David Hunter Hubel (1926–2013)

David Hunter Hubel studied the development of the visual system and how the brain processes visual information in the US during the twentieth century. He performed multiple experiments with kittens in which he sewed kitten's eyes shut for varying periods of time and monitored their vision after reopening them. Hubel, along with colleague Torsten Wiesel, received the 1981 Nobel Prize in Physiology or Medicine for that research. By using kittens as models for human children and sewn eyes as models for congenital vision disorders, Hubel's research demonstrated how vision impairments can affect the development of the visual system in humans. Furthermore, Hubel's research has informed surgeons about the importance of operating on infants with vision impairments during the first months of life to prevent deterioration of the visual cortex of the brain and permanent vision loss.

Hubel was born on 27 February 1926 to Elsie and Jesse Hubel in Windsor, Ontario. He received Canadian citizenship by birth right and US citizenship through his parents, who both had been born in the United States. Hubel's father was a chemical engineer. According to historian Robert Hurtz, his mother was interested in electricity and regretted never attending college to study it. When Hubel was three years old, his family moved to Montreal, Québec, where from 1932 to 1944 Hubel attended Strathcona Academy in Montreal. According to Hubel, he was interested in science, especially chemistry and electronics, from a very young age. While perusing those childhood interests, Hubel created a basement laboratory, where he once mixed chemicals that resulted in an explosion and a visit from the police.

In 1944, Hubel started his undergraduate degree in mathematics and physics at McGill University, in Montreal, Québec. Hubel graduated in 1947 and was immediately admitted to medical school at McGill despite having never taken an undergraduate biology course. While in medical school, Hubel spent his summers studying electronics in the physiology laboratory at Montreal Neurological Institute in Montreal, Québec. According to Hubel, at the Montreal Neurological Institute, he developed an in interest in the nervous system and studied under Herbert Jasper, a neurologist that studied epilepsy. In 1951, Hubel received his medical degree from McGill. He continued his studies at McGill, taking a yearlong internship, a yearlong neurology residency, a yearlong fellowship in a laboratory that studied clinical electroencephalography, or EEG, which is an electrophysiological way to monitor the activity of the brain. At McGill, Hubel also met Shirley Ruth Izzard, whom he married in 1954. The two had three sons, Carl, Eric, and Paul.

In 1954, Hubel moved to continue his neurology studies at John Hopkins University in Baltimore, Maryland, but he was drafted into the US military following the start of the Korean War. In the military, Hubel was assigned to the Neuropsychiatry Division of the Walter Reed Army Institute of Research in Washington, D.C., where he studied the visual cortex. The visual cortex is the part of the brain that is responsible for recognizing and analyzing visual information. Hubel worked under the supervision of Michelangelo Fuortes, who treated soldiers with spinal cord injuries. Hubel studied how the cortical cells, the cells of the visual cortex of the brain, react to different stimuli.

At Walter Reed, Hubel contrasted how cortical cells become activated in waking and sleeping cats. He created a tungsten microelectrode that explored electrical impulses of cortical nerve cells in cats. It was a small probe that he used to explore the visual cortex of anesthetized cats while they were awake and asleep, which enabled him to monitor the activity of each cell separately and see the difference in their reaction. He found that awake cats had higher amounts of cellular activity than did sleeping cats. Hubel also contrasted differences in cell activity and found out that some cells reacted better to different types of light. That suggested that simple stimuli like light are building blocks of vision and that a specific part of the visual cortex uses those blocks to form complete visual images.

In 1958, Hubel's military service ended and he moved to Wilmer Institute at John Hopkins Hospital in Baltimore, Maryland, to continue his visual cortex studies in Stephen Kuffler's laboratory. At the time, Kuffler and his laboratory staff focused on the cells of the retina of the eye, as well as the cells of the lateral geniculate body, which is a midway stop in the brain between the eye and the visual cortex of the brain. In 1959, the entire staff of Kuffler's laboratory moved to Harvard Medical School, in Boston, Massachusetts. At Harvard Medical School, Hubel worked on multiple projects that involved the visual system of cats with Torsten Wiesel, a researcher who Hubel had met at Walter Reed.

Hubel and Wiesel sought to determine how the visual processing beyond the retina of the eye and how the cells were organized along the visual pathway from the eye to the brain. They used Hubel's tungsten microelectrode to monitor the activity of nerve cells in visual cortex, or cortical cells. The nerve cells in that area lay in multiple layers and form columns. Hubel and Wiesel found that most of those cells reacted to stimulation of retinal cells differently. Some cells responded to specific directions of movement, while others reacted to specific colors. Cortical cells reacted weakly to small or diffused light, yet reacted strongly to straight lines of light, but the orientation of the line was important for a given cell, as different cells responded better to different angles of the line.

