Torsten Wiesel (1924–)

Torsten Nils Wiesel studied visual information processing and development in the US during the twentieth century. He performed multiple experiments on cats in which he sewed one of their eyes shut and monitored the response of the cat's visual system after opening the sutured eye. For his work on visual processing, Wiesel received the Nobel Prize in Physiology or Medicine in 1981 along with David Hubel and Roger Sperry. Wiesel determined the critical period during which the visual system of a mammal develops and studied how impairment at that stage of development can cause permanent damage to the neural pathways of the eye, allowing later researchers and surgeons to study the treatment of congenital vision disorders.

Wiesel was born on 3 June 1924 in Uppsala, Sweden, to Anna-Lisa Bentzer Wiesel and Fritz Wiesel as their fifth and youngest child. Wiesel's mother stayed at home and raised their children. His father was the head of and chief psychiatrist at a mental institution, Beckomberga Hospital in Stockholm, Sweden, where the family lived. Wiesel described himself as lazy and playful during his childhood. He went to Whitlockska Samskolan, a coeducational private school in Stockholm, Sweden. At that time, Wiesel was interested in sports and became the president of his high school's athletic association, which he described as his only achievement from his younger years.

In 1941, at the age of seventeen, Wiesel enrolled at Karolinska Institutet (Royal Caroline Institute) in Solna, Sweden, where he pursued a medical degree and later pursued his own research. Wiesel stated that he became interested in psychiatry due to his father's position at Beckomberga Hospital, and he worked at multiple mental hospitals during one year of his medical studies. According to Wiesel, his professors Carl Gustaf Bernhard and Rudolf Skoglund influenced his later interest in neurophysiology. In 1954, Wiesel obtained his medical degree and joined Bernhard's laboratory to do vision neurophysiology research. That year he also worked for the physiology department of Karolinska Intitutet and the child psychiatry ward.

In 1955, Wiesel accepted a postdoctoral fellowship position in Stephen Kuffler's Wilmer Institute laboratory at John Hopkins Medical School in Baltimore, Maryland. Kuffler's lab studied vision development in mammals and focused on differences in development between mammals and non-mammals. Wiesel and the Kuffler lab largely studied cats and their retina ganglion cells, the inner cells of the retina that receive visual information from photoreceptors in the eyes. While in Kuffler's lab, Wiesel completed an ophthalmology fellowship and studied the receptive fields of cat's retinal ganglion cells. Wiesel and Kuffler's study extended the work of 1967 Nobel Prize winners Haldan Keffer Hartline and Ragnar Granit by studying on-center and off-center receptive fields, which are mutually exclusive parts of the retina that have an on- center and off- periphery or vice versa. On-center cells can sense stimuli that off cells cannot and vice versa. In 1956, Wiesel was appointed associate professor at John Hopkins Medical School.

Wiesel began studying the origin of visual perception in 1958 with David Hubel, a researcher who had joined the Kuffler lab that same year. Wiesel and Hubel knew that the visual cortex of the brain, which is located on the back of the brain in the occipital lobe, is responsible for visual perception, yet they did not exactly know how that happened. Wiesel and Hubel moved to Harvard Medical School in Boston, Massachusetts, in 1959 with the rest of Kuffler's lab. That lab later formed Harvard Medical School's Department of Neurobiology.

At Harvard, Wiesel and Hubel studied the visual cortex of the brain by monitoring the difference in activity between its cells. They questioned whether cortical cells, or the cells of the visual cortex, responded similarly to both eyes or whether they were dominated by one eye. The researchers also wanted to know what brightness and patterns of light are best recognized by the majority of

cortical cells. Wiesel and Hubel inserted an electrode into the visual cortex of anesthetized cats that detected electrochemical changes in the cat's brain. Most cortical cells responded better to bright spots of light and lines of light shown at an angle. The study helped them see that any complex image is processed by multiple consecutive stimuli in the visual cortex.

As Wiesel and Hubel continued their research on cats at Harvard, they determined how cells are situated in the visual cortex and what the function of each of those cells is. They found that the visual cortex consists of ocular dominance columns that are stripes of neurons that respond greater to one of the eyes. The cells in those columns lie in multiple layers and span the entire visual cortex of the brain. Wiesel and Hubel discovered that the major difference between cortical cells is the amount of information they can process. Some cortical cells were simple, some were complex, and some were hypercomplex, meaning they could process increasing amounts of information from the eyes. Wiesel and Hubel also found that there were three major pathways of processing visual information, depending on whether the cortical cells were detecting movement, shape, or color. Furthermore, Wiesel and Hubel found that the cells responsible for all three of those functions were different and were located in different areas of the retina, as well as different areas of the visual cortex. Movement sensitive cells were unable to distinguish colors and the color sensitive cells were unable to distinguish movement. The major photoreceptor cells located in the back of the retina detect color because they are connected in a way that allows for light differentiation. Wiesel and Hubel published their findings in "Receptive Fields of Single Neurons in the Cat's Striate Cortex" in 1960.

