Fondazione Prada

IT BEGINS WITH AN IDEA

HUMAN BRAINS

Venezia

THE EXHIBITION

Fondazione Prada's initiative dedicated to neuroscience, "Human Brains," surveys different fields: from neurobiology to philosophy, from psychology to neurochemistry, from linguistics to artificial intelligence. Through a convergence of diverse scientific approaches, the human brain is examined in the plural—as expressed by the title—to underline its intrinsic complexity and the irreducible singularity of each individual.

The exhibition "It Begins with an Idea," curated by Udo Kittelmann in collaboration with Taryn Simon, is the latest manifestation of "Human Brains." This project is the result of an intensive investigative process, undertaken since 2018 by Fondazione Prada with the support of a scientific committee, in the field of neuroscientific studies. It serves as a multidisciplinary attempt to understand the human brain, its layered functions, and its centrality to human history.

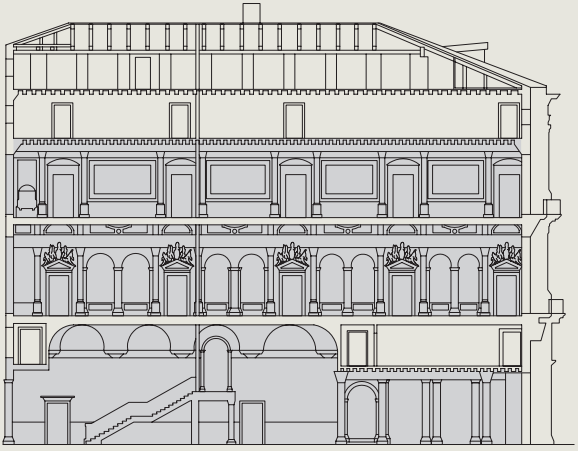
The brain generates our models of the world, coding our strategies of response, directing the stories we tell ourselves. The complexity of brain function takes over the three floors of Ca' Corner della Regina, through a global constellation of neuroscientists, philosophers, contemporary fiction writers, as well as surgery accounts, instruments of dissection, anatomical theaters, neural models, drawings, engravings, paintings, books, dream records, and memory amulets.

At the center of the ground floor, found footage of experiments, surgeries, and discoveries introduce the audience to a sampling of anatomies, mechanisms, and illustrations of the brain as we have come to know it. Stadium seatings, traditional in medical amphitheaters where live surgeries were given alongside lectures, invite the viewer into the position of an observing student or spectator, with the object of studying the history of neuroscience itself. Video lectures given by scientists in adjacent rooms focus on the human brain, movement, vision, and perception, language, memory, and emotion.

On the two upper floors, artifacts, documents, paintings, and other historical objects or their copies, encoding centuries of attempts to understand the human brain, are challenged by the words of fiction writers who call them forth, expanding the boundaries of our investigation scope, as well as revealing latent social, political, and personal histories. Together, objects and stories demonstrate and imitate the capacity of the brain to recollect and reprocess information, and to continually construct and assimilate its own order and disorder. While the exhibition's labyrinth of vitrines and monitors unfolds across two floors of Ca' Corner della Regina suggesting a potential single path, the invitation to hear a story-told reconfigures navigation at every turn. The rooms report an ongoing desire to understand the origin and location of thought and the mechanisms of movement and perception, but also the proliferation of brilliant theories, dark practices, and the application of theoretical models for the treatment of physical and mental illness.

At the center of the second floor, thirty-two screens broadcast neuroscientists and philosophers from five continents in conversation. The dialogue navigates a history of neuroscientific knowledge-making marked by rigor, breakthrough, and discovery—but also by error, transgression, and uncertainty. Its mechanical principles mimic those of the brain, morphing according to a logic of prediction and surprise. Like the brain, it is orchestrated as a self-organizing system that responds to itself.

Taken all together, the exhibition's focus is neuroscience: the polyphony, created by the collection of exhibited material and voices, traces the outlines of our bending selves, the gaps in our own knowledge, the path by which the history of neuroscience has been constructed, the seeds of future scientific inquiry, and the known and unknown of the human brain.



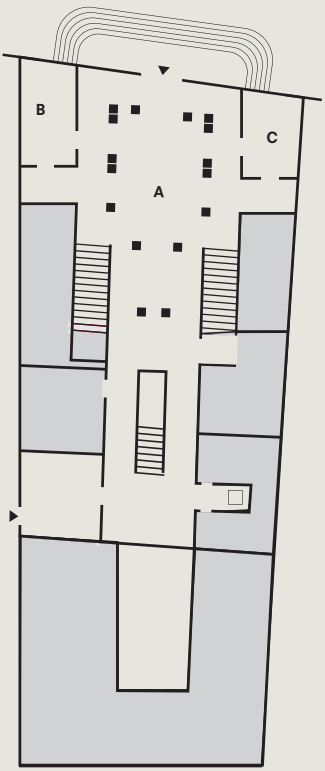
SPACES
GROUND FLOOR
FIRST AND SECOND NOBILE FLOORS
SECOND NOBILE FLOOR

GROUND FLOOR

At the center of the ground floor, stadium seating, traditional in medical amphitheaters where live surgeries were given alongside lectures, invites the viewer into the position of an observing student or spectator, with the object of studying the history of neuroscience itself.

Online found footage of experiments, surgeries, and discoveries introduce the audience to a sampling of anatomies, mechanisms, and illustrations of the brain as we have come to know it. These videos of neuroimaging, surgical operations and laboratory discoveries include a basement experiment uncovering how we process visual material, an operation seeking the pathways of memory, and an investigation into the neural tributaries of learning.

In the adjacent rooms lessons given by scientists and researchers Stefano Cappa, Guido Gainotti, Letizia Leocani, Andrea Moro, Maria Concetta Morrone, and Daniela Perani, focus on the human brain's ability to see, speak, move, remember, and feel emotions. Here syntax and neural components of language and consciousness stand alongside illusion of vision, sensory-motor performance and memory.



A
***Introduction to the Human Brain*, 2015**
Suzanne S. Stensaas, Department of Neurobiology and Anatomy and Spencer S. Eccles Health Sciences Library, University of Utah, Salt Lake City

David H. Hubel and Tornsten N. Wiesel's experiment on visual perception, Johns Hopkins University, Baltimore 1959

The neurophysiology of memory explained by Wilder Penfield, neurosurgeon of McGill University Montréal; footage from the film *Gateways to the Mind*, 1958
Produced by the Warner Brothers Pictures, released through the local offices of Bell Telephone System

***Modern MRI – Details & Diffusion*, 2017**
Video courtesy of the USC Mark and Mary Stevens Neuroimaging and Informatics Institute (www.ini.usc.edu)

***Neurons and synapses of the medial prefrontal cortex*, 2017**
Video courtesy of the USC Mark and Mary Stevens Neuroimaging and Informatics Institute (www.ini.usc.edu)

B
Letizia Leocani
***The Sensorimotor System*, 2022**

Maria Concetta Morrone
***Vision*, 2022**

Guido Gainotti
***Body and Mind in the Development of Emotions*, 2022**

C
Stefano F. Cappa
***We Are Memories*, 2022**

Andrea Moro
***Impossible Languages. A Journey to the Boundaries of Babel*, 2022**

Daniela Perani
***Neuroimaging for the Exploration of the Language System*, 2022**

FIRST AND SECOND NOBILE FLOORS

A labyrinth of vitrines and monitors unfolds across the two floors of Ca' Corner della Regina. Artifacts, documents, paintings, and other historical objects or their copies and facsimiles, encode centuries of attempts to understand the human brain. These are challenged by the words of fiction writers who call them forth, expanding the boundaries of our investigation scope, as well as revealing latent social, political, and personal histories.

The vitrines' objects and extended captions report an ongoing desire to understand the origin and location of thought and the mechanisms of movement and perception, but also the proliferation of brilliant theories, dark practices, and the application of theoretical models for the treatment of physical and mental illness. These artifacts and collected data form an imaginative contract with their assigned writer: a temporary moment of coherence before fictional reinvention.

Evolution has embedded in the brain a surprising ability to produce and absorb inaccurate memories. This counterintuitive brain function is an adaptive one that asserts the primacy of the present moment to meaning-making.

A 3D copy of two Sumerian cylinders with cuneiform texts reporting the earliest record of a dream (Iraq, 2120–2110 BCE); a papyrus facsimile listing forty-eight medical case histories, named for the American Egyptologist and antiquities dealer Edwin Smith who purchased it in Luxor (17th century BCE); Greek, Latin, Byzantine, Islamic, and Renaissance manuscripts and books—sometimes copies of the original—that have survived and proliferated through their adaptation and replication over time; a semi-circular Andean ceremonial knife used for medical operations and ritual sacrifices (Northern Peru, 13th-15th century); a scale model made by the CNR Laboratories of the anatomical theater at the University of Padua (1595, model 1933); *Cerebri Anatome* a book on brain anatomy by Thomas Willis, illustrated by architect Christopher Wren (1664); an 19th-century reprint of the *Kaishihen*, the first recorded dissection of a brain in Japan by physician and surgeon Shinnin Kawaguchi, illustrated by painter and draughtsman Shunmei Aoki (1772); two bronze carvings of the Shiva Nataraja dancing on Apasmara, the demon of ignorance (India, 18th-19th century); Francesco Calenzuoli's open head wax anatomical model (19th century); original drawings of neurons by Nobel prize winners Camillo Golgi and Santiago Ramón y Cajal (1883–1921); the work of Rita Levi-Montalcini which resulted in the discovery of the Nerve Growth Factor (1951 and 1964); an article published in *New Scientist*, documenting the first MRI of a human brain (1978); and more are called forth by the writers in the self-same way memories are retrieved, winnowed, and remodeled within the speculative process evolution dictates and fiction recreates.

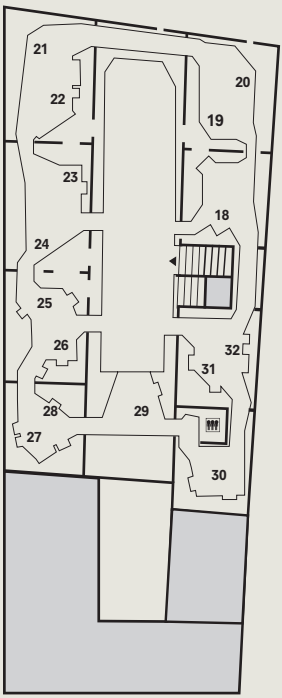
The artifact's stories in "It Begins with an Idea" were written by international writers to be performed in thirty-two short videos, directed by Taryn Simon and produced by

Fondazione Prada for the exhibition, in which renowned audiobook narrator George Guidall reads aloud all the newly commissioned literary texts. One voice is projected into multiple stories, languages, geographies, bodies, and realities: an intractable framework problem foundational both to how the brain works and to how the history of neuroscience has been constructed.

