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## Einstein's Brain: Lost and Found

Dean Falk

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## **FINDING EINSTEIN'S BRAIN**

By Frederick E. Lepore 2018

New Brunswick: Rutgers University Press

### **BOOK REVIEW**

Einstein's Brain: Lost and Found

*Finding Einstein's Brain* by clinical neuro-ophthalmologist Frederick Lepore, MD, is an eight chapter "biography" of Einstein's brain and, to some extent, his mind. It is also a scientific adventure story about the search for photographs, histological slides, and chunks of Einstein's brain that were lost to science and the public for decades. Full disclosure: I had the privilege of taking part in this adventure, and it is from this perspective that I offer the following review.

The book examines the substance, merits, and critiques of the still-growing handful of publications about histological and gross anatomical aspects of Einstein's brain. Not surprisingly, there is drama in this biography, beginning with the well-known facts that Einstein's eyeballs were purloined and his autopsy report went missing. Lepore contributes revelations about the academic politics that continue to surround attempts to access the photographs and parts of Einstein's brain that remain in the custody of some less-than-cooperative individuals, and he (generously) acknowledges criticisms from self-appointed devil's advocates who find absolutely nothing of value in the research that has been published, to date. But this book offers much more. The author synthesizes aspects of philosophy and contemporary neuroscience when he considers, for example, the neuroscience of consciousness, whether scholars are getting closer to determining if the brain and mind are the same thing (materialism) or different (dualism), and the possible neurological bases for Einstein's famous thought experiments (gedankenexperiments).

Lepore explains how he became involved in his quest to find the lost remains of Einstein's brain in Chapter 1 ('A Neurologist Walks in Princeton'), and in the preface he discloses:

'My particular perspective on Einstein's brain will be instructive, but it is not for everyone....Physicists will gape open-mouthed at the presumption of a guy who treats migraines writing about general relativity without resorting to math. (Actually, I included Einstein's field equation of gravitation in chapter 6 to placate them. I fear they

will see through my ruse.) Neuroanatomists will grouse, “Cortical surface anatomy! How quaint! Korbinian Brodmann and 1909 are asking for their study back.” Neuroradiologists and cognitive neuroscientists will disallow my conclusions based on nonliving brain tissue and chant in unison, “Where’s Einstein’s functional magnetic resonance imaging?” Sorry, that particular signature technology of neuroscience didn’t arrive until thirty-six years after Einstein’s death...I can only implore the reader to please heed the words of an old Arab proverb: “The dogs bark, but the caravan moves on”—and to turn the page.’ (p. x-xi).

Indeed.

Lepore’s biography of Einstein’s brain begins on April 18, 1955 when the 76-year-old died of an inoperable ruptured abdominal aortic aneurysm in Princeton Hospital (Chapter 2, ‘April 18, 1955’). Quaker pathologist Thomas Harvey (1912-2007) harvested and preserved the brain at autopsy and, shortly thereafter, acquired permission from Einstein’s son, Hans Albert, as well as from the executor of Einstein’s estate, to retain it and arrange for its study by qualified scientists. Lepore details Harvey’s meticulous photography of first the whole, and then the dissected, brain, and his subsequent guidance of the brain’s transformation into microscopic slides (keyed to a “roadmap” of the whole brain) and 240 gauze-wrapped chunks, many of which, today, float (somewhere) in two glass jars of formalin. He also describes the findings (or lack thereof) of every study that resulted (to date) from Harvey’s somewhat erratic efforts to facilitate research on the brain, and does so from a nuanced historical perspective (Chapter 3, ‘What the Neuropathologist Knew...and Didn’t Know;’). As the author shows, Harvey was severely criticized for his involvement with Einstein’s brain (Chapter 4, ‘The Lost Decades (1955-1985), the Cider Box, and the Microscope’), partly because of a sensationalized account (Paterniti, 2001) of his having, literally, taken parts of the brain “on the road.” Lepore met Harvey in 2000, and his description of their meeting sheds a fairer, softer light on the latter’s posthumous reputation:

‘On his sunny deck in Titusville, Harvey....voiced his disappointment “over the lack of reports from experts” and the fact that we had only “one brain” to study...I will always

remember the spirit of scientific inquiry defining his professional life and expressed even in his ninth decade at his retreat in rural New Jersey. Only later would I come to realize the great personal cost incurred by his pursuit of Einstein's genius.' (p. 7-8).

