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Brain Mutations Guarantee Our Individuality

Recent research shows that in brain development, cell mutations are ubiquitous

Each identical twin also has a unique brain; in fact, twins' brains are different halfway through pregnancy. Why? *PHOTO: ISTOCK*

By **MELVIN KONNER**

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It seems there are trees in the brain, and they help make each of us unique. In fact, we are all basically mutants, and according to a new study by Michael

Lodato and his colleagues at Harvard Medical School, mutated genes in brain cells proliferate throughout the brain's development.

Genes directly or indirectly make the brain's chemicals, as well as the locks that these chemical keys fit. They also help assemble the brain to begin with.

Small genetic differences help explain why each of us humans thinks, acts and feels like nobody else. Connections are forming and unforming when we memorize or forget a tune, fall in love or divorce, and write or read these paragraphs.

The brains of identical twins are a lot more similar than those of nonidentical ones, even aside from experience. Yet each identical twin also has a unique brain; in fact, twins' brains are different halfway through pregnancy. Why?

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One reason is experience. The twins had different positions in the womb and different supplies of hormones and nutrients. And when mom went to that loud rock concert—fetuses do react to and even remember sound—one of the twins may have had her ear closer to the abdominal wall. They have also competed with and influenced each other. The second reason is subtler: chaos. Not the kind in your teenager's bedroom, the scientific kind—sensitivity to initial conditions—according to which a butterfly flapping its wings in Japan famously causes a storm weeks later in Mexico.

It's the same in an embryo's brain. Tiny differences in an early cell division—say, one cell gets slightly different contents—will amplify as cells divide again and again, form nerve cells and arrange themselves in circuits. Chance and chaos limit genetic control.

Yet another way twin brains diverge: mutations after the egg and sperm unite. Every time a cell divides, errors occur; radiation and chemicals, even at very low levels, change DNA. And there are "jumping genes"—ones that duplicate themselves in different parts of the genome.

Dr. Lodato and his colleagues reported in Science last October that there are a lot more mutations than we thought. The researchers isolated hundreds of nerve cells from three donated postmortem brains, from unrelated adults.

New techniques make it possible to track the mutation history of a given cell line. Furthermore, most nerve cells stop dividing early—without which experience would not endure. Our brain cells carry their prenatal genetic signatures permanently, which means researchers can study those signatures. The scientists can map an individual nerve cell's genetic code and see where it differs from its forebears in the brain. So the researchers were able to trace the mutated cells' ancestry within each of the three people, a kind of family tree of cells inside each brain—as individual as a fingerprint, but far more important.

Since theoretically every cell in our brains (and bodies, except for eggs and sperm) should have identical genes, any differences must have resulted from mutation after the start of pregnancy. In fact, each cell on average had around 1,500 mutations. That's a minimum. Only some of these affect nerve-cell structure and function, but they guarantee the uniqueness of each brain.

So identical twins begin with identical genes, but soon gain some changed ones. And so do we all, each minuscule mutant planting a family tree of cells within our brains, before we even meet our moms and dads. Upon which they—along with siblings, friends, teachers and lovers—proceed to make each of us even more singular.