While the exhibition's labyrinth suggests a potential single path, the invitation to hear a story-told reconfigures the visitor's navigation at every turn. The human brain's tendency to project itself onto its environment is equaled by its necessity to absorb grounding beliefs and ideas. Brought together here, fiction and history tip each other back and forth in a vital play of certainty and interpretation regarding how stories, and histories, are told and by whom.

FIRST NOBILE FLOOR

SECOND NOBILE FLOOR



STORIES BY Salman Rushdie, Tilsa Otta, Ekaterina Sedia, Charu Nivedita, Ahdaf Soueif, Leanne Shapton, Daniel Galera, Cord Riechelmann, Sheng Keyi, Uzodinma Iweala, Hanan al-Shaykh, Katie Kitamura, Hervé Le Tellier, Sidarta Ribeiro, Tash Aw, Maria Stepanova, Ch'aska Anka Ninawaman, Chloe Aridjis, John Keene, Hari Kunzru, Rivka Galchen, Mieko Kawakami, Javier Cárdenas, Michele Mari, Paolo Giordano, Akwaeke Emezi, Helen Oyeyemi, McKenzie Wark, Daniel Kehlmann, Esther Freud, Ayọ̀bámi Adébáyọ̀, Alexander Kluge

NARRATED BY George Guidall
VIDEO DIRECTED BY Taryn Simon
PRODUCED BY Fondazione Prada for the project "Human Brains. It Begins with an Idea"

FIRST NOBILE FLOOR

1
Ù OR, THE INTERPRETATION OF DREAMS
Salman Rushdie (b. 1947, India)

In those early days of the world we didn't have words for many things we didn't understand. For example, we didn't have a word for the thing that happened in our heads during the nightly unconsciousness. In fact, the very idea of the nightly unconsciousness was frightening, and we had only recently invented a word for it that wasn't frightening. Before that we called it the nightly death and thought the gods inflicted it on us to remind us regularly of our puny mortality. Then they allowed us to be reborn in the morning and we were expected to be grateful.

CYLINDERS OF GUDEA
Iraq, *c.* 2120–2110 BCE, terracotta
Paris, Musée du Louvre, Département des Antiquités Orientales
Exhibition copy

Inscribed with *The Building of Ningîrsu's Temple*, the longest known text written in the Sumerian language, the Gudea cylinders record a dream of Gudea, who ruled the southern Mesopotamian city-state of Lagash from approximately 2150 to 2125 BCE.
Unearthed in 1877 during excavations at Telloh, Iraq, the cylinders are among the oldest surviving records of a dream. "Profound things came suddenly to me, but the meaning of what the nocturnal vision brought to me I do not understand … I have to tell her about this!" With these words, Gudea resolves to consult the goddess Nanshe, who explains that the dream contains the god Ningîrsu's directives concerning the construction of a new temple.

2
THE CIRCULAR ILLUMINATIONS
Tilsa Otta (b. 1982, Peru)

The brain remained exposed for approximately six minutes. The emperor enjoyed attending this part, while the god Ti's rays flowed like a brilliant breeze into His vassal. To be fair, everyone loved that moment: How not to adore that instant in which the soul found illumination through the profanation of the body?

SKULL OF AN ADULT INCA MALE WITH FIVE HEALED TREPANATIONS
Patallacta, Cuzco, Peru, *c.* 1476–1532 (Late Horizon)
Lima, Ministerio de Cultura – Museo Nacional de Arqueología, Antropología e Historia del Perú
Exhibition copy

In trepanation, a hole is cut, scraped, or drilled into the cranium. Found throughout the world at sites dating from the late Paleolithic through the present, trepanned skulls frequently bear evidence of prior trauma, testifying to trepanation's use as an early therapeutic measure.
This skull of an adult male was discovered in a burial cave in Patallacta, an archaeological site near the Inca capital of Cuzco, Peru. Consistent in size and shape, the five healed openings are notable for the smooth, inwardly beveled edges that indicate bone regrowth and the prolonged postoperative survival of the patient.

INCAN CEREMONIAL KNIFE (*TUMI*)
13th–15th century, bronze casting
Hamburg, MARKK – Museum am Rothenbaum

Characterized by a semicircular blade and typically made of copper, bronze, silver, or gold, a *tumi* is an Andean ceremonial knife that was used for medical operations and ritual sacrifices. This *tumi* was made by metalworkers of the Chimú civilization in northern Peru (1000–1470).
The figure on the right presses a *tumi* to the head of the central figure, who holds onto the figures on either side of him. The scene may depict a trepanation, a procedure practiced in the Andes, Europe, Africa, the Near East, and the Melanesian islands as early as the Neolithic period.

3
BUTTER
Ekaterina Sedia (b. 1970, Russia)

He goes silent. I imagine him sulking, pacing, slithering through the nasal cavities, spitefully kicking olfactory bulbs, until finally quieting down, hungry and drowsy, behind my eyeballs.

SINGLE-COLUMN CUNEIFORM TABLET
with a drawing of the demonic creature (*bennu*)
Assur (Qal'at Sherqat), Iraq, 8th century BCE, find division 14, 1914, clay
Berlin, Vorderasiatisches Museum, Staatliche Museen zu Berlin – Preußischer Kulturbesitz

Symptom descriptions, rituals, and prescriptions recorded on Mesopotamian magico-medical tablets testify to the attribution of involuntary movements and atypical behaviors to supernatural entities. Excavated from the Haus des Beschwörungspriesters (House of the incantation priest) in ancient Assur, one side of this tablet is inscribed with a small anthropomorphic figure possessing pointy ears, wavy horns, and a forked tongue. The other side is inscribed with prescriptions for treating several neurological and psychological pathologies, including *bennu*, a term used in Mesopotamian texts to refer both to demonic influence and to conditions such as epilepsy that cause convulsions or seizures.

4
TANDAV AT TADAKA
Charu Nivedita (b. 1953, India)

In the mythology surrounding Shiva, Apasmara is a dwarf. What had been an artistic inspiration in Nut's* prajnya*—consciousness on a transcendental plane—manifested itself to the psychiatrists as evidence of mental aberration, an incident of acute psychosis.

SHIVA NATARAJA
India, XVIII 18th century, bronze
Stuttgart, Linden-Museum Stuttgart

SHIVA NATARAJA
India, XIX 19th century, brass casting
Stuttgart, Linden-Museum Stuttgart

Originating in the 9th and 10th centuries in the Tamil region of southeastern India, the sculptural typology of Shiva Nataraja represents the continuous cycle of creation and destruction.
While performing his cosmic dance, Shiva tramples the demon of ignorance, Apasmara, who is typically depicted with physical features characteristic of dwarfism. In Sanskrit, the word *apasmara* refers to the negation or loss of consciousness; in Ayurveda, it refers to epilepsy. An alternate name for the figure trampled by Shiva, Muyalagan, likewise resembles the Tamil word *muyal vali* (epilepsy), so named because the rapid breathing that may follow an epileptic seizure is thought to resemble that of a *muyal* (hare) that has caught the scent of a predator.

5
VERSO
Ahdaf Soueif (b. 1950, Egypt)

He lists treatments for everything—except for our head. If your skull is broken they don't do anything except wait for you to 'arrive at the turning point.' That's what they call it. But he says that what's inside the skull is rippled 'like molten copper' and that it 'throbs and flutters.' And that the wound there will—basically—kill the person.

EDWIN SMITH PAPYRUS
plates II, III, IV, V, Thebes, Egypt, 16th–17th Dynasty, *c.* 1600 BCE, papyrus and ink
New York, Courtesy of the New York Academy of Medicine Library
Exhibition copy

The Edwin Smith Papyrus is one of the oldest surviving surgical texts. Its forty-eight case histories record physical examinations of patients, detailed anatomical observations, and the diagnoses, treatments, and prognoses of injuries. Cases one through nine contain the earliest known descriptions of

several types of brain injuries, and cases six and seven contain the earliest known references to the brain, the meninges, and cerebrospinal fluid. Written in Egyptian hieratic script around the 17th century BCE (and likely based on material from a thousand years earlier), the papyrus is named after an American Egyptologist and antiquities dealer who purchased it in Luxor in 1862. Originally a continuous roll, the papyrus was cut into separate sheets in the 20th century for the sake of convenience.

PAPYRUS EBERS
Egypt, *c.* 1500 BCE, scroll, papyrus and ink
Leipzig, Papyrus-und Ostrakasammlung der Universitätsbibliothek Leipzig
Exhibition copy

Named for Georg Ebers, the German Egyptologist and novelist who acquired it in 1873, the Papyrus Ebers is a compilation of medical texts comprising seven hundred natural and supernatural remedies for afflictions ranging from crocodile bites to household pests.
Dating from the first half of the 16th century BCE, the papyrus includes an account of a migraine and a description of the circulatory system that notes the function of the heart and the existence of blood vessels throughout the body.

HEART-SHAPED AMULET
engraved with chapter 30 of the *Book of the Dead*, Egypt, 25th–31st Dynasty, *c.* 712–332 BCE, green faïence
Turin, Museo Egizio

Heart amulets were placed on the chests of mummies to protect the bodies of the deceased and to facilitate passage to the afterlife.
In Egyptian culture of the Late Period, the heart was believed to be the seat of an individual's feelings, consciousness, rational soul, and memories of past deeds, and the word *ib* (heart) was used to indicate the mind. The heart was accordingly retained during mummification (unlike the brain, which was usually removed from the body and discarded).
This heart-shaped amulet featuring a human head physically associates the heart and the mind. The amulet's surface is inscribed with chapter 30 of the *Book of the Dead*, in which the heart of the deceased is implored not to speak against itself during the judgment ceremony in the afterlife.

6
OATH
Leanne Shapton (b. 1973, Canada)

I fainted, just once. Feeling dizzy in a Toronto bar, I pushed outside for some air, took a few steps. I was wearing a pink silk velvet dress, sleeveless, mini, and then knew I was falling, knew the dress was short, knew how hard my head would hit the pavement, and knew, in a blissful, euphoric surrender, that none of it could be helped. I knew, in those five-tenths of a second, complete happiness.

BYZANTINE CODEX REPORTING THE TEXT OF THE HIPPOCRATIC OATH
1100–1199, Urbinate Greco 64, sheets IIv–1r, 115v–116r, papyrus manuscript
Vatican City, Biblioteca Apostolica Vaticana
Exhibition copy

Attributed to Hippocrates of Cos (*c.* 460–370 BCE), the Hippocratic oath delineates the obligations of a physician to patients, medical students, and the physician's own medical teachers. The pledging physician vows to prescribe only beneficial treatments, to refrain from doing anyone harm or injustice, and to respect patient privacy and confidentiality.
Adaptations of the oath, which reflect the sensibilities of other cultures and eras, guide standards of medical ethics to this day. In this Byzantine codex, the oath is written in the form of a cross, reflecting the text's adaptation and use by 12th-century Christian physicians..