After noting that Einstein underwent electroencephalography (EEG) in 1951 to observe changes in his brainwaves associated with thinking about problems of relativity, and after reviewing Einstein's published introspections about how he thought, Lepore adds:

'Based on these glimpses of Einstein's interest in his own cognition, I believe he would have endorsed the spirit of scientific inquiry that led Harvey and his successors to begin studying his brain . . . .' (p. 26).

I became acquainted with Fred Lepore serendipitously. Although Einstein was best known as a physicist, he was also an expert violinist. An intriguing MRI study of the gross anatomy of precentral hand representations in the cerebral cortices of expert musicians (Bangert and Schlaug, 2006) together with five published photographs of Einstein's whole brain (Witelson et al., 1999) made me yearn for access to the 'calibrated photographs [that] were taken of all views of the whole brain and of the dissected hemispheres' by Harvey after he harvested Einstein's brain (Witelson et al., 1999, p. 2149). But where were all of those unpublished photographs? In an effort to find out I emailed Lepore because I had been deeply impressed by his 2001 analysis ('Dissecting genius: Einstein's brain and the search for the neural basis of intellect'). Could he help find those unpublished photographs? He emailed back that he didn't know where they were, but that he would try to find out. Thus began one of the most exhilarating scientific adventures of my life—and I think his.

And locate the long-lost photographs Lepore did, along with a treasure trove of other Einstein materials that had 'vanished when Harvey packed his bags and left Princeton Hospital in 1960' (p. 97), including letters, a copy of his Last Will and Testament (March 18, 1950), and microscopic slides that had been meticulously prepared from his brain (Fig.1). It took Lepore more than a year to locate the late Dr. Harvey's archives (which, as it turned out, were in the cellar of his companion) and another year to persuade the Harvey family that these priceless materials should be placed in a reputable academic institution where they would be properly

curated and made available to qualified researchers as, indeed, Einstein's relatives had wished from the start. Make no mistake, had it not been for Fred Lepore, it is unlikely that these materials would now repose at the United States National Museum of Health and Medicine (NMHM)!



Figure 1. Boxes holding microscopic slides prepared from Einstein's brain after it was harvested in 1955. These materials are curated by the U. S. National Museum of Health and Medicine. (Photograph by Dean Falk, 2011.)

As Lepore details, we gained access to the Einstein materials in September of 2011 because of the expressed wishes of the Harvey family and the hospitality of the NMHM's Director, Dr. Adrienne Noe, who eventually agreed to join us in publishing a detailed description of the newly emerged photographs of Einstein's brain (Falk et al., 2013). Thanks to Noe, our paper provides details about the acquisition and accession of all of the archival materials donated by the Harvey estate and expresses the hope that the other traces and remains of Einstein's brain that are still lost will eventually be donated to the NMHM:

'Interest in this collection is such that its most robust study may be achieved when as much material as possible, natural and archival, is reassembled in one place, physically or virtually. The National Museum of Health and Medicine has an interest in providing

appropriate curation for such materials and related items in order to achieve that potential.’ (Falk et al., 2013, p. 1305).

I finally met Lepore in person when we rendezvoused at the UNMH to access the Einstein materials. To say that he showed up ready and well-equipped to undertake serious research is an understatement (Fig. 2). As Lepore describes it:

‘The intellectual exhilaration experienced on that day in Silver Spring was scientific exploration at its most invigorating....The myriad notes and digital photographs we took that sunny September day would provide the foundation for our discovery of Albert Einstein’s astonishing brain anatomy. Months of work lay ahead of us.’ (p. 19).



Figure 2. Frederick Lepore (left) ready to collect data and (right) ‘intellectually exhilarated’ at the U. S. National Museum of Health and Medicine. (Photographs by Dean Falk, 2011.)

