

The Secret Life of Einstein's Brain His genius lives on in two glass jars and a few dozen photographs

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Once or twice a month between 1955 and 1956, Thomas Harvey, a pathologist at Princeton Hospital, rode the train to Philadelphia and walked across the campus of the University of Pennsylvania to the medical school's Anatomy/Chemistry Building. There, in a locked closet in the basement, sat numerous glass specimen jars in which human brains floated in liquid preservative. In their anatomy classes, medical students regularly dissected these organs - all of them, that is, except the brain Harvey came to visit.

His routine never changed. Sitting at a table in one of the labs, he would stretch a pair of rubber gloves over his hands and carefully pluck the wet gray brain from its container. Slowly, he would turn it this way and that way, examining the hard jelly-like folds and grooves of the cerebral cortex, while lab technician Marta Keller waited patiently nearby. Finally, Harvey would point out the areas he wanted Keller to hone in on next.

During the following days, Keller would deftly wield the 12-inch blade of a sophisticated brain slicer and, following Harvey's directions, carefully cut out discrete, fist-sized blocks of gray matter from which she whittled tissue-thin specimens ready for microscopic study. Eventually, Keller cut and sliced the brain into 240 pieces, then stained and mounted anywhere from 500 to 1,500 slides.

All this was done in the name of scientific research, because although this organ looked quite ordinary on the outside, it was hardly standard on the inside. The tiny bits of brain matter Keller was cataloging belonged to one of the 20th-century's greatest intellects and its first true scientific celebrity: Albert Einstein.

How the cerebrum of the Father of Relativity came to reside in a basement lab of the University of Pennsylvania and eventually Princeton Medical Center is only part of the intriguing secret life of Einstein's brain. The journey of that brain is itself a testament to our obsession with genius, with the need to know where in that 3-pound mass of gray matter, that most evanescent of human experiences takes place: the leap of an imagination.

After the autopsy, it was the actions of Harvey, who not only removed and preserved but also photographed Einstein's brain, that made it possible for future researchers to study the great man's gray matter. For centuries, scientists have been consumed with trying to understand the origins of superior intelligence. What better way to do that than to study the Holy Grail of I.Q.? And if Einstein's brilliance could somehow be pinned to his brain anatomy, what might that teach us about our own intellectual potential?

Today, a New Jersey clinical neurologist continues what Harvey started. Frederick Lepore, who works at the University of Medicine and Dentistry of New Jersey's Robert Wood Johnson Medical School in New Brunswick, recently discovered a trove of never-before-published photographs Harvey snapped of Einstein's brain. Lepore also is one of the authors of a new study based on those photos.

"The cerebral cortex of Albert Einstein: a description and preliminary analysis of unpublished photographs," which appeared in November in the journal "Brain," makes the case that the surface architecture of Einstein's cerebrum is truly unique.

"All we can say is it's an extraordinary brain," says Lepore, who lives just blocks from Einstein's former home in Princeton. "I can't say where he thought of $E=mc^2$... All I can say is (the brain) is different."

Albert Einstein died at 1:15 a.m., Monday, April 18, 1955, at the age of 76, after spending the last 22 years of his life at Princeton's Institute for Advanced Study.

Nine hours after the demise of the most well-known mathematician on the planet, Harvey, then 43 and a member of the pathology department at what is now the University Medical Center of Princeton at Plainsboro, performed the autopsy. Shortly thereafter, his report went missing, likely the trophy of a hospital insider, according to Lepore and others. But the autopsy itself was recorded in the pathology department's logbook. Inside its now well-worn covers, on page 82, "Einstein, Albert," is printed in dark blue ink, the 13th name in a column of 15. The one-line entry indicates this was the 33rd autopsy of the year at the hospital, and on the opposite page, in Harvey's cramped cursive, the cause of death is listed as "ruptured abdominal aortic aneurysm."

During the autopsy, Harvey photographed the brain from every conceivable angle with his own 35mm Exakta camera. Although Einstein's family later disputed Harvey's claim that they gave him permission to keep the brain, multiple witnesses said Einstein himself had given unofficial approval for the scientific study of his brain.

Another of Einstein's organs, his eyes, also were removed during the autopsy and given to the mathematician's friend and long-time ophthalmologist, Henry Abrams, who had a private practice in Princeton. Einstein was godfather to one of Abrams' sons. What has never been clear is why the ophthalmologist was at the autopsy and whether it was he or Harvey who removed the eyes.

Abrams told a reporter many years later that he kept the eyes locked away in a safe deposit box in a bank vault. (Abrams died in 2009; the eyes have not been seen since.) The rest of Einstein's body, in accordance with his wishes, was cremated and the ashes spread at an unknown location.