HIPPOCRATES, *HIPPOCRATIS OPERA OMNIA*
[Hippocrates' complete works]
Danielem, Abrahamum & Adrianum à Gaasbeeck, Leiden, 1665 (original text *c.* 5th–4th century BCE), Greek and Latin edition, volumes I and II, printed book
Venice, Biblioteca Nazionale Marciana, 67D 144, 67D 145

In his treatise *De morbo sacro* (On the sacred disease), the Greek physician Hippocrates of Cos (*c.* 460–370 BCE) proposed that diseases were caused not by supernatural forces, as was then commonly supposed, but by natural ones subject to rational understanding.
Among the conditions whose divine etiologies Hippocrates rejected was epilepsy, known in Classical Greece as the "sacred illness." Hippocrates

instead attributed epilepsy to a disorder of phlegm, one of the four bodily humors central to his understanding of human health and emotions: "It is thus with regard to the disease called sacred: it appears to me to be in no way more divine nor more sacred than other diseases ... The brain is the cause of this affliction ... When the surplus phlegm from the brain runs down through the veins, the patient loses his speech and foams at the mouth, his hands are contracted, the eyes contorted, he becomes insensible, and in some cases the bowels are emptied."

7
GUIDE TO MANUFACTURING BODIES
Daniel Galera (b. 1979, Brazil)

The human mind requires a human body and perceives itself only through the relationship between its body and other bodies. Our company's advances in neuroscience and information technology have enabled us to scan, code, and store the sum total of data contained in an individual brain.

PLATO, *PLATONIS TIMAEUS A CHALCIDIO LATINO SERMONE TRANSLATUS*
[Plato's *Timaeus* translated into Latin by Calcidius]
Italy, 14th–15th century (original text 4th century BCE), Vaticano Latino 2063, illuminated manuscript on parchment
Vatican City, Biblioteca Apostolica Vaticana
[Exhibited from April to August]

PLATO, *TIMAEUS–INTERPRETATIO LATINA CHALCIDII*
[The *Timaeus* translated into Latin by Calcidius]
14th–17th century (original text 4th century BCE), Reginense Latino 1572, illuminated manuscript on parchment
Vatican City, Biblioteca Apostolica Vaticana
[Exhibited from August to November]

The dialogue *Timaeus*, written around 350 BCE, presents the most complete formulation of Plato's (*c.* 428–348 BCE) theory of the soul (*psyché*).
The *thymos*, or irascible soul, associated with emotion, is said to be located above the diaphragm in the upper torso, while the *epithymetikon*, or concupiscible soul, associated with desire for nourishment, is said to be located below the diaphragm in the lower torso. The logos, or rational soul, is the only part of the soul held to be "immortal" and "divine." It is said to be located in the head, which is described as "the most divine part, which dominates over the rest of the body in us and to which the gods gave the whole body as servant."

ARISTOTLE, *LIBER ARISTOTELIS DE HISTORIIS ANIMALIUM*
[Aristotle's *History of Animals*]
Italy, 13th century (original text 4th century BCE), Vaticano Latino 2095, Latin translation, illuminated manuscript on parchment
Vatican City, Biblioteca Apostolica Vaticana
[Exhibited from April to August]

ARISTOTELIS DE ANIMALIBUS LIBRI, THEODORO GAZA INTEPRETE
[Aristotle's *Book of Animals* translated by Theodorus Gaza]
Italy, 15th century (original text 4th century BCE), Vaticano Latino 2094, Latin translation, illuminated manuscript on parchment
Vatican City, Biblioteca Apostolica Vaticana
[Exhibited from August to November]

The Greek philosopher Aristotle (384–322 BCE) held that every living being is a composite of matter and form, with the soul being that which gives form to a natural, or "organic," body. The soul was the cause not only of life itself, but also of any powers of perception and thought that a particular living being might possess.
In *On the Soul* (*c.* 350 BCE), Aristotle proposed a hierarchy of souls in which the lowest position is occupied by the vegetative (or nutritive) soul, possessed by humans, animals, and plants; the middle position is occupied by the sensitive (or motor) soul, possessed only by humans and animals; and the highest position is occupied by the intellectual soul, possessed by humans alone.
Although he provided crucial contributions to the understanding of human brain anatomy, such as the identification of the meninges and the distinction between the cerebrum and the cerebellum, Aristotle disputed his predecessors' and contemporaries' claims that the brain controls sensation and movement.
Aristotle's cardiocentric model, which had antecedents in ancient Egypt and would later find favor throughout medieval Europe and the Middle East, instead attributed sensation and movement to the heart, which was considered the central organ of the body, the source of blood, blood vessels, and body heat, and the seat of the soul itself.

PLINY THE ELDER, *NATURALIS HISTORIA*
[Natural history]
Johannes de Spira, Venice, 1469 (original text *c.* 77–78)
Inc. V. 45, pen and ink illuminated incunabulum; Inc. V. 106, illuminated incunabulum with gold leaf
Venezia, Biblioteca Nazionale Marciana
[Inc. V. 106 exhibited from April to August, Inc. V. 45 exhibited from August to November]

The Roman author, naturalist, and military leader Pliny the Elder (23–79) defined the scope of his *Naturalis Historia* as "the natural world, or life." This thirty-seven-book magnum opus, which compiles more than two thousand observations from one hundred different authors, has informed not only modern biology and physiology, but also neuroscience, psychiatry, and neurology.
Opposing his cardiocentric contemporaries, Pliny asserted that consciousness resided in the head rather than the heart: "The brain is the most elevated of all the viscera, and the nearest to the roof of the head … The senses hold this organ as their citadel; it is in this that are centered all the veins which spring from the heart; it is here that they terminate; this is the very culminating point of all, the regulator of the understanding."

8
GALEN'S SOULS
Cord Riechelmann (b. 1960, Germany)

There is no longer any doubt that he identified the brain as the seat of that soul, the animal soul, the* spiritus animalis*, which makes movement possible and controls it in such a way as to allow behavior that is adaptive and suited to the environment.

GALEN, *PRIMA CLASSIS HUMANI CORPORIS ORIGINEM, FORMATIONEM, DISSECTIONEM, TEMPERATURAM, FACULTATES, FACULTATUMQUE CUM ACTIONES OMNES TUM INSTRUMENTA & LOCA SINGULA COMPLECTITUR …*
[Human body first class comprising origin, formation, dissection, temperament, capacities, and all activities as well as specific instruments and places …]
Venice, 1541–1542 (original text *c.* 1st–2nd century), printed book bound in hard parchment
Padua, Università degli Studi di Padova – Biblioteca medica centrale "Vincenzo Pinali" – Sezione antica

After completing twelve years of medical study, the physician-philosopher Galen (129–216) returned to his birthplace of Pergamon (in modern-day Turkey), where he served as surgeon to the city's gladiators, an experience that deepened his understanding of human anatomy and physiology. Repudiating the cardiocentric model championed by Stoic philosophers, Galen contended that thought, sensation, and movement were instead functions of the brain.
Upon moving to Rome, whose laws had long prohibited the dissection of human cadavers, Galen committed himself to the systematic dissection of animal subjects, favoring pigs and other species because they did not "differ greatly in their physical nature from man."

BUNDLE OF SURGICAL INSTRUMENTS
double-edged scalpel blades; scalpel with myrtle-leaf-shaped blade used for the opening of vertebral canal; bow-shaped surgical instrument used for cranial trepanation; lenticular chisel for cranial trepanation; possibly a scalpel and a pterygium knife; possibly two forceps with a portion belonging to a third instrument
Second half of 2nd century, bronze and iron
MIC – Soprintendenza ABAP di Ravenna, Forlì-Cesena e Rimini, Museo della Città "Luigi Tonini"

In 1989, the remains of a building complex constructed between the Roman Republic and the early Middle Ages were uncovered in Rimini, Italy. The complex contained the home of a famed 2nd-century military surgeon who, like his contemporary Galen, had received his medical training in Greece. Among the items found inside the building, known today as the Surgeon's Domus, were 150 surgical instruments, most of which had been bundled together by kind. The fusion of many of the bundled instruments in the heat of a fire preserved their original arrangements, demonstrating which ones had been stored together and thus providing clues as to their functions. Displayed here are several instruments, including bow drills, scalpels, and forceps, whose uses in the treatment of cranial fractures were described by Galen.

9
THE OLD APPRENTICE SCHOLAR
Sheng Keyi (b. 1973, China)

He began to recite the familiar words: "When someone's life begins, the essence is the first to form, and this gives rise to the brain matter, where the whole of human memory is located. The brain is the home of the* yuan shen*, the primordial spirit of life." The old apprentice scholar then talked about the relationship between the brain and consciousness, and the changes caused in the mind by this relationship.

HUANGDI NEIJING
[The Yellow Emperor's classic of internal medicine]
China, 19th century (original text *c.* 3rd century BCE–3rd century CE), printed book
Private collection

The *Huangdi Neijing* is the foundational text of traditional Chinese medicine. The work is composed of two texts, the *Suwen* (Basic questions) and the *Lingshu* (Numinous spindle). According to the *Huangdi Neijing*, the brain is the first organ formed and the seat of mental activities, visual and auditory processing, and some bodily movements. It is not, however, among the five *zang* organs or six *fu* organs that together regulate physiological functions. Further, psychological states are said to be controlled not by the brain, but rather by the *zang* organs, with happiness, anger, deep thought, melancholy, and fear housed in the heart, liver, spleen, lungs, and kidneys, respectively. Among the *zang-fu* organs, the heart is "the supreme monarch of all the organs" and thought to be the seat of the mind. The brain does nevertheless regulate the *zang-fu* organs, particularly in the event of their injury or long-term imbalance.

10
THE UNSEEN
Uzodinma Iweala (b. 1982, US)

That I could crack the skull of a man, I would show them all—trace for them these soft gyri that I have seen folded neatly into the heads of all beings. What viscous and silly notions lie tucked between. But then they would confirm me mad instead of merely thinking me so. Would they be so wrong?

ABŪ 'ALĪ AL-HASAN IBN AL-HASAN IBN AL-HAYTHAM, *KITĀB AL-MANAẒIR*
[Book of optics]
Cairo, *c.* 1083., Ms. Fatih 3212, manuscript
Istanbul, Republic of Turkey Ministry of Culture and Tourism – Presidency of Institution of Turkey – Süleymaniye Manuscript Library
Exhibition copy

In his *Kitāb al-Manaẓir*, Arab scholar Abū 'Alī al-Hasan ibn al-Haytham (965–1040), known in the West as Alhazen, contended that the eyes receive light reflected from objects, rather than emanating light themselves, as Ptolemy, Euclid, and ibn al-Haytham's contemporaries held. Considered the founder of modern optics, ibn al-Haytham proposed that impressions received by the retinas are then conveyed by the optic nerves to the brain, which he regarded as the true seat of all perception. With its systematically ordered experiments, detailed anatomical descriptions, and seminal research on the psychology of visual perception, ibn al-Haytham's seven-volume treatise simultaneously transformed the understanding of vision and light and laid the foundations for the modern scientific method, influencing scientists such as Roger Bacon and Johannes Kepler.