That pattern of response showed that simple stimuli require complex work of the visual cortex cells, as it indicated that all cortical cells need to work together to build a complete image of a single object. Hubel and Wiesel concluded that the retinal cells were connected to cortical cells in a way that allowed for differentiating types of light. They also found that some cortical neurons reacted greater to one eye than the other, which they called ocular dominance. Since the cells in the visual cortex laid in stripes and multiple layers, Hubel and Wiesel named them ocular dominance columns. They published their research in a 1962 joint article. In 1963 Hubel published his first book, The Visual Cortex of the Brain.

In the early 1960s Hubel and Wiesel also studied the development of the visual system and ocular dominance columns in kittens at Harvard Medical School. At the time, researchers knew that children with congenital cataracts, a condition where the lens of the eye is clouded at the time of birth, have vision impairments even after surgical correction of the condition. Hubel and Wiesel studied ocular dominance, or the increased response of select cortical cells to one eye, further and concluded that relative dominance of one eye over the other varies from one cortical cell to the other. About eighty-five percent of cortical cells react almost equally to both eyes. Therefore, Hubel and Wiesel questioned if those cells redistribute after birth to favor the eye without a congenital impairment, which would explain why people and animals with early vision impairments in one eye have irreversible binocular vision damage after those impairments are corrected.

Hubel and Wiesel conducted an experiment to show whether or not cortical cells redistribute to favor a non-impaired eye following impairment to the other eye. To mimic a congenital vision impairment, Hubel and Wiesel sewed shut one of the eyes of kittens for the first three months of their life and observed whether or not that would cause blindness in that eye and whether or not cortical cells would redistribute to favor the non-impaired eye. They hypothesized that somewhere along the pathway from the retina to the visual cortex an abnormality occurred that would cause the permanent vision damage. Upon opening the sutured eye after the first three months of the kittens' life, Hubel and Wiesel noted that the previously sutured eye was practically blind and the kittens could not see with it.

Hubel and Wiesel also probed the kittens' visual cortex with the microelectrode to monitor the activity of the cortical cells. They found that an uncharacteristically low number of neurons reacted to the stimuli seen by the formerly sutured eye, while an uncharacteristically high number of neurons reacted to the stimuli seen by the other, non-impaired eye. Their results showed how cortical neurons likely redistributed to the non-impaired eye while the other eye was sutured.

To confirm whether or not the cortical cells had redistributed, Hubel and Wiesel studied the anatomy of the kittens' brain after one of the eyes had been sutured for the first three months of the kittens' lives. The researchers found that the ocular dominance columns of the sutured eye minimized significantly, and significantly increased in the opened eye, which confirmed that the cortical neurons redistributed to favor the open eye.

Hubel and Wiesel repeated the same experiment with adult cats, but the results were significantly different. Hubel and Wiesel sutured one eye of adult cats for a year. Upon opening the eye, the researchers found no significant difference in response to stimuli or ocular dominance column size. That meant that the redistribution of cortical cells and change in ocular dominance columns only happen in kittens right after their birth. Hubel and Wiesel concluded that change in ocular dominance columns happens during the development of the visual system, which is completed sometime after birth.

In 1964, Hubel and Wiesel published those results and called the period of visual system development after birth the critical period, as it was so important to long term vision. Hubel and Wiesel carried out the research of visual system development until late 1970s. They experimented with kittens, adult cats, and primates.

Through their research, Hubel and Wiesel concluded that, if an infant is deprived of visual stimulation during the beginning of their life, the visual cortex becomes irreversibly damaged. Visual cortex develops structures from the stimulation of infant's retina, which was supported by the fact that almost no neurons reacted to stimuli in the formerly sutured eye in the kittens. Hubel and Wiesel also concluded that visual information helps the development of the brain, so visual impairments must be corrected in children at a very early age for them to have a fully functioning visual cortex.

Hubel received multiple awards for his description of ocular dominance columns and their development, many of which he shared with Wiesel. In 1968, Hubel was honored as George Packer Berry Professor of Physiology. Later in 1969 and 1978, Hubel and Wiesel received the Dickson Prize from Carnegie Melon University and the Louisa Gross Horwitz Prize from Columbia University. In 1981, they shared the Noble Prize for Physiology or Medicine with Roger W. Sperry, for their contributions to knowledge about how visual information is processed and how visual systems are developed. After receiving the Noble Prize, Hubel remained at Harvard for the entirety of his career.

In 1982, Hubel was elected as the Foreign Member of the Royal Society in Great Britain, where he gave lectures occasionally. In 1988, Hubel became the president of the Society of Neuroscience for a year. During that time, he spoke out publicly against animal rights and argued the importance of animal testing. In 2004, Hubel and Wiesel reconnected to publish the book Brain and Visual Perception: The Story of a 25-Year Collaboration, which talks about their partnership and research.

Hubel died on 22 September 2013 from kidney failure at the age of eighty-seven in Lincoln, Massachusetts.

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