In Chapter 5 (‘The Exceptional Brain(s) of Albert Einstein’), Lepore summarizes the findings from the three teams that, so far, have studied the photographs of Einstein’s brain, including ours. Although our team described differences between certain features in every lobe of Einstein’s brain and comparable features documented (and sometimes quantified) from the

cerebral cortices of ‘normal’ individuals in the literature (Connolly, 1950; Ono et al.,1990), it is worth repeating Lepore’s caveat regarding the temptation to over-interpret external cortical morphology:

‘Dear Reader, before going any further, I implore you to regard this startling variation of anatomy strictly as a fascinating example of structural biology and not a surrogate for Einstein’s intellect. If the unique neuroanatomy I have begun to outline suggests a tangible link to Einstein’s profound grasp of our universe, so be it...but always remember that not a shred of scientific evidence exists today that will allow us to bridge the explanatory gap between brain and mind.’ (p. 100).

For my money, the most sophisticated research that has been done on these photographs, to date, originated from a team in China (Men et al., 2014) (Fig. 4). As Lepore notes, that study ‘established that Einstein’s corpus callosum was significantly larger compared to young and old controls [which] must be regarded as proof positive that Einstein’s connectome (like his cortex) was exceptional’ (p. 239).

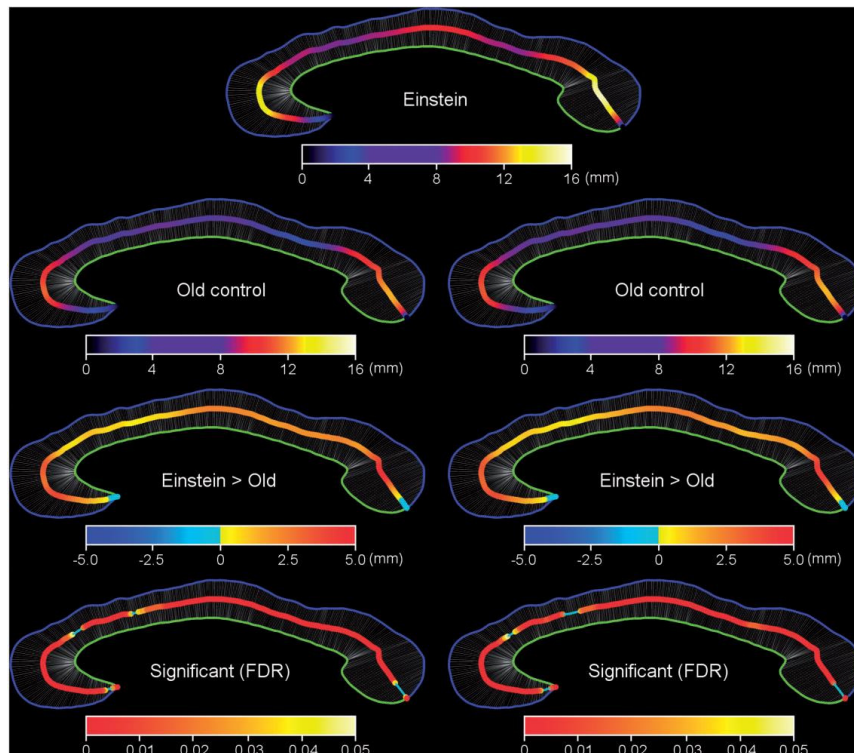


Figure 4. Distribution maps of corpus callosum thickness between Einstein and elderly controls; from Men et al. (2014).

*Finding Einstein's Brain* isn't just about neuroanatomy, however. It also contains wonderful discussions about relativity, other aspects of physics, and the personalities of the physicists Einstein hung out with. For example, the reader will find herself standing on that mythical railroad embankment watching a very long train zoom by until a person sitting in its exact middle (presumably on a flatbed) passes her line of vision precisely at the moment she (the reader) observes two lightning strikes equally close to the front and back ends of the train. Although the reader will perceive these flashes as having occurred simultaneously, not so for the train traveler in this thought experiment, famously associated with Einstein's theory of special relativity. What mind-bending fun it is to read Lepore's accounts of this and other thought experiments, and what subtlety he brings to them as someone who makes his living thinking about the visual perception of light in the brains of his patients!

