genetic influence on characters, including intelligence, tends to become less important over time as one accumulates experience and knowledge. Surprisingly, this theory has been contradicted by the results of studies that have shown that hereditary inheritance copes with the presence in childhood in a percentage higher than 20%, increases to 40% in adolescence and reaches a percentage of over 80 % at maturity.

Despite these results, Plomin and colleagues, in studies conducted in 2001 and 2003, stated that this could suggest that genetic influence affects a person's predisposition to learn to develop a certain IQ.

It is currently considered that intelligence is determined by hereditary factors and environmental factors. Studies published since 1966 by Sir Cyril Burt, who tested 53 pairs of monozygotic twins by determining the IQ (IQ), said at the time that hereditary factors have an 80% share in determining intelligence.

It is currently admitted that the percentage is around 50-60%. Research on the IQ of adopted children also supports the genetic determination of intelligence. They, even with quality education and in good living conditions, fail to exceed the IQ of their biological, natural siblings by more than 10%. Recent studies have identified 2 genes involved in determining intelligence: the IGF2R gene, placed on chromosome 6, and the CTSD gene (also called cathepsin D) located in the short arm of chromosome 11.

Research by Robert Plomin of the Institute of Psychiatry in London has shown that the IGF2R gene contains information for the receptor of an insulin-like growth factor and is present in several allele variants. One of them (allele 5) was identified in all subjects with an IQ over 160. Other research, led by Tony Payton of the University of Manchester, found that mutations in the CTSD gene decrease the IQ score by 30%, supporting its role. In determining intelligence.

R. Plomin and I. J. Deary (Plomin & Deary, 2015, pp. 98–108) bring to the fore a series of five genetic discoveries on differences in intelligence, increasing the heritability of intelligence from childhood to adulthood, general genetic effects on various cognitive and learning skills, assorted mating is greater for intelligence than for any other trait, positive thinking - as a factor in the development of intelligence and the fact that intelligence brings (some) genetics to “social” epidemiology. The two researchers believe that:

"Intelligence is a core construct in differential psychology and behavioural genetics, and should be so in cognitive neuroscience. It is one of the best predictors of important life outcomes such as education, occupation, mental and physical health and illness, and mortality. Intelligence is one of the most heritable behavioural traits. Here, we highlight five genetic findings that are special to intelligence differences and that have important implications for its genetic architecture and for gene-hunting expeditions. "

This study shows that the five findings emerged mainly from g studies that confirm new quantitative genetic technique from a complex genome-wide trait analysis (GCTA) that estimates genetic influence using genome-level genotypes in large samples of unrelated individuals.These results reveal important ideas about the genetic architecture of intelligence.

In his paper, Carey G. (Carey, 2003) argues for the need to understand how to measure the IQ score in the social sciences to move directly to genetic interpretation: "Nothing in behavioral genetics has sparked more acerbic and acrimonious debate that the issues surrounding the genetics of intelligence and social class. Science requires debate and argument, so differing opinions about heredity, intelligence, and social structure should be healthy signs. Instead, opinions are often stated with such a rhetorical voracity that personal and political agendas drown out sound empirical data. The sad consequence is that a chapter like this one is required in this book—there is simply too much misinformation about IQ test scores within the social sciences to proceed directly into a discussion of genetics."

In 2018, Robert Plomin, Sophie von Stumm in the study "The new genetics of intelligence", conclude that the new genetics of GPS IQ will bring the almighty variable of intelligence in all areas of life sciences, without the need to assess intelligence:

"Intelligence — the ability to learn, reason and solve problems — is at the forefront of behavioural genetic research. Intelligence is highly heritable and predicts important educational, occupational and health outcomes better than any other trait. Recent genome-wide association studies have successfully identified inherited genome sequence differences that account for 20% of the 50% heritability of intelligence. These findings open new avenues for research into the causes and consequences of intelligence using genome-wide polygenic scores that aggregate the effects of thousands of genetic variants. "

In a recent study (Deary, Cox & David Hill, 2021) of interest in this extremely exciting field, the authors discuss relevant issues discovered so far regarding the heritability and genetic architecture of differences in intelligence. Thus, studies of twins and families report that genetic differences are associated with individual differences in intelligence test scores. If studies of all ages are taken together, the genetic differences represent about 50% (standard error [SE] about 2%) of the variation in intelligence. Estimates of higher heredity are found in adult samples (where it may be 70% or slightly more) than in children (where estimates of up to 20-30% have been reported). The finding that intelligence is hereditary has been replicated in several data sets from different countries and periods. The mentioned study focuses on the results of new research, based on DNA, rather than on the traditional studies of twins and families.

From these results, it was concluded that this provides some support for the idea that the phenotypic structure of intelligence is due in part to genetic effects acting on a general factor of intelligence and also to more specific cognitive levels.

In the last decade, the heredity of intelligence has been investigated by direct DNA testing in large numbers of unrelated individuals. This is mainly based on testing for genetic variants called single

nucleotide polymorphisms (SNPs). Genetic statistics - the method used to estimate heredity is called the genome, a unique component with restricted maximum probability.