OPTICAE THESAURUS.
Alhazeni Arabis libri septem, nunc primùm editi. Eiusdem liber De crepusculis & nubium ascensionibus. Item Vitellonis Thuringolopoli libri 10
[Compilation of texts about optics, including the first edition of the seventh book and *De crepusculis & nubium ascensionibus* by Arab author Alhazen as well as the tenth book by Vitello Thuringopolonis]
Eusebius Episcopius & haeredes Nicolai Episcopii, Basel, 1572 original texts *c.* 10th–13th century), printed book
Cremona, Biblioteca Statale di Cremona
2 copies

11
THE THIRSTY FISH
Hanan al-Shaykh (b. 1945, Lebanon)

If the soul is ill, it will follow that the body will fall ill too. I was soon captivated by al-Balkhī's words, which whispered to me that there are people who suffer quietly and those who suffer and go mad, but that we are not created like that. When I read that he criticized doctors who focused on physical diseases and neglected mental disorders, I wanted him to examine me.

ABŪ ZAYD AḤMAD IBN SAHL AL-BALKHĪ, *MAṢĀLIH AL-ABDĀN WA AL-ANFUS*
[Sustenance for body and soul]
Baghdad, 1479 (original text *c.* 9th–10th century), Ms. Ayasofya 3741, manuscript
Istanbul, Republic of Turkey Ministry of Culture and Tourism – Presidency of Manuscript. Institution of Turkey – Süleymaniye Manuscript Library
Exhibition copy

In his treatise *Maṣālih al-Abdān wa al-Anfus*, Persian polymath Abū Zayd Aḥmad ibn Sahl al-Balkhī (850–934) details the somatic and psychological aspects of both physical and mental illnesses. Al-Balkhī argues that because "man's construction is from both his soul and his body … human existence cannot be healthy without the *ishtibak* (interweaving or entangling) of soul and body."
Citing the potential for sickness of the body to cause sickness of the psyche, and vice versa, he criticizes those physicians who focus on one category of illness without adequately addressing the other. After distinguishing between depressions with and without known causes, al-Balkhī accordingly urges physicians to treat the first type by advising patients of the physical hazards of their depressed psychological states, and to treat the second type through physical means such as purification of the blood.

ABŪ BAKR MUHAMMAD IBN ZAKARIYYĀʾ AL-RĀZĪ (RHAZES), *KITĀB AL-MANṢŪRĪ*
[al-Mansuri's book of medicine]
1183 (original text *c.* 9th–10th century), Ms. Or. 1512, manuscript on paper
Cambridge, The Syndics of Cambridge University Library

Convinced that mental disorders should be treated as medical conditions, physician, philosopher, and alchemist Abū Bakr Muhammad ibn Zakariyyāʾ al-Rāzī (Rhazes) (*c.* 854–925/935, al-Rayy, modern-day Iran) pioneered an early form of psychotherapy and introduced psychiatric wards to the hospital that he directed in Baghdad.
Al-Rāzī rejected mind-body dualism, attributing depression to disordered blood flow to the brain and incorporating diet, medication, and occupational therapy into the treatment of psychiatric conditions. His discharge plan, which stipulated that psychiatric ward patients should be given a sum of money to aid with reintegration into general society, is among the earliest recorded references to psychiatric aftercare.
Al-Rāzī's medical treatise *Kitāb al-Manṣūrī* comprises ten books, the first six of which address subjects that the author considered mainly theoretical in nature (diet, hygiene, anatomy, physiology, general pathology, and surgery), the last four of which address subjects considered more practical (diagnosis, therapy, special pathology, and practical surgery). The text was widely influential throughout the Islamic world, and a Latin translation by Gerard of Cremona became one of the most widely consulted medical manuals in medieval Europe.

ABŪ BAKR MUHAMMAD IBN ZAKARIYYĀʾ AL-RĀZĪ (RHAZES), *LIBER ALMANSORIS*
[Al-Mansuri's book]
14th century (original text *c.* 9th–10th century), Ms. Plut. 73.22, Latin translation, illuminated manuscript on parchment
Florence, Biblioteca Medicea Laurenziana
[Exhibition copy from June to November]

ABŪ BAKR MUHAMMAD IBN ZAKARIYYĀʾ AL-RĀZĪ (RHAZES), *CONTENTA IN HOC VOLUMINE. LIBER RASIS AD ALMANSOREM* …
[Compilation of medical texts]
Venice, 1497 (original text *c.* 9th–10th century), Latin translation, incunabulum
Fermo, Biblioteca Civica "Romolo Spezioli"

12
LIBER TROTULA
Katie Kitamura (b. 1979, US)

The womb being tied to the brain by way of the nerves, the man continued, and the humidity, presumably by way of these same nerves, working its way up to the brain out of the body in the form of the tears. A weeping brain, if you will.

LIBER TROTULA
[The book of Trotula]
15th century (original text *c.* 11th–12th century), Ms. 593, illuminated manuscript on paper
Bruges Public Library
[Exhibition copy during August]

TROCTA TROTULA, *DE PASSIONIBUS MULIERUM*
[On female diseases]
14th century (original text *c.* 11th–12th century), Vaticano Latino 4485, manuscript on parchment
Vatican City, Biblioteca Apostolica Vaticana
[Exhibited from August to November]

Consisting of three treatises that circulated first independently and then as a single compendium, the *Liber Trotula* is considered medieval Europe's most influential text on women's medicine. Its subjects include menstruation, childbirth, and women's physical constitution, with special attention paid to pathologies of the womb. Trota, who served a physician and professor at the medical school in Salerno, Italy, specialized in female reproductive health.
Rejecting her contemporaries' belief that women should endure maximal suffering in childbirth as punishment for Eve's sin, Trota championed the use of opiates during labor. Explicit references to the brain appear in paragraph 130 of the compendium, which circulated as part of the *Liber de sinthomatibus mulierum* (Book on women's diseases).

13
A CHANGE OF PERSPECTIVE
Hervé Le Tellier (b. 1957, France)

The charlatan duly does the honors and pretends to introduce the two water lilies—for which he paid a fortune in Rotterdam market—into Jan Van Der Meyde's head. The scalpel cut is excruciating for Jan, because it is accepted that suffering proves the efficacy of the cure. But he will come away unscathed and convinced that he is mad, just as he hoped.

HIERONYMUS BOSCH, *THE EXTRACTION OF THE STONE OF MADNESS*
***c.* 1501–1505, oil on oak panel**
Madrid, Museo Nacional del Prado
Exhibition copy

From the 15th century onwards, a popular tradition associated madness with a stone lodged in the brain. The metaphor was made literal in iconography in which an actual stone is removed from the skull via trepanation.
In *The Extraction of the Stone of Madness* by the Dutch artist Hieronymus Bosch, a white-haired man in peasant's clothing is trepanned by a surgeon whose upside-down funnel hat marks him as charlatan.
The image is inscribed with a reference to the folk belief that madness was caused by a stone lodged in the brain: *Meester snijt die key ras, Myne name is lubbert Das* (Master, rid me of this stone soon, My name is Lubbert Das). The object being extracted from the patient's brain is not, however, a stone, but rather a sprouted lily bulb.

PIETER JANSZ QUAST, *THE EXTRACTION OF THE STONE*
***c.* 1630, oil on copper**
St. Gallen, Kunstmuseum St. Gallen, gift of Annette Bühler 2005

Medieval European folkloric tradition attributed madness to a stone lodged in the brain. The attempt to remove this "stone of madness" through trepanation later became a popular motif in visual art, often serving as an allegory for dishonesty (represented by a quack doctor) preying upon stupidity (represented by a guileless patient).
***The Extraction of the Stone* is one of several such allegorical images produced by Pieter Quast (1606–1647), a Dutch artist known for his peasant interiors, comic theatrical scenes, and representations of the five senses.**

14
VENTRICLES, HEART, AND MINDS
Sidarta Ribeiro (b. 1971, Brazil)

"How is the head of man arranged? I declare that the surface of the brain is a map divided into fifty-two areas, just as the planet is divided into countries: one place for each thing, and everything in its place."

TRILINGUAL COMPENDIUM OF TEXTS INCLUDING A DIAGRAM OF THE BRAIN WITH FIVE CELLS OR "VENTRICULI"
England, first half of the 14th century, illuminated manuscript on parchment.
Ms. Gg.1.1
Cambridge, The Syndics of Cambridge University Library

Developed in the 4th and 5th centuries by the Early Church Fathers Nemesius (350–420) and Augustine (354–430), then reworked by Persian polymath Avicenna (980–1037), the ventricular doctrine proposed that the higher faculties of the soul reside in the ventricles, or zs1brain "cells," which were said to be spherical in shape as a result of the uniform pressure exerted on their walls by the "animal spirits."
Assembled in the early 14th century, this illuminated codex contains literary, historical, grammatical, scientific, astronomical, theological, pastoral, and devotional texts in Anglo-Norman, Middle English, and Latin.
The diagram of the human brain illustrates the five ventricles and their corresponding faculties of common sense, imagination, estimation, cogitation, and memory. It accompanies an anonymous treatise, *Qualiter caput hominis situatur* (How the human head is structured), which draws upon the works of Avicenna and the Italian philosopher Thomas Aquinas.

ALBERTI MAGNI PHILOSOPHIA NATURALIS
[Albertus Magnus's natural philosophy]
Michael Furter, Basel, 1506 (original text 13th century), printed book
Berlin, Staatliche Museen zu Berlin, Kupferstichkabinett, Graphische Gesellschaft zu Berlin

The most influential of the ventricular doctrines, which associated the mind's faculties with the ventricles of the brain, was developed by the German bishop and philosopher Albertus Magnus (1193–1280).
Albertus described a tripartite structure in which the first region was allocated to common sense and basic imagination, the second to creative imagination, fantasy, evaluation, and rational thought, and the third to memory and reminiscence.
Published as part of a sixteenth-century edition of Albertus's *Philosophia naturalis*, this woodcut illustration of the ventricles testifies to the enduring influence of his theory throughout the Middle Ages and into the Renaissance.

15
ON THE BRIDGE
Tash Aw (b. 1971, Taiwan)

As I continue my walk I am already dissecting my own brain, imagining filling it with hot wax as silken as the thoughts that are currently running through me, tracing the trajectory of these sensations from my eyes into my skull.

LEONARDO DA VINCI, ANATOMICAL DRAWINGS

Sheet of paper with drawings of the layers of the scalp and the cerebral ventricles, *c.*1490-92, red chalk, pen and ink
Windsor, Windsor Castle, Royal Collection Trust
Exhibition copy

Manuscript sheet with notes and brain drawings, 1506–1508, ink on paper
Weimar, Klassik Stiftung Weimar, Bestand Museen
Exhibition copy

Sheet of paper with drawing of the sectioned cranium, 1489, pen and ink
Windsor, Windsor Castle, Royal Collection Trust
Exhibition copy

This manuscript sheet presents Leonardo's exploded and section views of the human head, which show the facial nerves' direct connection to the brain through holes in the skull, as well as his notes concerning the *imprensiva*, a brain ventricle that he believed assembled raw sensory data before transmitting it to the *sensus communis* for processing. Questioning canonical medieval categories of brain anatomy, Leonardo instead sought to gain greater understanding of the brain through observation and dissection. By adapting a technique that he used to cast bronze sculptures, Leonardo also developed a method of obtaining wax casts of the brain ventricles.

