Voice from the distant past

An Egyptian mummy has broken his silence after 3,000 years

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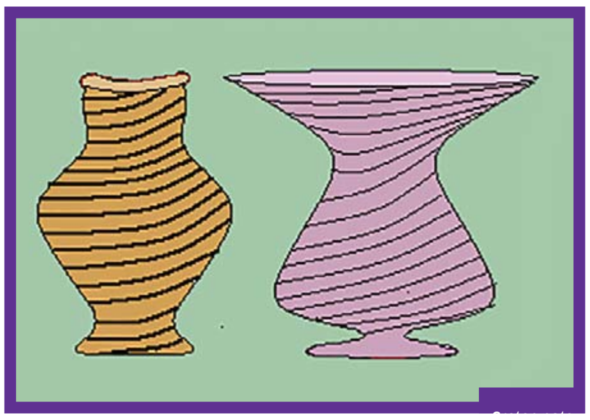
As images can be captured, prehistory can be brought visually to life. Cave art is a clear instance. Of sounds, however, this is not true. Recording became possible only in the 19th century, and we have no evidence of earlier sounds. Would ancient times appear more real if we could hear what those times sounded like?

D M Howard, J Schofeld, J Fletcher, K Baxter, G R Iball and S A Buckley, from the universities of London, York and Tübingen, Germany, Leeds Museums and Galleries and the Old Medical School, Leeds, describe in the journal, *Scientific Reports*, how they reconstructed the voice box of an Egyptian who lived 3,000 years ago. And then synthesised his voice. In some sense, the team has brought an Egyptian mummy back to life, to make out how the person spoke at least one syllable.

A person's voice is considered to be as unique as her fingerprints. A feature can be unique when it arises through the interplay of a great many, generally random factors, whose combination tends never to be repeated. Fingerprints are an example, because no two babies can share the physical conditions all through their time in the womb, which is when patterns on the fingertips are formed.



In the same way, each tone of a person's voice consists of a mix of several frequencies. These frequencies arise in the voice box, or larynx, an organ in the neck, which also enables breathing and swallowing. And the mix of frequencies that come out of the voice box is sensitive to the slightest differences in the dimensions. As the voice box is built up of millions of cells, each voice box is a little different, and each person has a different voice, like different fingerprints. The human ear can make out the difference — we may have noticed that we can usually identify persons who call on the phone as soon as we hear them say, "hello".

The paper says that if the exact dimensions of a person's vocal tract are established, current technology is able to reconstruct the vocal tract, and the person's vocal sound can be synthesised using electronics. This has been done with the larynx of living persons and the synthesised sound matched with the real voice. The exercise, however, has been done with living persons, where the soft tissue around the bones of the neck are there for use as the model for building the voice box — when what remains is only the skeleton, the precise shape is not available. Even when a body is embalmed and tissue is preserved, the vocal tract is missing or distorted, the paper says.

There are, however, instances of better-preserved mummies, where the technology that we now possess could possibly be successful. A project called "Voices from the past" was hence set up to see what could be done with best-preserved bodies of antiquity.

And one such, the paper says, is that of Nesyamun, a priest, incense-bearer and scribe at the Egyptian temple complex in Karnak in the ancient Greek city of Thebes. The body, which lies in the Leeds City Museum, is dated at about 1100 BCE and was unwrapped in 1824. And down the years since then, there have been several rounds of examinations, including x-ray studies and earlier forms of computed tomography, or CT, scan.

It was in 2016 that the mummy was moved from the museum to the well-equipped CT scan department of the Leeds General Infirmary. CT scan produces a series of x-ray images of slices of the tissue being examined, and with the help of a computer, the images can be combined to create a three-dimensional representation. There are then computer-controlled methods of building a physical object, to create a model, in this case of the larynx of the 3,000-year-old, brittle, fragile mummy. The soft tissue of the vocal tract of the Nesyamun mummy is essentially intact, the paper says, and could be modelled exactly, and the shape of the tongue and soft palate was estimated.

