

2021

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Recommended Citation

Rosensaft, Sydney (2021) "How Much DNA Do Identical Twins Really Share? Effects on the Study of Psychiatric Disorders," *The Synapse: Intercollegiate science magazine*: Vol. 28: Iss. 1, Article 17.
Available at: <https://digitalcommons.denison.edu/synapse/vol28/iss1/17>

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How Much DNA Do Identical Twins Really Share?

Effects on the Study of Psychiatric Disorders

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Did you know that identical twins are not actually identical? In a study of 381 sets of identical twins, only 38 had the exact same genes. There were more than 23 thousand possible postzygotic mutations discovered that can exist in identical twins, with a median of 14 per pair. Sure, identical twins are more similar than fraternal twins, but they differ greatly from each other. Differences in twin interests and identity are often attributed to environmental influences, but underlying genetic variations suggest that genes play a big role as well. Recent studies have found that identical twins' deoxyribonucleic acid (DNA) are very different, even from birth. These variations lead to significant life distinctions, including serious psychotic illnesses, and impact the reliability of twin studies.

For a long time, it was widely assumed that identical twins share the exact same DNA because they originate from the same fertilized egg. Once an egg is fertilized, it grows to a zygote. The zygote then enters the embryo stage, which is when it splits and develops two organisms, two twins. Since these twins are from the same zygote, they are known as monozygotic twins. On the other hand, fraternal twins originate from two separate fertilized eggs and are known as dizygotic twins. Dizygotic twins share no more DNA than regular siblings.

However, monozygotic twins' shared egg does not mean they have identical genetic information. The differences between monozygotic twins are apparent as soon as the splitting of the embryo begins. If the embryo does not split evenly, one twin may end up with more genetic material than the other. The more uneven the split, the greater the difference in genes, leading to more developmental differences in the twins. In a study of monozygotic

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triplets, gene mutations were generally only shared between two of the triplets, showing that those two individuals developed from slightly different cells than the third triplet. Once the twin's separate egg begins dividing and developing, genes mutate and lead to physical discrepancies. Sometimes the mutations lead to minor differences like differing eye or hair colors. Yet, depending on how many genes mutate, identical twins sometimes develop different skin tones, which can be shocking for parents who are told their children are supposed to look alike.

One of the most significant twin discrepancies that can come from mutations is the varying risk levels of developing psychological disorders. While environmental factors do affect the development of psychiatric disorders in twins, scientists are

realizing that genes play a bigger role in developing neurological disorders than previously believed. Identical twins live in similar environments and are often treated the same, so their differences are strongly attributed to genes. Genes influence how people interact with and shape their environment, which, in turn, can change how likely someone will develop a disorder. Two common disorders that develop in only one twin are schizophrenia and autism spectrum disorder (ASD).

When it comes to schizophrenia, only 48 percent of identical twins share a diagnosis. If one identical twin is diagnosed with schizophrenia, the other twin has only a 30 to 50 percent chance of developing the same disorder. Interestingly, when twins do both have a schizophrenia diagnosis, they have very similar symptom profiles.

In the case of ASD, the disorder is further complicated because there is not just one type of symptom, cause, or gene. Until recently, these differences in twin disorder diagnoses were thought to be due entirely to the environment. Typically, environmental factors have a huge influence on the development of ASD. However, research in twins shows that a shared environment had little impact on twins' likelihood of developing severe autism. Instead, it was mainly their genes. Therefore, twin DNA differences are more evident in severe cases of ASD, where the relevant genes can be more easily identified. These findings have both negative and positive implications.

On the negative side, acknowledging that twins are not truly identical means that twin studies are less reliable than previously thought. The basis of twin studies is the belief that, since twins have identical DNA, environmental effects can be isolated and studied. However, if twins do not truly share DNA, the basis of these studies is disproved, thereby creating questions about findings from past twin studies. Twin studies have been the gold standard in psychiatric disorder research, so this revelation poses a significant scientific challenge.

Luckily, there is an upside to discovering that different twin diagnoses are due to genetic variations: scientists can learn more about the genetic origins of psychiatric disorders. Many disorders originate in regions of genes called "copy number variants" (CNVs). Whereas most genes in a person exist only in two copies, CNVs can have zero to 14 possible copies. In identical twins, it is easier to trace the differing regions because there is less variance in overall genetic information than there would be in dizygotic twins or regular siblings. This understanding opens up a new pathway for research: using slight genetic differences in twins to learn more about psychiatric disorders. Although traditional twin studies that are thought to isolate environmental effects may not be reliable anymore, new studies that uncover the origins of psychiatric disorders now have the opportunity to flourish. ● ● ●