During the next few decades, Harvey parceled out bits of Einstein's brain to at least 18 researchers around the world - from Alabama to Argentina, Canada to California,

Hawaii to Japan. But the bulk of the brain remained, essentially, incognito until 1998 when Steven Levy, a New Jersey Monthly reporter, was told by his editor to "go find Einstein's brain." He tracked Harvey down in Kansas, where the pathologist kept the pieces of Einstein's gray matter, each wrapped in cheesecloth and soaking in pure alcohol, inside two Mason jars.

There was a flurry of media attention. Most people knew Einstein was long gone; they had no idea his brain was not. That discovery prompted writer Michael Paterniti to take a road trip with Harvey to deliver the brain to the mathematician's granddaughter, Evelyn Einstein, in California. In 2001, Paterniti wrote about the experience in his book "Driving Mr. Albert: A Trip Across America with Einstein's Brain." (For the record, Evelyn declined to accept her grandfather's gray matter.)

Earlier that same year, Lepore wrote an article based on previously published photographs Harvey had taken of Einstein's brain after it was removed during the autopsy. In "Dissecting Genius: Einstein's Brain and the Search for the Neural Basis of Intellect," published in the journal "Cerebrum," Lepore wrote about Harvey: "In the 1960s, he did everything you could do to examine the brain of a genius." Alas, neuroscience was in its infancy back then, and the mysteries entombed in the great one's gray matter remained locked away.

Enter Dean Falk, an evolutionary anthropologist at the School for Advanced Research in Sante Fe, N.M. In 2009, she published "New information about Albert Einstein's brain" in the journal "Frontiers in Evolutionary Neuroscience." Falk had been intrigued by previous studies of the photos that suggested there was a pronounced knob-like structure in Einstein's left motor cortex. This feature, she knew, was not uncommon in the brains of right-handed string players. Einstein, of course, was a rightie and played the violin most of his life. Applying techniques from paleoanthropology, Falk confirmed the existence of this unusual structure. But examining photographs of a part of the brain of this singular genius only whet Falk's desire to see more. Were there other photographs available, she wondered? She contacted Lepore, who told her she was probably out of luck, but he would try to find out for sure.

By this time, Harvey had died (in 2007) at the age of 94. So Lepore did the next best thing: He called Harvey's former companion, Cleora Wheatley, at the home the couple once shared in Titusville, N.J. When asked whether there might be more photos lying around, Wheatley replied, "I have a couple of cartons (of Harvey's papers) in my cellar."

Concerned that something important related to Einstein might be lost if the boxes were misplaced, Lepore offered to help Wheatley find an appropriate repository. Eventually, she and one of Harvey's sons decided to donate the papers to the National Museum of Health and Medicine in Silver Spring, Md., with the caveat that Lepore had access to the material.

Finally, in 2011, and only after numerous inquiries, Lepore was permitted to spend a single day (eight hours) with the contents of the boxes. It was there, at the National

Museum of Health and Medicine, that he uncovered a couple dozen photos of Einstein's brain that had never before been seen by scientists. Fourteen of those photos were made available to researchers last October. (Anyone now can view 350 digitized microscopic slides of the mathematician's brain through a \$9.99 iPhone app called Einstein Brain Atlas.)

Dean Falk pored over the new photos and was immediately impressed. "Man, this is like no other brain," she told Lepore. "This is the real deal. This brain has a different surface architecture." She noted that Einstein's parietal lobes, located on the top and toward the back of the head, were highly asymmetrical, with the right superior parietal lobule substantially larger than the left.

The parietal lobes, according to neuroscientists, are highly involved in visual-spatial skills, the kind that Einstein employed in his legendary thought experiments, like chasing a light beam, riding in an elevator in free fall and rocketing past a clock tower in a streetcar. Products of a vivid imagination, it was these thought experiments that led to new concepts about space, time and gravity.

It wasn't mathematics that made Einstein a genius. Equations were merely tools. It was the pictures in his head and those pictures were likely products of a right parietal lobe working overtime.

The first person who noted this asymmetry between Einstein's right and left parietal lobes was Sandra Witelson, a neurobiologist, at McMaster University in Canada, which has one of the largest collections of normal brains (125) in the world. During the 1990s, Harvey, familiar with Witelson's work, had sent her several blocks of Einstein's gray matter. Like other researchers, she found the material too degraded to be of much use, but the photographs of the whole brain were more conducive to study. In 1999, she wrote one of the first major papers analyzing Einstein's brain anatomy.

Of the 250 brain hemispheres in her collection, Witelson said, not one included the kind of expanded parietal lobe that was found in Einstein's right hemisphere - a parietal lobe that was at least 15 percent larger than any she'd ever seen.

"His anatomy is unique compared to every other photograph or drawing of a human brain that has ever been recorded," she told a reporter from the website LiveScience last November.