The result is a model of the ancient larynx, and the team was able to synthesise how one syllable spoken by the owner would have sounded. As the shape of the voice box is fixed, there is no way running speech can be synthesised, and it is just one syllable, a single sound. But it is a sound that was heard when Nesyamun, a person of importance in the politically volatile reign of pharaoh Ramses XI (circa 1099-1069 BCE), lived and spoke at the temple in Thebes, some 50 km from modern Athens. Playing back this single syllable when visitors view the remains in the museum, or visit the ruins at Thebes, is sure to enrich the experience.

Another instance of reproduction of voices from the distant past was reported over 20 years ago. This was when Landry and M'batu, scientist-archaeologists, reverse-engineered ancient Cretan pottery to recover samples of speech of the prehistoric potters.

Cretan pots, dated about 3,800 years ago, are decorated with a spiral groove that goes many times around, as if made by spinning the pots when still soft, with a metal stylus sliding down the side. Landry and M'batu said that if the Cretan potters were speaking while they did their work, the stylus would have vibrated with the speech, and would have recorded the sounds in the patterns on the pottery. It would be like how phonograph records are made.

As the Cretan pots were glazed, any such traces would be perfectly preserved. Micro-analysis of the grooves with "molecular mapping" has now shown that there were indeed some regular patterns in those grooves. And with a consistent pattern discovered in several pots, it appears that the Cretan potters chanted a standard drone, perhaps a prayer, when the pots were being decorated.

Given a pattern in the engravings, researchers were able to make provision for variations in the speed of rotation of the pots and decode some of the sounds. This was a reconstruction of Cretan speech, and comparison with information about Sino-Tibetan and other origins of language is said to have shown similarities. Although this assertion is controversial, the discovery was an exciting first instance of recovery of sounds from antiquity.

Crete is an island just south of Greece and less than 500 km from Thebes. The work on the mummy from Thebes is thus the second instance where we hear a sound that has its origin more than 3,000 years ago.

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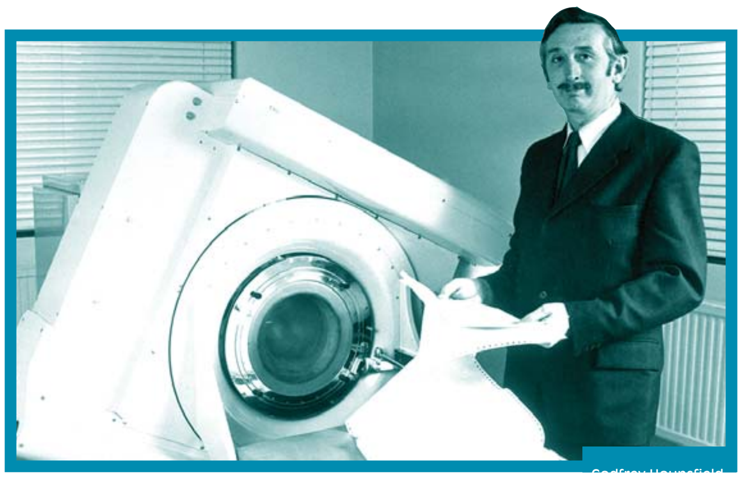
WITHOUT OPENING THE LID

Fifty years ago, the first computed tomography scan let doctors see inside a living skull — thanks to an eccentric engineer at the Beatles' record company



The possibility of precious objects hidden in secret chambers can really ignite the imagination. In the mid-1960s, British engineer Godfrey Hounsfield pondered whether one could detect hidden areas in Egyptian pyramids by capturing cosmic rays that passed through unseen voids.

Hounsfield held onto this idea over the years, which can be paraphrased as "looking inside a box without opening it." Ultimately, he figured out how to use high-energy rays to reveal what's invisible to the naked eye. He invented a way to see inside the hard skull and get a picture of the soft brain inside.

The first computed tomography image — a CT scan — of the human brain was made 50 years ago, in October 1971. Hounsfield never made it to Egypt, but his invention did take him to Stockholm and Buckingham Palace.