During the 1960s, Wiesel and Hubel studied the development of kitten's visual system as a model for human children's visual system at Harvard Medical School. They questioned whether congenital vision impairments, even if corrected, could cause permanent damage to vision. Multiple vision studies had already prevented kittens from seeing light during the first months after birth, but no study before had sutured their eyes fully shut for a prolonged period of time, which made kittens completely blind in the sutured eye until it was reopened. Wiesel and Hubel hypothesized that the visual system develops during the first months of life and that a visual impairment during the developmental stage could cause irreversible damage. The first place they looked for such damage was the visual cortex of the brain, or the final step in the information pathway from the eye to the brain.

Wiesel and Hubel tested their hypothesis about the possible effects of congenital vision impairment on kittens by sewing one of a kitten's eyes shut and later reopening that eye. The researchers then compared the electrical activity of the cortical cells in kittens that had one eye sewed shut to normal kittens of the same age. Wiesel and Hubel had previously noted that different cortical cells respond preferentially to one eye over the other, yet in normal kittens with no previous vision impairment, the majority of cortical cells reacted the same to both eyes. That suggested that in normal mammals, the majority of cortical cells respond the same way to both eyes, and that the distribution of cortical cells in normal kittens could be used as a baseline for calculating how much impairing an eye during early development affects cortical cell distribution.

Upon opening the sutured eye after the first three months of the kitten's life, Hubel and Wiesel noted that a very small number of cortical cells reacted to the retinal cells of the formerly sutured eye, whereas an abnormally high number of cortical cells reacted to the other eye that had normal vision. That result indicated that the kitten's cortical neuron preference was redistributed while one of the kitten's eyes was sutured. In other words, the normal eye compensated for the previously sutured eye, which caused the redistribution of the cortical neurons. Cortical cells responded preferentially to the normal eye because the cortical cells had received no visual information from the sutured eye during development.

Hubel and Wiesel repeated the same experiment with adult cats, but the results were significantly different. They sutured one eye of adult cats for a year. Upon opening the eye, no significant difference in response to stimuli or ocular dominance column size was recorded. That suggested that the mammalian visual system developed during the first few months of the life, and that once it developed, even prolonged impairments did not cause significant damage to neural pathways after the impairments were corrected. However, any impairment to the eye while the visual system was developing post-birth impacted the distribution of cortical neurons, causing irreversible loss of

vision in the impaired eye.

Wiesel and Hubel applied their conclusions to humans, which helped surgeons recognize the critical period during which the vision impairments need to be corrected after birth. The critical period was defined as the time during which the visual system develops and the cortical neurons distribute between ocular dominance columns. The critical period is especially important to children with congenital cataracts, or cloudiness of the lens of the eye present at birth, which causes blurry vision. Most children with congenital cataracts were operated months or even years after birth, and the blurry vision in the affected eye could never be fully corrected because the critical period had passed. If an impairment was not surgically corrected during the critical period of visual system development, the visual system would develop for only one eye, and the other would be left impaired for the rest of the human's life. As of 2017, surgeons operate on congenital cataracts more quickly, minimizing the risk of permanent visual impairment. Wiesel and Hubel published their findings in 1964 in an article titled "Effects of monocular deprivation in kittens."

During the same year, in 1964, Wiesel was appointed professor of physiology at Harvard, where he stayed until 1983. In 1973, Wiesel became the chairman of the Harvard Physiology Department. In 1981, Wiesel and Hubel won the Nobel Prize for Physiology or Medicine for their research on how visual information is transmitted and processed by the brain. They shared half of the prize with Roger Sperry, who studied the difference in specialization of the two hemispheres of the brain after cutting the corpus callosum, or the bond between the hemispheres in the middle of the brain. Just two years after winning the Nobel Prize, Wiesel moved to Rockefeller University in New York, New York. There he was appointed head of the Laboratory of Neurobiology. As of 2017, Wiesel still works at Rockefeller University.

Wiesel has been married four times. His first marriage was with Teeri Stenhammarand, whom he married in 1956 and divorced in 1970. He married his second wife, Ann Yee, three years later. The two had a daughter, Sara Elizabeth Wiesel, who was born in 1975. That same year, Wiesel divorced Yee. He was then married to Jean Stein from 1995 to 2007. In 2008, Wiesel married Lizette Mususa Reyes, who is his current spouse.

In 1991, Wiesel became the president of Rockefeller University. During his time as president of the university, Wiesel advocated for human rights and equality. He addressed the gender inequality at Rockefeller University by appointing the first female full professor. He also established six new interdisciplinary research centers that helped to expand the research faculty at Rockefeller University. In 1996, Wiesel received the Helen Keller Prize for Vision Research.

In 1998, Wiesel retired from his presidency of Rockefeller University and became the director of the Shelby White and Leon Levy Center for Mind, Brain, and Behavior at Rockefeller University. Wiesel also helped found the International Human Rights Network of Academies and Scholarly Societies, which promotes equality within the scientific community and encourages the exchange of ideas. Wiesel also founded the Israeli-Palestinian Science Organization, which promotes scientific research and collaboration in the Middle East and especially between Israel and Palestine.

Wiesel received a total of twenty scientific awards throughout his career, including his Nobel Prize in 1981 for his discovery of the critical period in visual system development as well as research on visual information processing by the visual cortex of the brain. Due to Wiesel's discoveries, surgeons can operate on congenital cataracts as soon as they are recognized in a child to avoid further impairment of that eye. As of 2016, Wiesel is active in the global human rights movement. He is also the co-director of the Shelby White and Leon Levy Center for Mind, Brain, and Behavior at Rockefeller University.

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