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# Heady Theories on the Contours of Einstein's Genius

*Stored Near a Beer Cooler and Sent Through the Mail, Physicist's Unusual Brain Comes Under Renewed Study*

By ROBERT LEE HOTZ

Seeking signs of genius, a researcher recently reconstructed the shape of Albert Einstein's brain with techniques normally used to analyze fossils. This mold of thought, she believes, reveals the imprint of a rare intelligence that transformed our understanding of space, time and energy.

By studying photographs of Einstein's brain taken at his death in 1955, paleoanthropologist Dean Falk at Florida State University identified a dozen subtle variations in its surface that may have heightened his ability to see physics in a new way. Her research suggests how the brain shaped the inner life of the 20th century's most famous mind.

"Einstein's brain is really unusual," says Dr. Falk. "On the surface at least, it looks different than others. It's suggestive."

Like every human brain, Einstein's was an island universe of thought.

The insights that revolutionized physics were the product of 25 billion neurons linked by billions of connections -- an essence of intellect so densely compacted that a thimble full of brain matter normally holds 50 million neurons and a trillion synapses. His ideas and impressions raced through a maze of 93,000 miles of insulated nerve fibers at 200 miles per hour.

No one knows exactly how intelligence and originality arises from the action of so many special cells. Researchers at Drexel University in Philadelphia and Northwestern University in Evanston, Ill., recently discovered that patterns of electrical brain activity, as measured by electroencephalograms, usually are different among creative thinkers than among more methodical problem solvers.

An expert on ancient neural evolution, Dr. Falk is accustomed to studying brains that no longer exist. She reviewed 25 autopsy photographs. She could see that Einstein's brain had an unusual pattern of grooves and ridges along its parietal lobes, suggesting a rearrangement of areas associated with mathematical, visual and spatial cognition.

Although he published 300 scientific papers, Einstein couldn't easily describe the way his mind worked. "A new idea comes suddenly and in a rather intuitive way," he once said. His thoughts moved "in a wildly speculative way." As a theorist, he sometimes solved physics problems by imagining himself riding alongside a light beam or falling in an elevator. "I rarely think in words at all. A thought comes

and I may try to express it in words afterwards ...I have no doubt that our thinking goes on for the most part without the use of signs and, furthermore, largely unconsciously."

Told that many people only think in words, he laughed.

By studying Einstein's neural remains, researchers like Dr. Falk pursue an inquiry at the confluence of science, folklore and medical history. For a century, scientists have compared famous brains in hopes of finding the link between neural structure and talent. It's heady work. "The brain is as close as we can get to the physical essence of what makes us human," she says.

To this end, Soviet scientists once conducted top-secret studies of Lenin's brain, seeking in its dead cells the intellectual seeds of social revolution, says University of Houston political economist Paul Gregory, who discovered the 1936 medical report hidden in Communist Party archives. More recently, researchers at the Institute of Medicine in Juelich, Germany, took apart the brain of a translator fluent in 60 languages, in hopes of finding the secret of his exceptional language ability. In both cases, the findings were inconclusive.

By itself, brain size is no true measure of intellect, comparative studies confirm. Einstein's brain weighed 2.7 pounds, less than most men. The brain of 1921 Nobel laureate Anatole France weighed just 2.1 pounds. At three pounds, Lenin's brain was exactly average. The brain of Russian novelist Ivan Turgenev outweighed them all at 4.4 pounds.

To understand the anatomical reasons our mental capacities often differ, researchers must look instead for subtle distinctions among neurons and synapses in structures associated with specific abilities. Nonetheless, the effort to study Einstein's brain was controversial from the start.

When Einstein died in New Jersey at the age of 76, an eccentric hospital pathologist named Thomas Harvey conducted a routine autopsy. But he removed the physicist's brain for later study -- apparently acting on his own authority. He soaked it in preservative and cut it into 240 pieces, each containing about two teaspoons of cerebral tissue. He mounted 1,000 slivers on microscope slides for study.

It was decades, though, before Dr. Harvey could persuade anyone to seriously examine them. Einstein's brain samples languished in a cider box next to the beer cooler under his desk.

Not until 1985 did the first scientific analysis appear. Pioneering neuroscientist Marion Diamond at the University of California, Berkeley, discovered that, in some tissue samples, Einstein's brain had more cells nurturing each neuron than normal. These well-tended cells, located in a region associated with mathematical and language skills, might help explain the physicist's "unusual conceptual powers," she speculates.

Then Dr. Harvey contacted neuropsychologist Sandra Witelson at McMaster University in Hamilton, Ontario. An authority on cognition and comparative neuroanatomy, Dr. Witelson had assembled the world's largest collection of normal brains, all cross-matched and cataloged by intelligence tests and behavioral surveys conducted while the donors were still alive.

"Unannounced, he sent me packages -- packets of slides -- just addressed to me without a return address," Dr. Witelson recalls. "These slides of Einstein's brain kept coming through the mail, unannounced and uninsured."

She compared Einstein's brain samples with dozens of normal men and women in her brain bank. Most of his brain was unremarkable, but she found that one area associated with visual and spatial reasoning -- the inferior parietal region -- was 15% larger than normal. Even more unusual, his brain lacked a special fissure there, effectively fusing two key brain regions into one.

"I can't prove that those were the regions that Einstein was using when he was thinking about relativity," says Dr. Witelson. "We suggested that anatomy could have given him an advantage in three-dimensional thinking."

No one knows whether the quirks of Einstein's brain structure were the cause or effect of his genius. Some of his gift, no doubt, was hereditary. But his research required intense study, and such concentrated effort can alter the brain physically. Regular meditation, for example, can increase the size of brain areas that regulate emotion, researchers at the University of California, Los Angeles, Laboratory of Neuroimaging reported last week in the journal Neuroimage.

Indeed, a curious knob-like feature that Dr. Falk saw in pictures of Einstein's motor cortex might be due to his early musical training. It resembled a structure detected in neural studies of experienced pianists and violinists, caused by hand exercises.

"I wish Einstein were alive," says Dr. Falk, "and we could ask a little more about how he thinks."

- Robert Lee Hotz also shares recommended reading on this topic and responds to reader comments at WSJ.com/Currents. Email him at sciencejournal@wsj.com.

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