16
THE INNER THEATER
Maria Stepanova (b. 1972, Russia)

For both Giordano Bruno and Giulio Camillo, the theater of memory is circular: circular, like the skull, in which the action takes place. This is true of any theater, though: the stage and the auditorium complement each other: we sit and watch, the actors do their work.

GIULIO CAMILLO, *L'IDEA DEL THEATRO*
[The idea of a theater]
Lorenzo Torrentino Impressor Ducale, Florence, 1550, printed book
Venice, Biblioteca Nazionale Marciana, Misc. 2087.1

Giulio Camillo (*c.* 1480–1544) dedicated the last years of his life to the design of his Theater of Memory, which he conceived as a room-size wooden construction in the style of the Vitruvian theater. Camillo's memory device was to contain "the Ideas of everything Celestial and Inferior," thus enabling its occupant to conceptualize and memorize the entire cosmos in symbolic form.
Standing on the stage gazing out at the audience, a visitor to Camillo's theater was to visualize seven tiers, each divided into seven sectors, creating a seven-by-seven matrix within which more than 200 images were distributed. The images in Camillo's theater were conceived as mobile, thus generating a vast range of significations through their continuous recombination.

GIORDANO BRUNO, *DE UMBRIS IDEARUM*
[The shadows of ideas]
Gilles Gourbin, Paris, 1582, printed books
Bologna, Alma Mater Studiorum – Università di Bologna, Biblioteca Universitaria di Bologna, A.V.Tav.I.F.I.414/1
Padua, Biblioteca Universitaria di Padova (MiC), B.16.b.60
Venice, Biblioteca Nazionale Marciana, 71 C 201.1
3 copies

***De umbris idearum* (1582) is the first major work on memory published by Italian philosopher Giordano Bruno (1548–1600). A treatise on the fundamental principles of Brunian mnemonics, its contents included three poems, a dialogue, and instructions on the use of an alphabet of images devised to express every word of common language.**
Unlike earlier mnemonics, which conceived of their constituent images as static, Bruno's mnemonic is predicated on his belief that the soul imparts life and movement to images, thereby animating them and rendering them active subjects in dynamic scenes.

17
THE KHIPU MASTER
Ch'aska Anka Ninawaman (b. 1972, Peru)

Our oldest sister would then stroke the slender cord that my parents handed to her, knot and imagination taking hold in her heart. Knot after knot, my turn would come. The breath of the slender cord seemed to recognize, to encircle me, accelerating the memories.

INCA KHIPU
Peru, 15th–16th century, cotton and wool, twisted and knotted
Milan, Museo delle Culture, Collezione Federico Balzarotti
[Exhibition copy from October to November]

The khipu is a system for recording information used by the Incas and other Andean peoples as early as 7th century, and widely employed from the establishment of the Kingdom of Cuzco (12th century) to the fall of the Inca Empire (1532).
Khipus consist of a main horizontal cord with a variable number of hanging cords. In addition to the type, number, and positions of knots, the material, length, end treatment, color, and spacing of each cord carry different meanings. Combinations of these could represent numbers, dates, and accounts as well as abstract concepts. Oral records of khipus were kept by experts called *khipu kamayuq* or *quipucamayos*, who passed oral knowledge of the khipu from one generation to the next.

SECOND NOBILE FLOOR

18
FOUR TOPOGRAPHIES
Chloe Aridjis (b. 1971, US)

As a blade slashes through nerve endings that once enabled all sorts of dialogue, he tunes out the professor's rhetoric and dwells instead on his own life paths, wondering how much separates him from the dead man below.

CNR LABORATORIES, MODEL IN TWO PARTS OF THE ANATOMICAL THEATER OF THE UNIVERSITY OF PADUA
1932–1933, polychrome wood
Milan, Museo Nazionale della Scienza e della Tecnologia Leonardo da Vinci

The anatomical theater of Padua, presented here in a scale model, was the first of its kind. It was built in 1594, from the design of anatomist Fabricius ab Aquapendente, as a wooden construction incorporated into Palazzo Bo, home to the University of Padua. Its most distinctive architectural feature is a funnel-shaped 12-meter-high auditorium of six concentric rows, with space for two hundred visitors to stand.
The dissection table lies in the center, over a trapdoor where the corpse could quickly be removed from view. The professor sat at the table, with assistants and students who held candles to provide enough illumination for the dissection. The front row was reserved for the dean of the school, professors, and nobles, while the second and third rows were reserved for students. The rest were open to the general public.

M. CAIMI, MODEL OF THE ANATOMICAL THEATER OF THE ARCHIGINNASIO
Bologna, 18th century, wood
Rome, Museo di Storia della Medicina, Dipartimento di Medicina molecolare, Sapienza Università di Roma

Around the 16th century, public dissections became popular in Bologna, especially during the carnival season. A permanent building for anatomical demonstrations was designed by Italian architect Antonio Paolucci in 1637. Its design, presented here in a scale model, is distinct from the practical-scientific Padua type, also popular at this time, which was funnel-shaped.
The Bologna type is characterized by a representative rectangular auditorium similar to a medieval meeting place and decorated with wood paneling, statues of twelve famous physicians and twenty famous anatomists of the Bologna studio, and two *spellati* ("without skin"), anatomical models displaying the muscles beneath the skin, sculpted in 1734 from a design by painter Ercole Lelli.

19
THE GREAT OPERATION
John Keene (b. 1965, US)

Dr. Bell is reviewing his surgical tools, freshly polished for this first task of the day, the knives and saws and drills glistening in the morning light spilling into the room, and observing the sketch artist, whose work he will refine for his lectures and, he intends, his anatomical guide.

CHARLES BELL, *ILLUSTRATIONS OF THE GREAT OPERATIONS OF SURGERY: TREPAN, HERNIA, AMPUTATION, ANEURISM AND LITHOTOMY*
Longman, London, 1821, printed book with color illustrations
Cambridge, The Syndics of Cambridge University Library, LA.9.4 e Path b.19
2 copies

Sir Charles Bell (1774–1842) was a Scottish surgeon and anatomist whose original observations were used to advance understandings of the nervous system, including the distinct functions of the motor and sensory nerves, seventh cranial nerve, and fifth cranial nerve. Bell also made illustrations of his patients undergoing surgeries.
***Illustrations of the Great Operations of Surgery* contains detailed anatomical drawings meant to assist surgeons in mastering their technique. Displayed here are a drawing of the consequences from the rupture of the dura mater by a tumor and an illustration of a trepanation performed on a depressed skull fracture, with the removed bone fragments carefully detailed in the lower left corner of the image. The book did not identify the patients.**

20
***CEREBRI ANATOME*, 1664**
Hari Kunzru (b. 1969, UK)

"The key to understanding the rational soul," says Professor Willis, "is anatomy. Almighty God has conceived his creation according to a plan. I look into nature as into a book. There, out of the recesses, by anatomy, is the truth brought forth from its den."

THOMAS WILLIS, *CEREBRI ANATOME: CUI ACCESSIT NERVORUM DESCRIPTIO ET USUS*
[Anatomy of the brain, including description and function of nerves], Jo. Martyn & Ja. Allestry, London, 1664, printed books with folding plates
Ministero della Cultura – Milan, Pinacoteca di Brera – Biblioteca Nazionale Braidense, BNB A.03.00433
Padua, Biblioteca Universitaria di Padova (MiC), A.93.a.85
Venice, Biblioteca Nazionale Marciana, 182D 165
3 copies

Thomas Willis (1621–1675) wrote *Cerebri Anatome* (1664) while a professor of natural history at Oxford. Willis believed that the rational soul, which separated humans from animals and connected them to God, could be understood through the study of anatomy. His method was devised in collaboration with physicians Richard Lower and Thomas Millington, as well as architect Christopher Wren, best known for St. Paul's Cathedral in London, who also provided the book's illustrations. The research carried out by Willis aimed to solve the "artifactual results" of the previous anatomists.
Willis, rejecting the belief at the time that mental functions resided in the cerebral ventricles, proposed the brain as the primary seat of the rational soul and the origin of movement, memory, thought, and appetite. His observations relied on experiments carried out on slices of brain extracted from the skull as opposed to traditional methods of in situ dissection. Willis focused on the arterial circle at the base of the brain, attempting to assign a function to the anatomy he described.
In 1774–1777, the area appeared in the *Bibliotheca anatomica* for the first time as the "circle of Willis."

21
MEMOIR OF CLEMENTE SUSINI, UPON THE HIRING OF A NEW ASSISTANT
Rivka Galchen (b. 1976, Canada)

It was only with the Frenchman's brain that my fantasy intruded. I had accepted its conventional convoluted cauliflower beauty. I obeyed my eyes and fingers in setting the tangle of its vasculature. But I added a tender lattice of lymphatics to the whole. I hadn't seen lymphatics. But I wished upon this gentle young man that he have a draining lace of lymphatics.

FRANCESCO CALENZUOLI, SECTION OF HEAD AND NECK WITH THE BRAIN EXPOSED
Copied from Meckel, Italy, 19th century, wax anatomical model, silk drape, wood, glass display case
Florence, Sistema Museale di Ateneo – Museo di Storia Naturale, Sede "La Specola"

Wax anatomical models were used in Italy starting in the late 17th century to exhibit the recent discoveries made in anatomy.
Inspired by the models he saw as a student in Bologna, the abbot Felice Fontana worked in Florence and Pisa to produce a large number of wax models to fill the need for instructing trainee surgeons in anatomy. While the Bolognese models usually contained pieces of the skeleton, the Florentine models were made entirely of wax. Plaster casts were made from dissected cadavers, which were refined by highly specialized modelers who added blood vessels and nerves.
Fontana died in 1805, but the Florentine workshop continued its activity under the direction of modeler Clemente Susini, and of other modelers after Susini's death, in 1814. Among them were Francesco and Carlo Calenzuoli and Luigi Calamai.

22
REMAINS
Mieko Kawakami (b. 1976, Japan)

It was believed that the soul could be found deep inside the brain, in the pineal body, an organ that measured no larger than a pea. The doctors

could not put into words the unfathomable mystery before them—what it meant for a soul, which ought to be invisible and untouchable, to be witnessed and documented by another. They instead perceived only a faint terror.

