

# LOST IN THOUGHT

Though billions are now spent to study the brain, anatomists once thought it a useless cerebral slush

*Tell me where is fancie bred,  
Or in the heart, or in the head.*

For Portia, a character in Shakespeare's *The Merchant of Venice* (1596), the question was anything but symbolic. Some anatomists of Shakespeare's day held that the source of thought was the brain, others the heart. The debate, moreover, had been going on for 2,000 years.

To the ancient Hebrews, heart was the source of intellect and emotion. Mesopotamians, early Hindus, and ancient Chinese hailed the heart and ignored the brain. The ancient Egyptians, when embalming, left the heart and aorta in the body, while the brain was unceremoniously scooped from the skull like so much oatmeal. The Greeks were divided. Pythagoras, Plato and Galen chose the brain, while Democritus, Aristotle, the Stoics and the Epicureans favored the heart. Aristotle (384-322 B.C.), after dissecting 49 species of animal, from sea urchin to elephant, decided that the brain could not be the storehouse of sense, for upon touching it in a living animal, there was no sign of sensation.

Not so, said Galen (A.D. 129-199), a physician who worked in Alexandria, Egypt, approximately 500 years later. He pushed Aristotle's method a bit further. "If we press the brain a little too much," he wrote in his book *On the opinions of Hippocrates and Plato*, "the victim is rendered without sensation and without all voluntary movement." For Galen, that was proof of the brain's importance. The heart, however, was a different story. "I recall that once I permitted a certain person to grasp it with blacksmith's tongs since otherwise, when it moved, beating very strongly, it slipped from the hands. But not even thus was the animal injured in its sensation or voluntary movement, only it cried out greatly, breathed incessantly, and all its limbs shook violently. However, if you compress the brain in the same way you will see everything to happen quite contrarily." With a bit more skill, Galen also delved into the subtleties of brain anatomy, and gave rapt descriptions of the brain's ventricles.

Down through the ages, it was either heart, head, or sometimes both. In *The Arabian Nights*, when the caliph asks where the seat of understanding is located, the slave girl Tawaddud echoes bits of both Galen and Aristotle: "Allah casteth it in the heart whence its illustrious beams ascend to the brain and there become

BY WILLIAM J. BROAD



*The three cells as seen by Albertus Magnus (1206-1280) in his Philosophia.*

fixed." And Aristotle's ideas were venerated even after the advent of modern anatomy. In 1588 Andrea Cesalpino, an anatomist at the University of Padua in Italy, wrote that "the heart is not only the origin of all the veins but also of the nerves."

The brain, or part of it anyway, did have some early backers other than Galen. St. Augustine (A.D. 354-430) and another bishop of the period, Nemesius of Emesa, took Galen's description of the brain's ventricles, added a few metaphysical twists, and put the seat of the soul in the spaces that we now know are filled with cerebrospinal fluid. The brain itself was mere padding. This odd combination of fact and fancy had considerable influence for more



*A 1627 woodcut depicts cerebral convolutions as coils of the small intestine.*

than 1,300 years. Our two lateral ventricles were considered one cavity, so instead of four ventricles, the good fathers counted three psychic "cells" in all. They believed the first cell, the *sensus communis*, received sensations. The resulting images were formed either in the rear part of the first cell or in the second, the *imaginativa*. The second was also the seat of reasoning and judgment. Memory and sometimes motion were concocted within the third cell, the *memorativa*. It sounds simplistic. Yet complex variations on this theme show up in hundreds of pictures from the 12th through the 17th centuries. In 1490 Leonardo da Vinci drew a sagittal section of the brain showing three ventricles, anatomically farfetched and labeled according to the three cell theory. One of the most popular portrayals of cell doctrine was done in 1503 by Gregor Reisch, a prior of Freiburg and confessor to Emperor Maximilian I. It shows lines from ear, nose, tongue and eye going to the front of the first cell. In 1619, Robert Fludd, a mystic and philosopher, elaborated the three cell doctrine into a personal cosmos complete with extracerebral constellations.

The rise of Renaissance learning, and an increasing number of human dissections, helped cut down the cell doctrine. In 1490, for example, Leonardo was content to depict the brain according to the cell tradition. Between 1504 and 1507 he injected wax into the brain ventricles of an ox and could not find the perfect circles the church fathers had described. His later drawings, however, though anatomically correct, were still labeled according to cell doctrine. Some 30 years later, Andreas Vesalius was the first modern anatomist to break completely with the mystery of psychic cells. As described in his epoch-making book *Fabrica* (published in 1543, the same year Copernicus put the sun at the center of the universe), the ventricles were anatomically perfect. But for function, Vesalius went back to an ancient idea that the ventricles were the reservoirs of animal spirits responsible for sensory and motor activity in the body. The brain itself was still considered an inconsequential lump of clay.

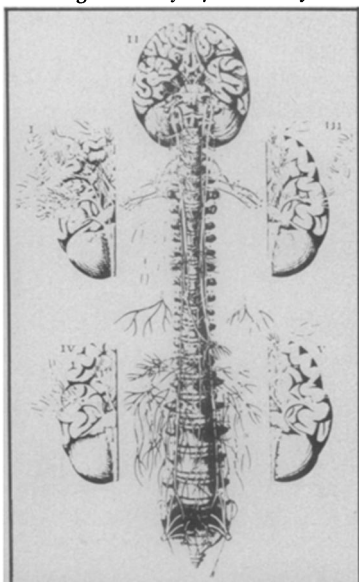
After Vesalius the pace of anatomical inquiry picked up. Graveyards were raided after midnight. Bodies of dead criminals would mysteriously disappear from the hangman's gallows. In back rooms and basements, brains were sliced, diced, squeezed, weighed, pulverized and powdered. The new microscopes were also

brought to focus on the cerebral cortex and, in the tradition of cerebral chaos, wildly divergent conclusions were reached. Marcello Malpighi thought the cortex was made up of "glands," Frederick Ruysch of "blood vessels," and Anton van Leeuwenhoek of "globules." And, though all were in error, their observations stimulated further research.