Genetic inheritance plays an important role in the development of intelligence, explains Dr. Andreas Heinz, head of the psychiatry and psychotherapy clinic at the Charité Clinic in Berlin. However, many recent studies have also revealed the "overwhelming influence of the environment" on the performance of the human intellect.

Despite the studies, a clear answer on the weight of some factors, be they genetic, cultural, educational, biological, in determining intelligence does not exist at this time. It remains a source of reflection for each of us and, at the same time, a formidable challenge for 21st-century research.

Genetic diseases that affect intelligence

Down syndrome is a chromosomal genetic disease that affects about one in a thousand children. The first to describe the syndrome in 1866 was the British physician John Langdon Down.

In 1959, the French pediatrician and geneticist Jérôme Lejeune discovered that Down syndrome was caused by the presence of an additional chromosome 21, resulting in several 47 chromosomes, compared to 46, as a human normally has.

One of the conditions associated with Down syndrome is a sub-normal level of intelligence, which affects almost every child with Down Syndrome, but is usually only mild to moderate; severe mental retardation is rare (IQ: 40-80);

Angelman syndrome occurs in both sexes and is mainly characterized by problems with the nervous system. Children are very active and with diminished attention, have difficulty understanding and learning, developmental delays, and sometimes eye problems. But life expectancy is normal.

Schizophrenia is psychopathology characterized by thinking, emotions, and behaviors with severe disabilities. Adoption studies have shown that a high percentage of adopted children, whose biological parents suffered from schizophrenia, also suffered from schizophrenia or associated conditions. Adopted children who did not have parents suffering from schizophrenia were very rarely diagnosed with this disorder. Studies in twins have estimated that the risk of heredity for schizophrenia is about 80%.

Other disorders with potential genetic roots are autism, attention deficit hyperactivity disorder (ADHD), bipolar disorder, major depression, and schizophrenia.

Studies have found an IQ of between 57% and 73%, and the most recent have shown that heritability for IQ has reached 80% and 86%.

It is believed that up to 40% of those with depression inherit it, and 60% are other environmental factors. Research has shown that people with parents or siblings who have depression are up to three times more likely to have this condition.

There are studies that have estimated that heritability is 83% in terms of risk for autism.

Studies in twins in childhood consistently report high heritability of 70-80%, while studies in adult samples show only moderate heritability of 30-40% when it comes to ADHD.

3. The Role of Genetics in Determining Human Behavior

Behavioral genetics integrates data from genetics, epigenetics, biology, neuroscience, psychology, ethology, and statistics, to understand the contribution of genes and the environment to behaviors and other psychic traits and abilities.

Behavioral genetics is the field of study that examines the role played by genetic and environmental influences on animal behavior, including human behavior. Often associated with the "gene versus environment" debate, behavioral genetics is an interdisciplinary field, involving contributions from biology, neuroscience, genetics, epigenetics, ethology, psychology, and statistics. Behavioral genetics specialists study the inheritance of behavioral traits. In humans, this information is often collected through the use of genetic association studies and family studies, including the study of twins versus adopted children.

Behavioral genetics is the study of organisms both behaviorally and genetically. The genetic analysis describes the genetic architecture of each species and is used to study individual differences in the description of a trait, in this case, behavior. Behavioral genetic analysis is a method of determining the degree to which a particular behavioral trait can be genetically influenced[1].

Personality traits are moderately hereditary

Over the years, strong phenotypic correlations have been reported between personality traits and a wide range of psychopathological conditions. However, it is not known whether these correlations have a genetic or environmental basis.

Are the specific symptoms of depression hereditary?

The result of molecular and behavioral genetic research on these questions has led to a shift in understanding depression from a broad-spectrum disorder to a collection of individual symptoms that vary in severity and etiology. The fact that depression cannot be inherited as a unitary disorder is highlighted by the results of molecular genetic studies.

An antisocial personality disorder is characterized by a disregard for the rights, feelings, and safety of others. Antisocial personality disorder has been shown to have a genetic link.

How much of what we humans think is the result of our choices freely and how much is determined by the possession of certain genes? If there are genes that lead to the development of criminal behavior, what is the role of the environment in which the individual is raised to reach the result? What implications (and what risks) can this knowledge have for society and the individual?

Why don't allele genes (in pairs) that seem unfavorable to the individual be eliminated in natural selection? Finally, if he admits that the possession or absence of a particular genetic package may be associated, even to a relative extent, with the risk of developing it with certain personality traits, which could lead to criminal behavior, then that is this responsibility of the individual in his behavior? Are we still the people responsible for what we do? Or are we simply what our genes are? So how can individual responsibilities be established?

