

# Genetics And Its Influence on Learning

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**Abstract:** The past few decades witnessed the era when the behavioural differences were considered to be rooted from the effect of nurturing i.e., environment. However now there are many evidences that encourage the fact that many human traits, favourable or unfavourable, are substantially influenced by the genetic architecture of an individual. Though the impact of heredity(nature) is normally combined with that of environment (nurture), the prominent effect of nature on learning ability cannot be denied. This paper focuses on the concept of genetic inheritance of traits and how it affects the learning characteristic. *Keywords:* Genetics, Inheritance, Learning, Nature, Nurture

## Introduction

Genetics science has revolutionized the whole world at an unbelievable speed. Those impossible tasks which were unimaginable in the last century are surprisingly achievable with the advancement of research and development of genetic science. DNA analysis and modification is equipped with the possibility to test for serious diseases and treat them before getting critical. Catching culprits, creating eco-friendly energy resources, developing identical species through stem cell technology, all of these herculean tasks are made possible by the research and application of genetics. Genetics has widened its scope in numerous sectors like agriculture, law, public health, medicine, environment, social policies etc.

When the desired learning doesn't occur among young children or adolescents, blames are shifted on everybody else with reasons like unsupportive parents, incapable teachers, poor behaviour etc, however the fundamental reasons are far deeper. The whole education system is based on the prediction that children are 'Blank slates', but this fact is denied by behavioural genetics. According to this theory all children are born likely with same potential, just like a blank slate, which is then written by the society, school and family members. It is commonly believed that students become successful learners due to excellent parents, supportive teachers etc, and if they become antisocial, it's their faulty upbringing. However, many studies show that children are not blank slates, they arrive with their own set of characteristics like needs, habits, appetite, temperaments etc. Even if different children of the same families are grown in the same environment, there is very less resemblance among them as they grow further. Sometimes the environment is considered as a key factor of influence, but in the case of learning and cognitive development, the contrary is true. The genetic factors are more influential over time. Hence the fact that genes influence the individual learning contradicts the blank slate philosophy.

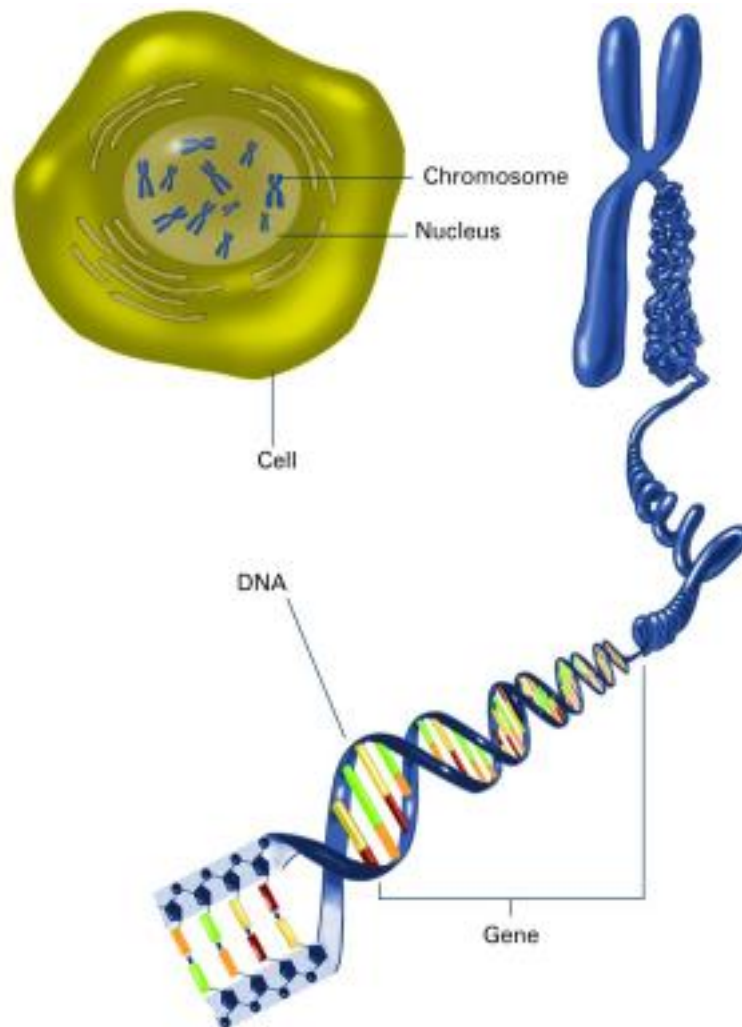
### Genetics Concepts:

The effect of nature (inherited genes of parents) and nurture (environment) are intertwined in the learning of human beings. Children look like their parents due to nature and nurture. Parents pass on their genes to their offspring, half of the genes of the mother and father are passed, though the other half is not passed on, they carry the parent's characteristics and eventually influence the children's characteristics.