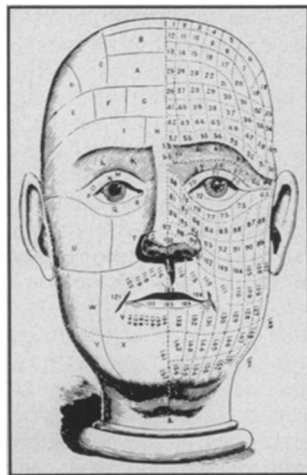
It took Thomas Willis, a professor of natural philosophy at Oxford, to suggest in his 1664 book *Cerebri anatome* that the functional center of the brain was in its substance, and not in the fluid-filled ventricles. The study of brain tissues led him to propose that the corpus striatum received all in-coming sensations, the corpus callosum housed the imagination, and the cerebral cortex was the seat of memory. The functions were, of course, the same as those of the cell doctrine. But now, at least, they were in the brain tissue itself. By the 18th century, descriptions and drawings of the brain's parts were becoming better, but understanding of function was still a farce.

Then, ironically, a theory that was totally wrong helped focus attention on the right questions. Some people called it phrenology. Its founder, Franz Joseph Gall (1758-1828), called it cranioscopy. By whatever name, a cult of the cranium surfaced at the start of the 19th century. It held that the brain had specific areas of function and that mental and moral attributes of a person could be determined by examination of the cranium. Gall named 27 mental faculties on areas of the skull, such as pride, love of offspring, sense of sound and friendship. As a boy, Gall had observed that individuals with a retentive memory had protruding eyes. Later on, he speculated that large frontal lobes, the site of memory in his system, pushed the eyes outward. "Persons who have eyes like this," Gall wrote in his 1819 *Anatomie et physiologie*, "compile dictionaries, write history; they are very suitable for the functions of librarian or conservator; they gather the scattered riches of all centuries; they compile learned volumes; they scrutinize antiquities and, no matter how

*Advances in accuracy are shown by this 1714 drawing of the sympathetic system.*



little they may have of the other faculties, they are the admiration of all the world on account of their vast erudition." Gall, it is said, had such eyes. In New York, city of extremes, the phrenological system was elaborated by J. W. Redfield, M.D., to include 160 centers, including economy, submissiveness, faithful love, and republicanism. Phrenological busts became the rage. By 1916, L. N. Fowler advertised his newest model as having "upward of 100 divisions." The ad's blurb went on to tell how "newly discovered organs are added, and the old organs have been subdivided to indicate the various phases of action which many of them assume. It is a perfect model, beautiful as a work of art, and is undoubtedly the latest contribution to phrenological science, and the most complete bust ever published."



*The phrenological system of J. W. Redfield was the most elaborate ever concocted.*

The cult of cranial bumps, for all its sideshow atmosphere, still fueled important studies. Gall, its founder, went underneath the skull and labeled the cerebral convolutions according to his system. Though in error, the idea led other anatomists to pay closer attention to the cortical surface. The gyri were named, the frontal, temporal, parietal and occipital lobes of the brain were identified, and, by the 1860s, much gross brain anatomy had been pinned down.

And a new era opened up in 1870. Two young Germans, Eduard Hitzig and Gustav Theodor Fritsch, working in Hitzig's bedroom, gently pushed an electrode into a living dog's brain and applied a current. The results were revolutionary. A jerk of the dog's leg or a twitch of its tail allowed the two scientists to come up with a crude map of the motor cortex.

It didn't take long before the human cortex was explored with somewhat the same technique. An American physician, Roberts Bartholow, in 1874 came across a patient, Mary Rafferty, who had a large cranial defect that exposed the rear part of each cerebral hemisphere. "I passed an insulated needle into the left posterior lobe so that the noninsulated portion



*In 1619 mystic Robert Fludd depicted the three cell doctrine as a holy cosmos.*

rested entirely in the substance of the brain," Bartholow wrote. "When the circuit was closed, muscular contraction of the right upper and lower extremities ensued. Mary complained of a very strong and unpleasant feeling of tingling in both right extremities, especially in the right arm, which she seized with the opposite hand and rubbed vigorously. Notwithstanding the very evident pain from which she suffered, she smiled as if much amused." Mary later died of meningitis.

The advent of anesthesia and neurosurgery paved the way for further research. Between 1874 and 1914, there were at least 74 studies, using small jolts of electricity, on the human motor cortex alone. The rush of activity, however, resulted in many exaggerations and wild claims. In 1881, a diagram of mapped cortical areas showed at least 363 neurological sites that had supposedly been differentiated with an electric probe. It was a hoax, not unlike the wild exaggerations made by phrenologists at the time.

Since the turn of the century, progress has been steady. Out of the hundreds of studies, most notable are those of Wilder Penfield of Montreal who made great leaps in cerebral localization by working with fully conscious patients. The results are graphically shown in his sensory and motor homunculi, which illustrate the relative importance of areas around the cerebral hemispheres.

Explorations of the brain continue at an ever more furious pace, as evidenced in part by this double issue of SCIENCE NEWS. But in the midst of the march of progress, of course, there are always echoes of a different time. It was not long ago that C. G. Jung, when questioning a Pueblo chief, received this reply: "I know you white men think with the brain. That accounts for your shortcomings. We red men think with the heart." □