Which brings me to one of my favorite parts of the book (in Chapter 6, 'How Does a Genius Think?') that underscores a point about the author's "voice." Lepore's writing combines erudition, unexpected asides to the reader (e.g., notes to "tiger moms" regarding their efforts to raise baby Einsteins), and occasional interjections of humor. I don't know if Lepore intended readers to chuckle at the following description of dueling thought experiments, but that was my reaction:

'Beginning in the 1920s, Einstein and Niels Bohr lit up the Valhalla of physics as they hurled intellectual lightning bolts at each other in a titanic scientific debate to establish the truth or artifice of quantum mechanics. (Spoiler alert: most judges would assert that Bohr and quantum mechanics prevailed.) However, in 1930 the outcome of the quantum controversy still hung in the balance, and Einstein called into question the indeterminacy of time and energy with a diabolically clever thought experiment now known as Einstein's box . . . . Bohr was deeply troubled by this frontal assault on quantum mechanics: During the whole evening he was extremely unhappy . . . . After a sleepless night, Bohr was able to shore up the now shaky edifice of quantum mechanics by using



Einstein's greatest achievement, the theory of general relativity, against him [in a counter thought experiment].' (p. 151-152).

Or, how about:

'If the functions of average frontal lobes ascend to the empyrean heights of our "gnostic, mnestic, and intellectual processes," [Fulton, 1951, p. 447] then in order to grapple with the implications of Einstein's abnormal frontal neuroanatomy (to quote Jaws), neuroscience is "gonna need a bigger boat." ' (p. 100-101).

Chapter 7 ('The Pursuit of Genius') explores the fascination that the public and scholars alike have with genius, and the efforts, both historic and recent, to determine 'what makes a genius tick' (p. 179). Lepore asks if there is 'evidence for a legitimate link between intelligence and brain structure' (p. 194) and revisits the quest to localize the mind within the brain (the 'ghost in the machine,' p. 203). And what about consciousness—what is that? As Lepore explains, there are no simple answers to these intellectual quagmires. They are, nonetheless, fascinating to ponder.

Chapter 8 ('Where Do We Go from Here? (And Where Have We Been?)) revisits classic cases that provided the first glimpses about the basic organization of the human brain, including Broca's aphasic patient (dubbed Tan), the unfortunate railroad foreman, Phineas Gage, whose frontal lobe was pierced by a tampering iron, and the surgery patient who underwent a bilateral medial temporal lobectomy (Henry Gustav Moliason, better known as H.M.—remember him?). Leaving the rearview mirror behind, this chapter then examines what is on the horizon for the neurosciences and suggests the possibility that future studies may reveal information about the microscopic neural networks of Einstein's brain:

'Of the two-thousand-plus microscopic slides sectioned by Thomas Harvey and Marta Keller in 1955, many (the precise number is unknown) were processed with Weigert stain, which reveals myelinated axons under light microscopy. Despite the plentiful availability of slides that displayed the myelinated connections of Einstein's brain, white matter was largely ignored in the six peer-reviewed studies (published between 1985 and

2006) of Einstein's neural microanatomy that focused on cell counts and glial morphology.' (p. 239).

In addition to many photographs of Einstein's brain, microscopic slides from his brain await future scientists at the NMHM. At the beginning of the book, Lepore comments that 'We shall see if Harvey's brash and spontaneous brain dissection can speak informatively across the decades to modern neuroscience' (p. xi). *Finding Einstein's Brain* shows not only that Harvey's "postcards" from 1955' have spoken, but also that they may have a whole lot more to say.

Dean Falk

Hale G. Smith Professor of Anthropology & Distinguished Research Professor

Florida State University, Tallahassee, FL; US

Senior Scholar

School for Advanced Research, Santa Fe, NM; US

[dfalk@fsu.edu](mailto:dfalk@fsu.edu)

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