An engineer's innovation

Hounsfield's early life did not suggest that he would accomplish much at all. He was not a particularly good student. As a young boy his teachers described him as "thick."

He joined the British Royal Air Force at the start of World War II, but he wasn't much of a soldier. He was, however, a wizard with electrical machinery — especially the newly invented radar that he would jury-rig to help pilots better find their way home on dark, cloudy nights.

After the war, Hounsfield followed his commander's advice and got a degree in engineering. He practiced his trade at EMI — the company would become better known for selling Beatles albums, but started out as Electric and Music Industries, with a focus on electronics and electrical engineering.

Hounsfield's natural talents propelled him to lead the team building the most advanced mainframe computer available in Britain. But by the '60s, EMI wanted out of the competitive computer market and wasn't sure what to do with the brilliant, eccentric engineer.

While on a forced holiday to ponder his future and what he might do for the company, Hounsfield met a physician who complained about the poor quality of X-rays of the brain. Plain X-rays show marvellous details of bones, but the brain is an amorphous blob of tissue — on an X-ray it all looks like fog. This got Hounsfield thinking about his old idea of finding hidden structures without opening the box.

A new approach reveals the previously unseen

Hounsfield formulated a new way to approach the problem of imaging what's inside the skull.

First, he would conceptually divide the brain into consecutive slices — like a loaf of bread. Then he planned to beam a series of X-rays through each layer, repeating this for each degree of a half-circle. The strength of each beam would be captured on the opposite side of the brain — with stronger beams indicating they'd travelled through less dense material.

Finally, in possibly his most ingenious invention, Hounsfield created an algorithm to reconstruct an image of the brain based on all these layers. By working backward and using one of the era's fastest new computers, he could calculate the value for each little box of each brain layer. Eureka!

But there was a problem: EMI wasn't involved in the medical market and had no desire to jump in. The company allowed Hounsfield to work on his product, but with scant funding. He was forced to scrounge through the scrap bin of the research facilities and cobbled together a primitive scanning machine — small enough to rest atop a dining table.

Even with successful scans of inanimate objects and, later, kosher cow brains, the powers that be at EMI remained underwhelmed. Hounsfield needed to find outside funding if he wanted to proceed with a human scanner.

Hounsfield was a brilliant, intuitive inventor, but not an effective communicator. Luckily, he had a sympathetic boss, Bill Ingham, who saw the value in Hounsfield's proposal and struggled with EMI to keep the project afloat.

He knew there were no grants they could obtain quickly, but reasoned the United Kingdom Department of Health and Social Security could purchase equipment for hospitals. Miraculously, Ingham sold them four scanners before they were even built. So, Hounsfield organised a team, and they raced to build a safe and effective human scanner.

Meanwhile, Hounsfield needed patients to try out his machine on. He found a somewhat reluctant neurologist who agreed to help. The team installed a full-sized scanner at the Atkinson Morley Hospital in London, and on 1 October 1971, they scanned their first patient: a middle-aged woman who showed signs of a brain tumour.

It was not a fast process — 30 minutes for the scan, a drive across town with the magnetic tapes, 2.5 hours processing the data on an EMI mainframe computer and capturing the image with a Polaroid camera before racing back to the hospital.

And there it was — in her left frontal lobe — a cystic mass about the size of a plum. With that, every other method of imaging the brain was obsolete.

Millions of CT scans every year

EMI, with no experience in the medical market, suddenly held a monopoly for a machine in high demand. It jumped into production and was initially very successful at selling the scanners. But within five years, bigger, more experienced companies with more research capacity such as GE and Siemens were producing better scanners and gobbling up sales. EMI eventually exited the medical market — and became a case study in why it can be better to partner with one of the big guys instead of trying to go it alone.

Hounsfield's innovation transformed medicine. He shared the Nobel Prize for Physiology or Medicine in 1979 and was knighted by the Queen in 1981. He continued to putter around with inventions until his final days in 2004, when he died at 84.

In 1973, American Robert Ledley developed a whole-body scanner that could image other organs, blood vessels and, of course, bones. Modern scanners are faster, provide better resolution, and most important, do it with less radiation exposure. There are even mobile scanners.