For instance, parents having genetic inclination towards learning, can have an interest in reading which may induce learning habits in the child. This phenomenon, when a parent's trait impacts results for their offspring by moulding the climate that they accommodate for them, is called genetic nurture. It depicts how a parent's qualities can indirectly transfer to their children's attributes.

Genetics is the scientific study of genes and heredity—of how certain qualities or traits are passed from parents to offspring as a result of changes in DNA sequence. A gene is a segment of DNA that contains instructions for building one or more molecules that help the body work. Our DNA, with all genes, is stored in chromosomes, structures where proteins wind up DNA tightly so that it fits in the nucleus. Humans have 23 pairs of chromosomes. The two chromosomes in each pair contain the same genes, but they may have different versions of those genes because one chromosome in each pair is inherited from our mother and the other from our father. (<https://nigms.nih.gov/education/fact-sheets/Pages/genetics.aspx>)

Figure 1: DNA makes up genes and is spooled within chromosomes inside the nucleus of a cell. source: NIGMS



Any difference or variation in genes hamper the normal functioning of that gene. Changes in DNA may cause inaccurately formed proteins which don't perform its actual function. Similar to the inherited characteristics, some diseases can also be passed on from parent to child.

#### **Learning:**

Learning is the most significant process in human life. It is a continuous process which starts from birth and continues till the end of life. It enables us to adapt to the changes in the environment around us and lead an effective life. Learning is a wide concept. It is not limited to only acquiring skills about any subject matter, it also involves gaining experiences from the environment. (<https://zerotoeternity.com/psychology/what-is-learning-in-psychology/>)

Learning is defined as a relatively permanent change in your behaviour, or behavioural potential, produced by experience.

Learning is the behavioural modification which occurs as a result of experience as well as training (Gales).

Learning is the process of acquisition of knowledge, habits and attitudes (Crow and Crow).

Learning is a permanent behaviour change not a temporary one. For example, the behavioural changes caused due to some illness, fatigue etc. can't be considered as a learning process. The behavioural changes happening due to growth and development are also not considered as learning. Learning can happen through direct or indirect experiences as well. It is a cognitive process. Learning is an ongoing process which happens in all stages of life, by constructing or reconstructing experiences. John B Watson, founder of Behavioural School of thought, was the first to prove that learning results in behavioural changes.

#### **Key characteristics of Learning:**

- Learning is a process of acquiring experiences.
- Learning can be described as the process of acquisition, retention and modification of experience.
- It establishes the relationship between a stimulus and response.
- Learning is aimed at problem solving and makes adaptations and adjustments with the environment around.
- It results in permanent behavioural changes.
- Learning process involves synthesis of old and new experiences to make new patterns.
- Learning involves definitive goal setting for need satisfaction in an effective way. ● Learning is a continuous and universal process.
- The behavioural changes resulting from learning can be favourable or unfavourable.

(<https://www.managementstudyguide.com/definition-characteristics-and-types-of-learning-in-psychology.htm>)

Learning has three major types: Classical learning, Observational Learning, and Operant Conditioning.

- **Classical learning:**

In this learning type neutral stimulus is associated with a stimulus that produces a specific behaviour naturally.

- **Observational learning:**

In this learning type, learning happens through observation. Learning by observing the behaviour and actions of others.

- **Operant conditioning:**

In this type of learning behaviour is associated with the occurrence of significant event. Behavioural changes are dependent on consequences of significant events.

**Influence of genetics on learning:**

Numerous studies in behavioural science show that genetics or heredity plays a crucial role in learning. However, the effect of heredity and environment go hand in hand, in the formation of effective learning traits. Heredity forms a healthy individual who is capable of learning. Measuring the effect of heredity on the individual without taking the environment in consideration is hardly possible and can lead to erroneous results. However, the environmental factors can be controlled to an optimal extent. The genetic influence can affect the exposure to the environment, is termed as gene-environment correlation.