SHINNIN KAWAGUCHI, *KAISHIHEN*
[Notes on the dissection of a cadaver]
Japan, 1802, manuscript with illustrations by Shukuya Aoki
Princeton (NJ), East Asian Library and the Gest Collection, Princeton University Library

Influenced by Toyo Yamakawi's medical text *Zōshi* (1759), as well as by European anatomical texts that came to Japan mainly through trade with the Dutch, the Japanese physician and surgeon Shinnin Kawaguchi (1736–1811) performed the first recorded dissection of a brain in Japan. In 1770, he was given two executed cadavers and a head to dissect. Kawaguchi performed the operations himself, on the site of the execution of the bodies.
The *Kaishihen*, complete with a large number of illustrations by painter and draughtsman Shunmei Aoki (1737–1802), was published by Kawaguchi and his colleague Gengai Ogino (1737–1806) in 1772. Displayed here is a copy of the original work dated 1802.

SEII SUGAWARA, *FUJIN ZŌZU*
[Pictures of female internal organs]
Japan, 1774, scroll with Nihonga illustrations
Chiba, Library of Health Sciences (Inohana Library), Chiba University
Exhibition copy

Toyo Yamawaki (1705–1762) was among the first recorded physicians in Japan to perform and comment on the dissection of a human body. His dissection of an executed criminal and his observations of the body's internal anatomy, recorded in the text *Zōshi* (1759), led him to question traditional Chinese medicine's descriptions of the body's functions. The work was also influenced by the anatomical atlas *Syntagma Anatomicum* (1641) by the German anatomist and botanist Johann Vesling (1598–1649). In 1772, Yamawaki's son Tomon Yamawaki (1736–1782) performed a full dissection of a body, whose records were illustrated by Seii Sugawara and published in 1774.

KANZEN MIKUMO – GENSHUN KOISHI – RANSHŪ YOSHIMURA, *SEYAKUIN KAINANTAIZŌZU*
[Seyakuin's male anatomical chart]
Japan, 1798, manuscript with illustrations, ink and color on paper
Kyoto, Kyoto University, Main Library, RareBooks
Exhibition copy

Published in the form of a *kaiboemaki*, or scrolls of anatomical pictures, the *Seyakuin Kainantaizōzu* is the drawn report of an autopsy performed on a thirty-four-year-old male executed as a criminal in Japan in 1798. The dissection team included the physicians Kanzen Mikumo, Genshun Koishi, and Ranshu Yoshimura. The dissection by the physician Seyakuin is illustrated by the painter Ranshū Yoshimura (1739–1816) in thirty-six illustrated tables, with captions and explanations reporting and expanding on Dutch anatomical sources, which had come to Japan through commercial exchange.
In 1783, Yoshimura had produced illustrations for the *Heijiro Zozu*, which described an autopsy conducted by Nankei Tachibana. As a comparison of the Seyakuin with the *Heijiro Zozu* shows, the last ten years of the 18th century saw an increase in the precision of the technical, graphical, and medical aspects of anatomical practice.

23
LOUIS VICTOR (DOESN'T) SPEAK
Mauro Javier Cárdenas (b. Ecuador)

And so when I'm dead and at last Dr. Broca's allowed to dislodge my brain from my head—slippery, like a lizard—I know you know I know that that's all I am to you, doctor, a specimen to be plumbed for brain parts—he will discover clues to the electrifying evolution of my brain.

LOUIS VICTOR LEBORGNE'S BRAIN
black-and-white photographs
Paris, Bibliothèque de Sorbonne Université, Collections d'Anatomie Pathologique Dupuytren

In 1861 the French physician Paul Broca (1824–1880) cared for the patient Louis Victor Leborgne (1809–1861), who was suffering from aphasia, an

extreme difficulty in speaking. Analyzing Leborgne's brain after his death, Broca noted a lesion on the left frontal lobe of the brain that he interpreted as the main cause of the language deficit, a condition that became known as Broca aphasia.
After studying the brains of twenty-five additional patients with aphasia, Broca concluded that speech articulation was localized in the left frontal lobe. He also noted that most patients with aphasia recovered some of their abilities, suggesting that the right hemisphere was able to take over some of the functions of the left hemisphere.

24
PULCHRONEURONS
Michele Mari (b. 1955, Italy)

In those drawings the academicians saw how the brain was made; the birth of the impulse, the electric shiver, the cradle of the cogito was there, in those thin filaments, in those dots, little did it matter that between neurons there was continuity, as Golgi thought, or contiguity, as Ramón y Cajal argued, the synapses were guaranteed in any case, honor and merit to the synapses!

CAMILLO GOLGI
The spinal cord; The diffuse nerve network; Human cerebral cortex section, anterior central; Neuron; Neuron*;* Neuron; Neurons*;* Neurons of the hippocampus; Neuron; Neuron with C. Golgi's original signature; Neurons*;* Neurons*;* Neurons*;* Neuron*;* Purkinje neuron*;* The hippocampal; The hippocampal circumvolution; Vertical section fragment of a human cerebellar circumvolution; Vertical section of human cerebellar circumvolution
c. 1883–1884, drawings on paper
Pavia, Università di Pavia – Sistema Museale di Ateneo – Museo per la Storia dell'Università di Pavia

SANTIAGO RAMÓN Y CAJAL
Connections between Purkinje neurons of the cerebellum; Granular neurons of the olfactory bulb of a 20-days-old cat; Giant pyramidal cell of the human motor region (30-year-old male); Section of the olfactory bulb of a cat; Cross section of the superior sphenoid area of the rabbit; Frontal section of the brain; Front section of the mouse thalamus; Large neuron with short axon, from the cortical layer of medium pyramidal neurons; Axons of the Purkinje neurons of the cerebellum; Neurons from the superficial layers of the developing cerebral cortex; Front section of the inner ear (labyrinth) in a few-days-old bird; Vacuolated Purkinje neurons taken from the cerebellum of a 25-day-old cat; Degeneration of Purkinje neuron axons; Degeneration of cerebellar Purkinje neuron axons, found in a drowned man; Various neuronal types from layers 4, 5, and 6 of the cat's visual cortex
c. 1895–1921, drawings on paper
Madrid, Instituto Cajal (CSIC), Legado Cajal

In 1873, Italian histologist Camillo Golgi (1843–1926) developed the *reazione nera* or black reaction, a new method for using chemicals to stain nerve cells to make them visible in brain tissue under a microscope. With this procedure, axons (the parts of the neuron that transmit electrical pulses), dendrites (which receive communication from other cells) and glia (non-neuronal cells) turn black and show their shape.
Golgi observed a dense network of axons and dendrites connecting brain areas through the transmission of an electrical nervous impulse. Because his black reaction stained only 3 percent of neurons, Golgi's view was limited, and he supported the popular "reticular theory" that said neuronal processes physically fuse with each other.
Fourteen years after its discovery by Golgi, Santiago Ramón y Cajal (1852–1934) used a modified version of the black reaction to challenge Golgi's interpretation of the architecture of the neural system. Cajal inferred that axons and dendrites ended freely and supported the "neuron theory" that the nervous system is composed of a large number of independent cells. Both scientists published their findings accompanied by hand-drawn illustrations of cell structures. In 1906, they shared the Nobel Prize despite their opposing theories.

25
LIKE WATER OFF A DUCK'S BACK
Paolo Giordano (b. 1982, Italy)

Levi-Montalcini would draw the fibers in her notebooks: they seemed to radiate from the ganglia like hair.

RECTORAL DECREE SUSPENDING FROM SERVICE RITA LEVI-MONTALCINI signed by dean Azzo Azzi, volunteer assistant at the Clinic of nervous and

mental illnesses of the Turin University, October 18, 1938, typescript and signed document on institutional letterhead
Turin, Archivio Storico dell'Università di Torino

RITA LEVI-MONTALCINI – VIKTOR HAMBURGER, "SELECTIVE GROWTH STIMULATING EFFECTS OF MOUSE SARCOMA ON THE SENSORY AND SYMPATHETIC NERVOUS SYSTEM OF THE CHICK EMBRYOS"
***Journal of Experimental Zoology*, vol. 116, no. 2, The Wistar Institute of Anatomy and Biology, Philadelphia, 1951**
Milan, Biblioteca di Biologia, Informatica, Chimica e Fisica dell'Università degli Studi di Milano

RITA LEVI-MONTALCINI, "NERVE GROWTH FACTOR"
***Annals of the New York Academy of Sciences*, vol. 118, no. 3, New York Academy of Sciences, New York, 1964**
Private collection

In 1939, after the enactment of anti-Semitic racial laws, Rita Levi-Montalcini (1909–2012) left her position at the University of Turin. By 1940, she had set up a home laboratory where, inspired by findings of the embryologist Viktor Hamburger, she studied neurogenesis in the chick embryo. In 1947, Hamburger invited her to his laboratory at Washington University in St. Louis, where she stayed for thirty years.
Levi-Montalcini's development of an in-vitro culture technique that allowed neurons to be grown outside of an embryo led to her discovery of the nerve growth factor (NGF). This discovery was driven by Levi-Montalcini's 1952 visit to Hertha Meyer's laboratories in Rio, where she observed nerve cell growth in response to the proximity of cancerous cells. The discovery was also supported by biochemist Stanley Cohen.
NGF, the first neurotrophin, promotes the growth and survival of certain categories of neurons, as well as synaptic pruning to remove nerve cells with poor connectivity. NGF has been shown to play a role in learning and memory in the adult brain, and its biological functions are still being studied. In 1986, Levi-Montalcini and Cohen shared the Nobel Prize.

26
BERGER'S DOLL
Akwaeke Emezi (b. 1987, Nigeria)

Ilse knew that her skull was a cap over her brain, and that her head was made of caps. A cap of bone, a cap of white touching silver over the bone, a cap of skin, a cap of hair, and her father piercing through it all, looking for something everyone else called impossible.

HANS BERGER, "ÜBER DAS ELEKTRENKEPHALOGRAMM DES MENSCHEN"
***Archiv für Psychiatrie und Nervenkrankheiten*, vol. 87, no. 1, Springer Verlag, Vienna, 1929**
Pergine Valsugana (Trento), Azienda Provinciale per i Servizi Sanitari, Biblioteca dell'ex Ospedale psichiatrico

HANS BERGER, "ÜBER DIE ENTSTEHUNG DER ERSCHEINUNGEN DES GROSSEN EPILEPTISCHEN ANFALLS"
***Klinische Wochenschrift*, no. 14, Springer Verlag, Vienna, 1935**
Kork, Deutsches Epilepsiemuseum

HANS BERGER, "DAS ELEKTRENKEPHALOGRAMM DES MENSCHEN"
***Nova Acta Leopoldina*, series 6, n. 38, Leopoldina Nationale Akademie der Wisseschaften, Halle (Saale), 1938**
Kork, Deutsches Epilepsiemuseum

German psychiatrist Hans Berger (1873–1941) first measured electrical activity in the brain by injecting novocaine on the scalp and recording from an electrode placed in the periosteum and a galvanometer.
He recorded his first electroencephalogram, or EEG, on July 6, 1924, from a seventeen-year-old boy during a neurosurgery. Later, he was the first person to noninvasively record the electrical activity of the brain.
In 1929 he published the article *Über das Elektrenkephalogramm des Menschen* describing his findings, including the results of experiments performed on his son, Klaus, and his daughter, Ilse. In this paper, Berger demonstrated the appearance and disappearance of alpha and beta waves following an epileptic seizure.