By 2020, technicians were performing more than 80 million scans annually in the United States. Some physicians argue that number is excessive and maybe a third are unnecessary. While that may be true, the CT scan has benefitted the health of many patients around the world, helping identify tumours and determine if surgery is needed. They're particularly useful for a quick search for internal injuries, after accidents, in the emergency room.

And remember Hounsfield's idea about the pyramids? In 1970 scientists placed cosmic ray detectors in the lowest chamber in the Pyramid of Khafre. They concluded that no hidden chamber was present within the pyramid. In 2017, another team placed cosmic ray detectors in the Great Pyramid of Giza and found a hidden, but inaccessible, chamber. It's unlikely it will be explored anytime soon.

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PLUS POINTS

Our photosynthesis

A multi-institutional team from Indian Institute of Technology-Mandi, IIT-Delhi and Yogi Vemana University have replicated the structure of the leaf in a low-cost inorganic catalyst to enable light-induced production of green hydrogen and ammonia.

Results of their recent work, led by Venkata Krishnan, associate professor, School of Basic Sciences, IIT-Mandi, has been published as an article in the prestigious *Journal of Materials Chemistry A*. The article is co-authored by his research scholar, Ashish Kumar from IIT-Mandi. The other authors include his collaborators, Saswata Bhattacharya and Manish Kumar from IIT-Delhi, and Navakoteswara Rao, and M V Shankar from Yogi Vemana University, Andhra Pradesh. As early as 1912, a pioneering Armenian chemist, Giacomo Ciamician, in his paper titled "The Photochemistry of the Future" challenged scientists of his day to imagine using sunlight to produce chemicals much like plants do in photosynthesis. This challenge was met in the 1970s with researchers showing the possibility of harvesting the sun's light energy to produce chemicals using special light-activated materials called photocatalysts, thus heralding what is now known as the "photocatalysis era". Since then, many photocatalysts have been discovered to bring about light-enabled reactions for various purposes, and studies are ongoing in many areas of photochemical synthesis to discover new photocatalysts and improve existing ones for better performance.

The researchers have addressed the main bottlenecks of photocatalysis — poor light absorption, photogenerated charge recombination and the need for catalytically active sites to use sunlight to effectively drive chemical reactions. They have improved the properties of a low-cost photocatalyst, calcium titanate, through an approach called "defect engineering" and have shown its efficacy in producing green hydrogen and ammonia in two light-driven reactions. Specifically, the defect engineering was done by incorporation of oxygen vacancies in a controlled manner. These oxygen vacancies act as catalytically active sites to promote the surface reactions and thereby enhance the photocatalytic performance.

"We were inspired by the light harvesting mechanism of leaves and replicated the surface and internal three-dimensional microstructures of the leaf of the Peepal tree in the calcium titanate to enhance light harvesting properties," said lead researcher Krishnan. By this way, they improved the efficiency of light absorption. In addition, the introduction of defects in the form of oxygen vacancies helped to solve the problem of recombination of photogenerated charges.

Safe together

It is safe for people to receive a dose of the Covid and flu vaccine at the same time, new research shows, and nor is there any negative impact on the immune response as a result of co-administration.

Scientists behind the United Kingdom's "Combining Influenza and Covid-19 Vaccination" study said their findings support the government's plans to roll out Covid booster jabs alongside flu shots, where it is deemed practical.

A trial led by a team at the University of Bristol showed that the reported side effects of co-administration were mainly mild to moderate, concluding that "concomitant vaccination raises no safety concerns and preserves the immune response to both vaccines".

Rajeka Lazarus, a consultant in infectious diseases and microbiology, and chief investigator for the study, said the research demonstrated that "it is possible to protect people from both Covid-19 and flu at the same appointment". The results of the study, which has yet to be peer-reviewed, have already been shared with the Joint Committee on Vaccination and Immunisation and the UK's medicines regulator. The results are due to be published in *The Lancet*.

— The Independent