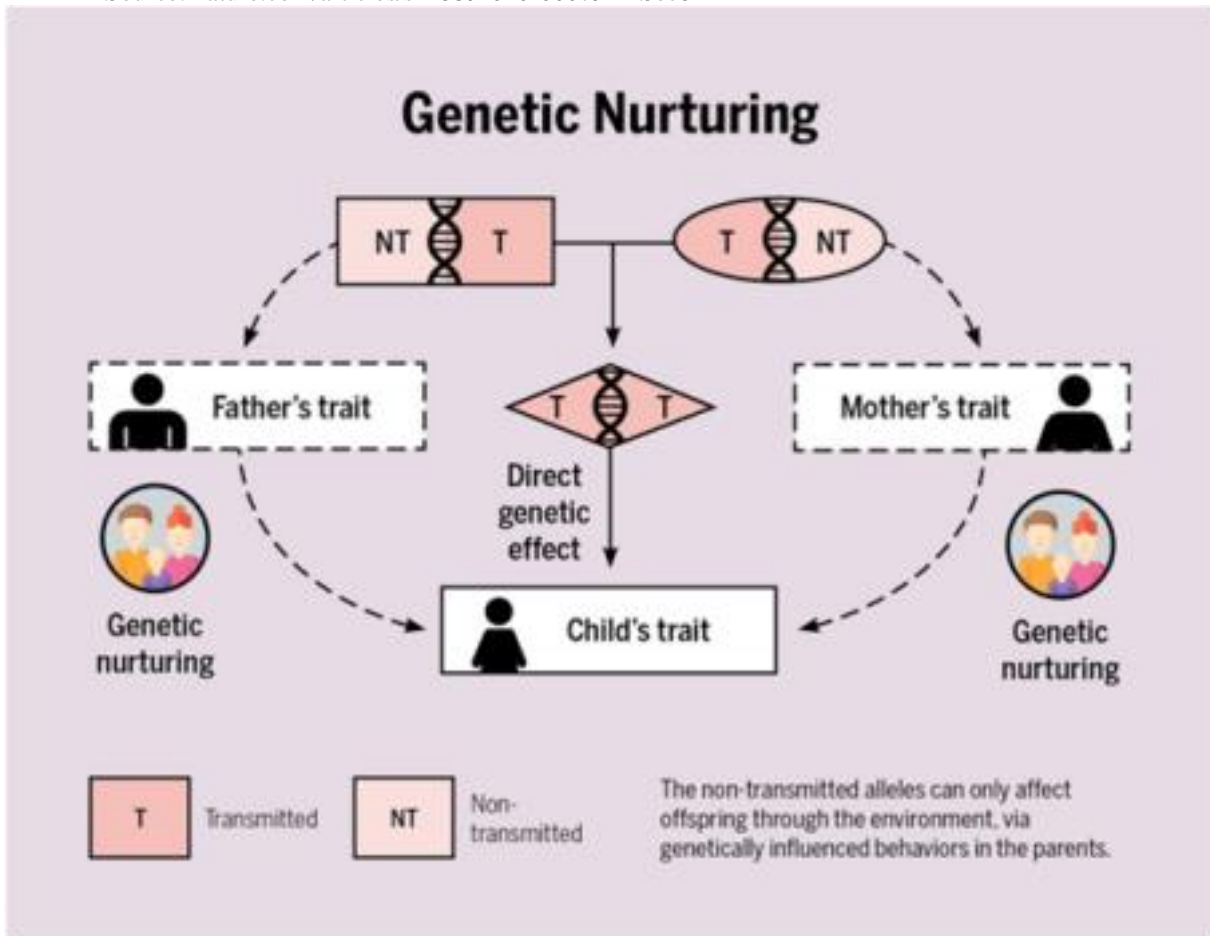
For instance, in a home, where children are encouraged for their curiosities and their doubts are addressed in an elaborated way, the chances of good reading, writing habits in the child is more likely. This is the environmental impact. However, on the other side, the influence of genetic factors cannot be denied as parents with reading and writing difficulties often get children facing the same kind of problem. Similarly, research shows that the genetic traits of parents who are excellent readers and writers, transfers in their children, who enjoy the world of reading and writing. Intellectually deprived families may have children with learning difficulties.

Twin study has been used widely over the decades to understand the role of genes and heredity. Identical twins are genetically identical to each other while fraternal twins are like ordinary siblings having only half of their genes in common. While studying intelligence, researchers observed that IQ scores of identical twins raised together were similar to each other; however, those for fraternal twins were less similar. This fact boosts the power of genetic influence in intelligence. Further, many studies also indicate that the IQ score of identical twins raised apart are highly similar to those of identical twins raised together, which is strong evidence of genetic influence.

<https://ierqta.blogspot.com/2017/07/the-effect-of-heredity-and-environment.html>

Figure 2 Genetic nurturing design.

Source: nature.com/articles/s41539-020-00079-z#Sec8



Studies of adopted children who have no biological connection with their adopted parents indicates that the learning ability of adopted children has a very thin connection with the learning ability of their adopted parents. Once they leave the

influence of an adoptive home, they adopt the learning traits of their biological parents. These findings highlight the influence of genetics in learning.