Studies conducted in recent years have begun to shed light on clues that can answer these questions. Thus, it was concluded that the possession of an allelic variant (a pair of genes) that does not work properly, instead of those with good functioning, which regulates the metabolism of neurotransmitters

[1] Mohîrță, Ionel, Genetics of human behavior - Course notes - Faculty of Communication and International Relations, Danubius University.

involved in mood modulation, impulse control, and reward and punishment mechanisms. , can be associated with an increased risk for the individual who put the dysfunctional variant in the development of abnormal and unacceptable social behaviors.

Analyzing the relationship between genes and normal or pathological behavior, the researchers discovered a MAO -A gene that has an influence, if not functioning correctly, on violent or criminal behavior. It is a gene that deals with the secretion in the normal amount for a human body of a substance called the enzyme monoamine oxidase A, an enzyme responsible for maintaining a balance of the hormone serotonin involved in regulating mood and modulating behavior. Serotonin is also called the hormone of happiness, it maintains good mood and pleasure in humans. If this gene, which leads to the maintenance of the balance of serotonin secretion, has a defect, the individual who possesses the defective gene may develop violent behavior. However, if the environment in which he grows up is a healthy and protective psycho-social environment, the individual will not develop criminal potential. If the individual grows up in an unhealthy environment, which has exposed him to abuse and ill-treatment, with a defective gene, he may develop violent behavior.

Therefore, the fact that an individual possesses the defective gene does not imply the definite development of violent behavior but is a greater vulnerability factor to adverse external events that could result in the development of abnormal behavior. This vulnerability seems to increase in the presence of stressful environmental conditions for the child.

Similarly, the presence of genes that do not work well in an individual leads to a greater vulnerability to anxiety and depression, or other behavioral changes, especially in adverse environmental conditions. We have a gene for depression, anxiety, etc.

Genes indeed influence us in addition to the way we look and our behavior, but it is equally true that recent studies show that through a healthy, optimistic attitude, positive thinking, a healthy diet, we humans can influence the genes that we inherited from our parents. In which case the responsibility for what we do is ours or in other words, our behavior is the exclusive result of what we think.

Behavior is the set of objective manifestations of people, through which the psychic life is externalized. According to the Galtonian dichotomy, if the intellect represents one half, the behavioral character outlines the other half of the human personality. In all areas of personality, the genetic component is the predominant part. Behavior is a phenotype with great variability.

4. Conclusions

Behavioral genetics, young discipline, branch of genetics that studies the relationship between heredity and behavior (IQ, mental disorders, social integration disorders). It investigates series of monozygotic and dizygotic twins raised in similar or special environmental conditions, the frequency of mental disorders in exogamous and endogamous populations, the family concentration of mental disorders, and mental retardation, the relationship between chromosomal abnormalities and intelligence or behavior. All research has shown that mental development normally involves the participation of heredity and the environment. Many forms of mental retardation are genetically conditioned. In experimental conditions in animals, by selective crosses and by comparing inbred lines and offspring resulting from the crossing of these lines, the role of heredity in the genesis of aggression, preference for alcohol, sexual behavior is studied.

Instinctive behavior, based on the unconditional reflex has a strictly genetic determinism, while learning is based on the conditional reflex is essentially a product of the environment, made on a certain genetic

background. Thus, the behavior of the body, as well as the rest of its phenotype, is the result of the genotype-environment interaction. Individual differences in behavior are based on the variation of genetic factors, the variation of environmental factors, and their interaction.

The latest studies focus on the results of new, DNA-based research rather than traditional studies of twins and families. From these results, it was concluded that this provides some support for the idea that the phenotypic structure of intelligence is due in part to genetic effects acting on a general factor of intelligence and also to more specific cognitive levels.

Of great interest will be the study *Using DNA to predict intelligence* that will appear in ScienceDirect, the most important source of scientific, technical, and medical research in the world, on the concerns of researchers for the use of DNA to predict intelligence. There are revolutionary researches that will bring considerable benefits in this foray into the complex world of intelligence, which is becoming increasingly interdisciplinary for scientists.

References

Baker, C. (2004). *Behavioral Genetics. An introduction to how genes and environments interact through development to shape differences in mood, personality, and intelligence*. New York, NY, USA.

Carey, G. (2003). *Human genetics for the social sciences*. New York: Sage.

Carrol, J. B. (1993). *Human cognitive abilities: A survey of factor-analytic studies*., New York, NY, USA: Cambridge University Press.

Dăbală, I. *Genetics of human behavior. Implications of human genetics in psychology*. Faculty of Psychology and Educational Sciences - course - "Babeş-Bolyai" University Cluj-Napoca.

Deary, Ian J.; Cox, Simon R. & David Hill, W. (2021). Genetic variation, brain, and intelligence differences. *Molecular Psychiatry*.

Mohîrță, Ionel. *Genetics of human behavior* - Course notes - Faculty of Communication and International Relations, Danubius University.

Plomin, R. & Deary, I. J. (2015*).* Genetics and intelligence differences: five special findings. *Mol Psychiatry*; 20(1), pp. 98–108.

Plomin, R.; DeFries, J. C.; Knopik, V. S. & Neiderhiser, J. M. (2013). *Behavioral genetics*. New York.