Falk also confirmed additional ridges and grooves in Einstein's prefrontal cortex. This is where our most advanced thinking takes place, including planning, focused attention, perseverance and imagining scenarios - yes, those thought experiments again. Evolutionary history tells us that an increase in brain volume was accompanied by an increased complexity in the convolutions of the brain. The more "wrinkled" the brain matter, the more intellectual bang for the cerebral buck.

Falk found other surprises as well.

"The motor face area in Einstein's left hemisphere was extraordinarily expanded into a big rectangular patch that I've not seen in any other brain," she told Scientific American last November.

Not only the face, she said, but the tongue. Falk didn't have a ready explanation for that, but she was reminded of the time a media-weary Einstein stuck out his very long tongue at a photographer who promptly took one of the most reprinted photographs of Einstein's life. Falk suddenly decided on an impromptu "experiment" to determine if Einstein's tongue was as unusual as his brain. Could she stick hers out as far? She stepped in front of a mirror and imitated the famous photo. Yes, she could. Nothing out of the ordinary there, she concluded.

Instead, perhaps this unusually large part of the motor cortex had something to do with how Einstein referred to his creative process as not only visual, but muscular. "The words, or the language, as they are written or spoken, do not seem to play any role in my mechanism of thought," he once observed.

Mysteries remain, not the least of which is the location of genius. In fact few, if any, of the scientists who have studied the photographs or pieces or microscopic slides of Einstein's brain believe they are any closer to finding his aha moments in his brain anatomy. Perhaps that's why only a half-dozen peer-reviewed studies of Einstein's brain have made it into print since his death. The paper published last November by Lepore, Falk and Adrienne Noe of the National Museum of Health and Medicine may be the most recent, but it will surely not be the last. Our fascination with the brain and our obsession with genius make that a near certainty.

So, where is Einstein's brain now?

Elliot Krauss, chief of pathology at the University Medical Center of Princeton at Plainsboro, has been caretaker of the brain tissue since Harvey passed down those two famous glass jars.

"About 1993 or 1994, Harvey showed up at my door one day," Krauss recalls. "He was carrying a citrus carton with two large Coplin jars with Einstein's brain matter. He introduced himself and he asked if he could have some absolute alcohol (a preservative). After that, he would come in every now and then to chat. In the early 2000s, I said, 'You know, Dr. Harvey, you're not getting any younger. When you die, (Einstein's brain matter) is going to fall into the wrong hands.' Two weeks later, he appeared again with the same carton, same jars. 'Here it is, Elliot, it's all yours.'"

Krauss considers himself the curator of the material and is both protective of it and circumspect about the public curiosity that still surrounds it. When the medical center recently moved from its location on Witherspoon Street in Princeton to Plainsboro, he personally oversaw the transfer of the jars.

"I have a great sense of reverence and responsibility, and I don't take it lightly or wear it on my shirt sleeve," he says. "The one thing I understood from Harvey was that Einstein and his family didn't want the brain to be used for anything other than research."

This is primarily why Krauss is reluctant to allow the jars to be viewed and doesn't say where in the medical center they are stored.

When he does finally take them out for his visitor to see, he carefully places the glass containers on his desk, not far from the photograph of his wife and three sons and an old hourglass. The dozens of blocks of brain matter are not really visible - only the cheesecloth in which they are wrapped and the little round white tags attached to each piece. Every six months, he says, he refills the containers with absolute alcohol.

Einstein's mind was more than muscular; it was a force of nature. His brain bloomed with ideas he turned into images, images he turned into insights, insights he turned into universal truths. Einstein's life was equally muscular. He was no aesthete, no ivy-tower-bound hermit. He played the violin for trick-or-treaters at Halloween, enjoyed vanilla ice cream with chocolate sprinkles and loved sailing, which he said helped clear his head.

If there is any meaning at all in the gray matter of a man now dead fifty-eight years, it is hard to find it floating in those jars.

As a scientist, Krauss takes his duty seriously. As an admirer of Einstein, he finds it mournful.

"What's remarkable to me is the genius of who Einstein was is now condensed to a bunch of little blocks in a jar. It's sad. It's really sad. This is our sum total. At the end of the day we're little blocks to be studied. For the rest of us, what are we going to have to show at the end of the day? You're dead. Dust to dust."

Krauss has been a pathologist for three decades and has been at the medical center since 1989. The last time he performed an autopsy, he says, was a year and a half ago. Only six were performed at the medical center in 2011, and the new incarnation of the hospital in Plainsboro was built without a dedicated autopsy suite. Advances in diagnostic technology have made most autopsies a thing of the past.

When asked what will happen in 10 or 20 years to the remainder of Einstein's brain still in his care, the 61-year-old doctor pauses thoughtfully.

"What will I do? I've thought of giving it to the Smithsonian. I would have given it to the Armed Forces Institute of Pathology, but it was decommissioned a few years ago."

Krauss's voice trails off. Another pause. Then he adds, "I'm not ready to give it up yet."