Philosophers René Descartes and Immanuel Kant argued that cognitive ability is largely the result of genetic compositions. They proposed that humans have a certain amount of inborn cognitive inclinations resulting from their parents' genes. The study by Frank et al (2007) on how genes influence learning, focused on the connection of learning traits with three separate genes. **Discs, large homolog 3 (DLG3)** is a gene associated with learning and memory. A large portion of the variance in higher cognitive function across the population can be accounted for by genetic factors (Friedman et al, 2008). For example, although there are multiple separable components of executive function, as indexed by latent factor analysis (Miyake et al, 2000), these components share a nearly perfectly (99%) heritable 'common factor' that is itself separable from general intelligence and perceptual speed (Friedman et al, 2008).

From the research conducted over 6000 pairs of twins who are part of the UK-representative Twins Early Development Study, it is found that about 70% of the stability in achievement is explained by genetic factors, while 25% is accounted for by the twins' shared environment, such as growing up in the same family and attending the same school. The remaining 5% was explained by their non-shared environment, such as different friends or different teachers. (Rimfeld, Margherita, 2018)

During the process of cell division (meiosis), the chromosomes from each parent combine and then divide. During this process, changes in both the structure of the chromosomes and their respective genes can occur and this may give rise to genetic abnormalities that are the cause of some learning disabilities. It is believed that between 30-40% of moderate to severe learning disabilities are caused by changes in the genetic makeup of an individual (Knight et al, 1999) and developments in genetic technology arising from The Human Genome Project suggest that the percentage may be higher. Hence, it is evident that genetics plays a vital role in the learning ability of an individual.

It is commonly assumed that if a learning trait is highly heritable, then it cannot be changed or improved, however by applying various environmental factors many improvements can be observed in the learning characteristic.

#### Conclusion:

Genetics has a major role in the learning ability of the human being. Though its impacts are significantly identified and combined with the environmental factors, strong evidence shows that genetic architecture accounts for a substantial variation in the learning process. However, it is also evident from many studies that the influence of heredity on learning ability can also be altered to a certain extent with education, teaching methodologies and daily experiences and environmental factors. The influence of heredity on learning is substantial. The advances in research and DNA testing at the birth of a child can be used to recognize the genetic deformity in learning traits which can lead to development of learning disability or reading problems, and early diagnosis and interventions can be provided.

#### References:

1. Asbury, K., & Plomin, R. (2013). *G is for genes: The impact of genetics on education and achievement*. John Wiley & Sons.
2. Bouchard Jr, T. J. (2004). Genetic influence on human psychological traits: A survey. *Current directions in psychological science*, 13(4), 148-151.
3. Bueno, D. (2019). Genetics and learning: How the genes influence educational attainment. *Frontiers in psychology*, 10, 1622.
4. Cesarini, D., & Visscher, P. M. (2017). Genetics and educational attainment. *npj Science of Learning*, 2(1), 1-7.
5. Frank, M. J., & Fossella, J. A. (2011). Neurogenetics and pharmacology of learning, motivation, and cognition. *Neuropsychopharmacology*, 36(1), 133-152.
6. Hart, S. A., Little, C., & van Bergen, E. (2021). Nurture might be nature: Cautionary tales and proposed solutions. *NPJ science of learning*, 6(1), 1-12.
7. <https://dnalc.cshl.edu/view/1367-DLG3-Gene.html#>
8. <https://dnalc.cshl.edu/view/1390-Genes-for-Learning-and-Memory.html#:~:text=Learning%20and%20memory%3A%20DLG3%3ADiscs,postsynaptic%20density%20of%20excitatory%20synapses.>
9. <https://ierqta.blogspot.com/2017/07/the-effect-of-heredity-and-environment.html>  
[https://lx.iriss.org.uk/sites/default/files/resources/NES\\_Unit2.pdf](https://lx.iriss.org.uk/sites/default/files/resources/NES_Unit2.pdf)
10. Genetics and its influence on learning 13 <https://nigms.nih.gov/education/fact-sheets/Pages/genetics.aspx>
11. <https://www.bbc.com/future/article/20180905-how-genes-influence-achievement-and-success-in-school>
12. <https://www.bbc.com/future/article/20180905-how-genes-influence-achievement-and-success-in-school#:~:text=In%20recent%20years%2C%20researchers%20have,and%20even%20in%20different%20subjects>
13. <https://www.frontiersin.org/articles/10.3389/fpsyg.2019.01622/full>
14. [https://www.ipl.org/essay/Importance-Of-Heredity-And-Environment-In-Learning-PCZJEH4NS\\_U](https://www.ipl.org/essay/Importance-Of-Heredity-And-Environment-In-Learning-PCZJEH4NS_U)
15. <https://www.managementstudyguide.com/definition-characteristics-and-types-of-learning-in-psychology.htm>
16. <https://www.sciencedaily.com/releases/2021/08/210819125249.htm>
17. <https://zerotoeternity.com/psychology/what-is-learning-in-psychology/>
18. Plomin, R. (1999). Genetics and general cognitive ability. *Nature*, 402(6761), C25-C29.