MAX KOHL LOOP GALVANOMETER FOR MEASURING BRAIN WAVES
Germany, 20th century, metal
Jena, Friedrich-Schiller-Universität Jena, Collection of scientific and technical devices for physics

27
BIG DAY
Helen Oyeyemi (b. 1984, Nigeria)

The physician had grown slightly more abstracted in his nature in the months since he'd applied strong electric shocks to his own skull. The effects were still palpable. When the physician got headaches, they were extra special—it was if an outsized tongue covered his cranium with its clammy fur.

LUIGI GALVANI – GIOVANNI ALDINI, *DE VIRIBUS ELECTRICITATIS IN MOTU MUSCULARI COMMENTARIUS*
[Commentary on the effect of electricity on muscular motion]
Societas Typographica, Modena, 1792, printed book, etched plates
London, The Royal Society

During a course of experiments on the effect of atmospheric electricity on dissected frogs, Italian physician Luigi Galvani (1737–1798) observed muscle retraction in a frog leg that was attached to a metal mount and touched with a scalpel. From this reaction and further experimentation, Galvani theorized the existence of "animal electricity" flowing from the brain to the muscles.
In 1791, he published his findings in *De viribus electricitatis in motu musculari commentarius*. Galvani's results were contradicted by the Italian physicist Alessandro Volta, who did not believe in animal electricity and argued that the electrical charge was produced from the contact of the two metals conducted by a fluid. Giovanni Aldini, a nephew of and assistant to Galvani, used both theories in his work, which led to the development of various forms of electrotherapy and noninvasive brain stimulation.

GIOVANNI ALDINI, *DE ANIMALI ELECTRICITATE DISSERTATIONES DUAE*
[Two dissertations on animal electricity]
Typographia Instituti Scientiarum, Bologna, 1794, printed books, etched plates
Turin, Accademia delle Scienze di Torino
Padua, Università degli Studi di Padova, Biblioteca medica centrale "Vincenzo Pinali", Sezione antica
2 copies

GIOVANNI ALDINI, *ESSAI THÉORIQUE ET EXPÉRIMENTAL SUR LE GALVANISME*
[Theoretical and experimental essay on galvanism]
Fournier Fils, Paris, 1804, vol. 1 and 2, printed books, etched plates
Cremona, Biblioteca Statale di Cremona
Turin, Accademia delle Scienze di Torino
2 copies

Luigi Galvani's position in the dispute with Alessandro Volta on the precise nature of galvanism was defended by his nephew, Giovanni Aldini (1762–1834).
Aldini conducted public experiments in which he used voltaic piles to stimulate the corpses of animals and humans, in order to demonstrate the existence of animal electricity by making body muscles spasm and facial muscles contract.
In 1804, Aldini published the accounts of his experiments in a two-volume, 680-page-long treatise called *Essai théorique et expérimental sur le galvanisme*. It also contained the results of a series of studies on the use of galvanism to treat patients with mental conditions, with apparent success. This treatment can be considered an early form of electroconvulsive therapy (ECT).

28
IN NIGHTMARES BEGIN POSSIBILITIES
McKenzie Wark (b. 1961, Australia)

Gonna take this noise, this static, that the doc shoots through my brain like bad speed. Gonna amp it up, a feedback squall. Gonna be the switchboard.

LUCIO BINI – UGO CERLETTI, ELECTROCONVULSIVE THERAPY MACHINE
Italy, 1938–1940, metal
Reggio Emilia, Musei Civici di Reggio Emilia – Museo di Storia della Psichiatria

Italian neuropsychiatrists Ugo Cerletti (1877–1963) and Lucio Bini (1908–1964) were the first to use an electroshock machine on a human subject to induce seizures with electricity for therapeutic effect. The

use of electroshock would replace metrazol and insulin therapy and the chemical induction of seizures.
Cerletti and Bini first carried out their experiments on animals to demonstrate the harmlessness of electroconvulsive therapy (ECT). In 1938, they applied it for the first time on a patient with schizophrenia.
In the 1940s and 1950s, ECT was used widely in the treatment of drug-resistant depression as well as mania, catatonia, and schizophrenia.
The application of ECT can be controlled through electrode placement, length, and intensity of the stimulus. Currently, ECT is typically delivered to anesthetized patients under scrutinized conditions.

29
INSIDE THE HEAD OF BLACK JOHN
Daniel Kehlmann (b. 1975, Germany)

I imagine Dr. Deijman tightening his grip on the knife and making a cut. He knows that the soul cannot be seen, but he nonetheless expects to track it down by looking more closely than anyone before him.

RENÉ DESCARTES, *OPERA PHILOSOPHICA*
[Philosophical works]
Daniel Elzevir, Amsterdam, 1672, printed book
London, Wellcome Collection

RENÉ DESCARTES, *L'HOMME DE RENÉ DESCARTES ET UN TRAITÉ DE LA FORMATION DU FŒTUS*
[René Descartes's treatise on man and the formation of the fetus]
Daniel Elzevir, Amsterdam, 1677 (first edition 1664), printed book
London, Wellcome Collection

In the first half of the 17th century, French philosopher René Descartes (1596–1650) entered the centuries-old debate on the identification of the seat of thought. Considering the soul and the body to be ontologically separate but interacting entities, he sought to specify both their mode and site of interaction, identifying the latter with the pineal gland. As the only unpaired element of the brain, the pineal gland was held responsible for unifying perceptions received from the paired organs of sense.
In Descartes's writings, the "little gland H"—as he termed it—is usually illustrated as a pear-shaped body suspended in the middle of the ventricles, which he still believed to be inflated by "animal spirits" communicating the soul's spiritual autonomy to the mechanism of the body.

REMBRANDT VAN RIJN, *THE ANATOMY LESSON OF DR. JAN DEIJMAN* (fragment)
1656, oil on canvas
Amsterdam, Amsterdam Museum
Exhibition copy

The only surviving fragment of a much larger group portrait, which was severely damaged by a fire in 1723, Rembrandt's painting provides unique evidence of the dissection of a human brain in the context of public anatomical demonstrations in 17th century Flanders.
The scene refers to the actual lecture delivered by the *praelector* and *doctor medicinae* Jan Deijman, who performed his autopsy on the corpse of Joris "Black Jack" Fonteijn, a tailor executed for robbing a textile store and threatening those present with a knife.
Notably, Dr. Deijman is portrayed as he lifts the falx cerebri, showing the pineal gland. According to Descartes's authority, the latter was considered the seat of the soul, and therefore the event marked a crucial moment in the public spectacle of the dissection.

30
DURING THE CONTORTIONS
Esther Freud (b. 1963, UK)

I was hired as a servant, but my condition attracted the attention of the neurologist Charcot, who chose me for a demonstration of hysteria. Willing, I fell into a trance, danced, enacted scenes of an erotic nature, contorting my body, as I had been taught.

EUGÈNE PIRODON (AFTER ANDRÉ BROUILLET), *A CLINICAL LESSON AT THE SALPÊTRIÈRE*
1888, lithograph on paper
London, Freud Museum London

In 1885, the Austrian neurologist Sigmund Freud (1856–1939) went to Paris to study under the supervision of French neurologist Jean-Martin Charcot

at the Salpêtrière hospital. There, Freud took up his work on hysteria, from which his theories of psychoanalysis ultimately emerged.
The lithograph displayed here portrays Charcot as he delivers a clinical lecture on hypnosis involving a demonstration on his patient Marie "Blanche" Wittmann to a group of physicians.
In 1889, Freud returned from Paris with the print, which he hung over the couch in his consulting room, first in Vienna and then in England, where it is still preserved.

SIGMUND FREUD
***Die Traumdeutung*, Franz Deuticke, Leipzig – Vienna, 1900**
London, Freud Museum London

***La Interpretación de los Sueños*, Biblioteca Nueva, Madrid, 1931**
Private collection

***La interpretación de los sueños*, Editorial Ercilla, Santiago de Chile, 1936**
Private collection
***L'interpretazione dei sogni*, Astrolabio, Rome, 1952**
Private collection

***The Interpretation of Dreams*, G. Allen, London, 1913**
London, Freud Museum London

***Yume Handan*, Shunyodo, Tokyo, 1930–1933**
London, Freud Museum London
***Vyklad snu*, Julius Albert, Prague, 1937**
London, Freud Museum London

***Meng de jie xi*, Chih Wen Publishing Co., Taipei, 1972**
Taiwan, National Central Library

In 1900, Sigmund Freud published *The Interpretation of Dreams*. The book introduces the theory of the dynamic unconscious, here discussed in relation to dream interpretation. According to Freud, dreams could provide access to the unconscious processes and desires that affect a person's behavior without their conscious knowledge. These desires affect the psyche and cause neurotic symptoms with no underlying physical condition (hence the need for a means to access and interpret them).
The early editions of *The Interpretation of Dreams* from across the globe testify to the swift diffusion of Freudian theories, as well as to their variable reception in different cultural contexts.

31
ON THE HEAD OF AN IDIOT (NO. 8)
Ayọ̀bámi Adébáyọ̀ (b. 1988, Nigeria)

This phrenology came to them through his aunt, a governess in Vienna. She wrote his Ma to say this mapping of his head would help him understand his character and abilities. Why this is the case, he cannot tell. He does not think his scalp has more to say about him than his hands.

KORBINIAN BRODMANN, *VERGLEICHENDE DER GROSSHIRNRINDE: IN IHREN PRINZIPIEN DARGESTELLT AUF GRUND DES ZELLENBAUES*
[Comparative localization studies in the brain cortex: its fundamentals represented on the basis of its cellular architecture]
Johann Ambrosius Barth, Leipzig, 1909
Turin, Biblioteca Federata di Medicina "Ferdinando Rossi" – Università degli Studi di Torino
Reggio Emilia, Biblioteca scientifica Carlo Livi – AUSL di Reggio Emilia
2 copies

The relevance of the research carried out in early 1900 by physician Korbinian Brodmann (1868–1918) is demonstrated by the reliability of his maps of the brain, still studied today.
Brodmann's name is associated with his 1909 text, *Vergleichende Lokalisationslehre der Grosshirnrinde in ihren Prinzipien dargestellt auf Grund des Zellenbaues*, in which the German physician published his graphical organization of the human cortex. Brodmann created a system of cytoarchitectonics in which the cortex was subdivided into fifty-two areas, each signified by a number on the basis of its cell type and laminar structure. Though Brodmann's approach focused on anatomical evidence rather than on physiology or behavior, many of his brain areas have gone on to be associated with different nervous functions.

