# The powerful indirect influence of genes on children's success

## Through parenting, genes become effective even if a child didn't inherit them

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October 28, 2019

Twenty months ago, I became a parent. From the early days of my pregnancy through the nearly two years I have been raising my daughter, family members, pediatricians and newspaper articles have provided a steady stream of advice about the best ways to ensure her optimal development. Much of this advice focuses on parenting. If I talk a lot to my daughter, if I regularly read bedtime stories, if I take her to museums and libraries, the advice goes, I will increase her chances of becoming a high-achieving, well-behaved child. This guidance reflects the widespread belief that parents influence their children's development through their parenting.

In addition to being a parent, I am a behavioral genetics researcher. Because of my work, I know that parenting is not the only path through which parents contribute to their children's development. Another path is via genes. Parents pass on genes to their children, and these genes influence how children develop, affecting their achievement at school and beyond. The significance of genes first became apparent in twin and adoption studies. More recently, researchers have been able to directly measure people's DNA and connect variations in genetic makeup with life outcomes, including educational attainment.

In public debates, the effects of parenting and genes are often pitted against each other, as exemplified by the phrase "nature *versus* nurture." As a result, the ways in which genes and parenting work together tend to be overlooked.

One reason for this oversight is a narrow view of how genes influence human development. It is often assumed that genes work only by shaping the biology and behavior of the person who carries the genes. For example, my daughter's genes might influence the architecture of her brain, which in turn influences her ability to concentrate, and so forth. However, genes can also operate indirectly, by modifying the behavior of the people surrounding an individual. For instance, my genes might influence my behavior in ways that affect my daughter's development,

To find out more about such processes of gene-environment interplay, my colleagues and I studied a cohort of 860 British mothers and their children. Our study team visited these families repeatedly, beginning when children were 5 years old and continuing until they reached the age of 18.

When the children were young, study visitors observed the families' home environments and how the mothers interacted with their children. They documented whether children received cognitive stimulation (e.g. books were read to them) and warm, sensitive parenting (e.g. mothers treated them affectionately); how chaotic the household was (e.g. noisy, crowded, with an unpredictable daily schedule); and whether the home was safe and tidy (e.g. childproof and relatively clean).

Mothers and children also reported their perceptions of the parenting they provided and received, respectively. When the children were 18 years old, we recorded information about their school achievement.

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We also measured mothers' and children's genes. We focused on a genetic signature that had been previously discovered in a study of educational attainment. In that study, the researchers measured the genomes of millions of people to identify genetic variants that were associated with educational attainment. People who carried more of these education-related genetic variants completed slightly more schooling than those with fewer such variants.

We found that parenting and genes worked together to influence children's achievement. Mothers who carried more of the gene variants that had been found to be linked with educational achievement differed in their parenting. They provided more cognitive stimulation and warmer, more sensitive parenting, and they also raised their children in less chaotic environments and safer, tidier homes.

This interplay between mothers' genes and parenting was found to have implications for children's achievement: Children of mothers with more education-related genetic variants did better in school because of the parenting they received from their mothers, and in particular because they benefited from more cognitive stimulation. This was the case regardless of the children's own education-related genetic variants. In other words, having a mother who carries more such genetic variants paid off for the child (in terms of better performance at school) even if the child did not inherit these variants, because of the greater cognitive stimulation these children received from their mothers.

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To sum up: Our findings show that genes influence children's development not only via the children's biology and behavior, but also via their social environments which are shaped by factors such as parenting. Those social environments can be modified through interventions such as early childhood home visiting programs and high-quality childcare. Making interventions of this kind more widely accessible to families will help to ensure that all children are able to grow up in stimulating environments, regardless of genetic background.

Our findings also show that "nature" and "nurture" are much more closely intertwined than "nature versus nurture" debates commonly lead us to believe. We need to consider both genes and environment if we want to gain a more complete understanding of the processes shaping children's lives.

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