PHRENOLOGY CABINET
19th century, wood, felt, metal (cabinet), plaster and glue (heads)
Edinburgh, The Anatomical Museum, The University of Edinburgh

At the turn of the 18th century, the Viennese physicians Franz Joseph Gall (1758–1828) and Johan Gaspar Spurzheim (1776–1832) were pioneers in the field, today wholly discredited, of phrenology. Gall and Spurzheim believed that mental faculties such as instincts, sentiments, reason, and understanding were located in specific areas of the brain and that the strength or prominence of these faculties could be judged based on the size and shape of the brain areas as they pressed against the skull. Gall thought that the more relevant an aspect was, the more prominent the volume of the corresponding area would grow, molding the skull around it and making it possible to investigate personalities and mental conditions through the palpation of the head. In 1813, Spurzheim began lecturing in England with sculptor William Bally (1796–1858).
In 1832, Bally produced a set of sixty miniature phrenological specimens to be sold as teaching tools for aspiring phrenologists, accompanied by printed descriptions written by Spurzheim. The busts were scaled down from plaster casts of actual heads that best exhibited phrenological types.

32
EYES FROM ANOTHER COUNTRY. HOW SECRET INTELLIGENCE SERVICES WERE ASTONISHED BY A NEWSPAPER ARTICLE
Alexander Kluge (b. 1932, Germany)

This meant neuroscientists could, for the first time, directly observe the tone of speech and life within the working human brain: the communication going on in the "Republic of the Mind."
CARL D. ANDERSON, "THE POSITIVE ELECTRON"
***The Physical Review*, vol. 43, no. 6, The American Institute of Physics, Lancaster–New York, 1933**
Private collection

Positrons, the first antiparticles ever to be detected, were accidentally discovered by the American physicist Carl David Anderson (1905–1991) while studying cloud-chamber photographs of cosmic rays.
In 1932, he noticed that these images contained a number of tracks apparently caused by positively charged particles too small to be protons. This fact led Anderson to the identification of positively charged particles with the same mass as electrons, which he called "positrons" or "positive electrons."
This revolutionary discovery earned Anderson the Nobel Prize in physics in 1936. It also influenced medical diagnosis, leading to the development of Positron Emission Tomography (PET), an imaging technique crucial for the study of brain molecular functions.
Displayed here is the first publication announcing the discovery of positrons, illustrated with images of Anderson's cloud chambers.

"BRITAIN'S BRAINS PRODUCE FIRST NMR SCANS"
***New Scientist*, vol. 80, no. 1130, London, 1978**
Private collection

J.W. BELLIVEAU ET AL., "FUNCTIONAL MAPPING OF THE HUMAN VISUAL CORTEX BY MAGNETIC RESONANCE IMAGING"
***Science*, vol. 254, no. 5032, American Association for the Advancement of Science, Washington, 1991**
Private collection
2 copies

Magnetic resonance imaging (MRI) is a noninvasive imaging technique that enables the observation of anatomic structures, physiological functions, and the biochemical composition of tissues.
In the early 1970s, the methods of the chemist Paul Lauterbur and the physicist Peter Mansfield for using a gradient magnetic field to stack two-dimensional images of an object to create a three-dimensional view and for "line scan imaging" were adopted into the first MRI technology for use on human subjects. Lauterbur and Mansfield's advancements led to the first pictures of a section through a live human head. The nuclear magnetic resonance (NMR) images were recorded in 1978, by Hugh Clow and Ian Young at the EMI Central Research Laboratory (CRL), in Hayes, Middlesex.
In the early 1990s, high-resolution MRI was first applied to the imaging of human brain function by John Belliveau, leading to the invention of functional magnetic resonance imaging (fMRI).

KENNETH KWONG, J.W. BELLIVEAU, ET AL., "DYNAMIC MAGNETIC RESONANCE IMAGING OF HUMAN BRAIN ACTIVITY DURING PRIMARY SENSORY STIMULATION"
***Proceedings of the National Academy of Sciences of the United States of America*, vol. 89, no. 12, United States National Academy of Sciences, Washington, 1992**
Milan, Biblioteca di Biologia, Informatica, Chimica e Fisica dell'Università degli Studi di Milano

SEIJI OGAWA ET. AL., "INTRINSIC SIGNAL CHANGES ACCOMPANYING SENSORY STIMULATION: FUNCTIONAL BRAIN MAPPING WITH MAGNETIC RESONANCE IMAGING"
***Proceedings of the National Academy of Sciences of the United States of America*, vol. 89, no. 13, United States National Academy of Sciences, Washington, 1992**
Milan, Biblioteca di Biologia, Informatica, Chimica e Fisica dell'Università degli Studi di Milano

In the 1990s, functional magnetic resonance imaging (fMRI), which measures stimulus response and regional brain activity, was devised by John Belliveau. The technology was perfected by two independent research teams, Kenneth Kwong's at MGH NMR Center (now Martinos Center) and Seiji Ogawa's at AT&T Bell Laboratories.
Kwong and Ogawa demonstrated that cerebral activation could be imaged by exploiting endogenous contrast, a technique currently known as BOLD (Blood Oxygen Level Dependent), thereby eliminating the need for injection of an external agent.
Today, fMRI plays a crucial role in the study of brain functions ranging from primary sensory responses to cognitive and motor activities.

SECOND NOBILE FLOOR

On the second floor, neuroscientists, psychologists, neurolinguists, and philosophers from five continents are broadcast in an assembly of thirty-two screens. They investigate neuroscientific experiments and their philosophical and ethical dimensions.

Like the brain, The Conversation Machine—videos, interviews, and orchestration by Taryn Simon, produced by Fondazione Prada for the exhibition—is a self-organizing system. It responds to itself, continually constructing and assimilating its own order and disorder.

In clips excerpted from over 140 hours of interviews, participants appear to listen and respond to each other's statements. They enter and exit. Objects that refer to their work appear in flashes. Clusters of discussants migrate across the screens. Others sit in sustained, active silence. Like the brain, the conversation morphs according to a logic of prediction and surprise. Attention and distraction maximize and minimize responsiveness in human brains. The "listeners" in the conversation mark this balance while the viewer's attention is by turns captured, lost, redirected, tested, split, and pulled. Objects, empty chairs, fidgets, speaker and screen changes incorporate distraction—the conductor of attention—directly into the environment.

The participants talk about research, experiments, ideas of "me," survival, biological changes carved by trauma. The brain feeds on mismatch, connections, stimuli. The conversation navigates a history of neuroscientific knowledge-making marked by rigor, breakthrough, and discovery—but also by error, transgression, and uncertainty. It attends also to the continual presence of absences: gaps, missing perspectives, hidden layers. It tracks forces of violence, extinction, and oblivion embedded in our brains alongside creativity, regeneration, and resilience.

D
THE CONVERSATION MACHINE
VIDEOS, INTERVIEWS AND ORCHESTRATION BY Taryn Simon
PRODUCED BY Fondazione Prada for the "Human Brains. It Begins with an Idea" project

WITH
Yasmin Abofoul, Huda Akil, Polina Anikeeva, Anirban Bandyopadhyay, György Buzsáki, David Chalmers, Patricia Churchland, Antonio Damasio, Stanislas Dehaene, Daniel C. Dennett, Catherine Dulac, David Erritzoe, Lisa Feldman Barrett, André Fenton, Karl Friston, Ali Ghazizadeh, Carl Hart, Suzana Herculano-Houzel, Amadi O. Ihunwo, Erich Jarvis, Bianca Jones Marlin, Kumi Kuroda, Joseph E. LeDoux, Mahmoud Bukar Maina, Catherine Malabou, Eve Marder, Hannah Monyer, David Poeppel, Supratim Ray, Daniela Schiller, Wolf Singer, Mitchell Joseph Valdés-Sosa, Angela Vincent, Charles Yang, Rafael Yuste, Li Zhaoping

1
YASMIN ABOFOUL
(b. 1990, Palestine) The Hebrew University of Jerusalem, Israel

2
HUDA AKIL
(b. 1945, Syria) University of Michigan Medical School, Ann Arbor, MI, US

3
POLINA ANIKEEVA
(b. 1982, Russia) MIT – Massachusetts Institute of Technology, Cambridge, MA, US

4
ANIRBAN BANDYOPADHYAY
(b. 1975, India) National Institute for Materials Science, Tsukuba, Japan

5
GYÖRGY BUZSÁKI
(b. 1949, Hungary) New York University School of Medicine, NY, US

6
DAVID CHALMERS
(b. 1966, Australia) New York University, NY, US

7
PATRICIA CHURCHLAND
(b. 1943, Canada) University of California, San Diego, CA, US

8
ANTONIO DAMASIO
(b. 1944, Portugal) University of Southern California, Los Angeles, CA, US; Salk Institute for Biological Studies, La Jolla, CA, US

9
STANISLAS DEHAENE
(b. 1965, France) Collège de France, Paris, France

10
DANIEL C. DENNETT
(b. 1942, US) Tufts University, Medford and Somerville, MA, US

11
CATHERINE DULAC
(b. 1963, France) Harvard University, Cambridge, MA, US; Howard Hughes Medical Institute, Chevy Chase, MD, US

12
DAVID ERRITZOE
(b. 1974, Denmark) Imperial College London, London, UK

13
LISA FELDMAN BARRETT
(b. 1963, Canada) Northeastern University, Boston, MA, US; Massachusetts General Hospital, Boston, MA, US; Boston College, Chestnut Hill, MA, US

14
ANDRÉ FENTON
(b. 1967, Guyana) New York University, New York, NY, US

15
KARL FRISTON
(b. 1959, UK) University College London, London, UK

16
ALI GHAZIZADEH
(b. 1980, Iran) Sharif University of Technology, Tehran, Iran; School of Cognitive Science, Institute for Research in Fundamental Sciences, Tehran, Iran

17
CARL HART
(b. 1966, US) Columbia University, New York, NY, US

18
SUZANA HERCULANO-HOUZEL
(b. 1972, Brazil) Vanderbilt University, Nashville, TN, US

19
AMADI O. IHUNWO
(b. 1963, Nigeria) University of the Witwatersrand, Johannesburg, South Africa

20
ERICH JARVIS
(b. 1965, US) The Rockefeller University, New York, NY, US

21
BIANCA JONES MARLIN
(b. 1986, US) Columbia University's Zuckerman Institute, New York, NY, US

22
KUMI KURODA
(b. 1974, Japan) RIKEN Brain Science Institut, Wako-shi, Saitama, Japan

23
JOSEPH E. LEDOUX
(b. 1949, US) New York University, New York, NY, US; Emotional Brain Institute, New York University, New York, NY, US

24
MAHMOUD BUKAR MAINA
(b. 1986, Nigeria) University of Sussex, UK

25
CATHERINE MALABOU
(b. 1959, France) Kingston University, London, UK; European Graduate School, Saas-Fee, Switzerland-La Valletta, Malta; University of California Irvine, Irvine, CA, US

26
EVE MARDER
(b. 1948, US) Brandeis University, Waltham, MA, US

27
HANNAH MONYER
(b. 1957, Romania) Heidelberg University Hospital, Heidelberg, Germany

28
DAVID POEPPEL
(b. 1964, Germany) New York

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Ca' Corner della Regina
Calle de Ca' Corner
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Information
T +39 041 81 09 161
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