The 1981 Nobel Prize in Physiology or Medicine

The Nobel Assembly of Karolinska Institutet decided to award the Nobel Prize in Physiology or Medicine for 1981 with one half to Roger W. Sperry for his discoveries concerning "the functional specialization of the cerebral hemispheres" **and** the other half jointly to David H. Hubel and Torsten N. Wiesel for their discoveries concerning "visual system".

Summary

The cerebrum is **made up** of two halves, the hemispheres, which are structurally identical. These hemispheres are united to one another through a system consisting of millions of nerve fibers. **Therefore**, each hemisphere is continually informed about what is happening in the other. For more than a century we **have** known that, **despite** their similarities and close linking, the two hemispheres generally perform different functions. The left hemisphere is the center for speech and, **accordingly**, **has** been described as the dominant one and **has** been considered to be superior to the right hemisphere. Outside of **this**, little was known about where in the brain the higher functions were centered until the beginning of the 1960s when Sperry began his investigations. Sperry **has** brilliantly succeeded in extracting the secrets from both hemispheres and in demonstrating that **they** are highly specialized and **also** that many higher functions are centered in the right hemisphere.

Of all the sensory impressions proceeding to the brain, the visual experiences are the dominant **ones**. Our perception of the world around us is based essentially on the messages reaching the brain from our eyes. For a long time **it** was thought that the retinal image was transmitted point by point to visual centers in the brain; the cerebral cortex was like a movie screen, so to speak, upon which the image in the eye was projected. Through the discoveries of Hubel and Wiesel we now know that behind the origin of the visual perception in the brain there is a much more complicated course of events. **By** following the visual impulses along **their** path to the various cell layers of the optical cortex, **they** were able to demonstrate that the message about the image falling on the retina undergoes a step-wise analysis in a system of nerve cells stored in columns. In this system each cell **has** its specific function and is responsible for a specific detail in the pattern of the retinal image.

Roger W. Sperry

Normally, both cerebral hemispheres are linked through the cerebral commissure, which is **built up** of hundreds of millions of nerve fibers. **When** Sperry in the beginning of the 1950s began **his** experimental studies on animals, the functional significance of these connections between both hemispheres was entirely unknown. In experiments on monkeys Sperry found that, **if** these connections were severed, each cerebral hemisphere would retain its ability to learn, **but** that what **had** been learned by one hemisphere was not accessible to the other. A neurosurgical technique called commissurotomy (similar to what Sperry **had** performed on monkeys) **had** also been carried out at that time in a number of patients suffering from severe epilepsy. A majority of **these patients** showed an improvement **as well as** a decrease in the frequency of epileptic seizures. **Otherwise**, the operation entailed no obvious changes at all with regard to the patients' general behaviour and reactions. And psychological test methods could not demonstrate any impairment at the patients' ability to perceive and learn.

When, early in the 1960s, Sperry **had** the opportunity to study these patients; he was able to show, through brilliantly designed test procedures, that each cerebral hemisphere in these patients **had** its own world of consciousness and was entirely independent of the other with regard to learning and retention. **Moreover**, each **had** **its** own world of perceptual experience, emotions, thoughts and memory completely out of reach of the other cerebral hemisphere.

Sperry was able to demonstrate that the isolated left hemisphere is concerned with abstract thinking, symbolic relationships and logical analysis of details, particularly temporal relationships. It can speak, write and make mathematical calculations; in its general function it is analytical and computer-like. **It** is **also** the more aggressive, executive, leading hemisphere in control of the nervous system. The right hemisphere is mute and generally lacks the possibility to communicate with the outside world.

It is, as Sperry expresses **it**, "a passive passenger who leaves the driving of behaviour mainly to the left hemisphere." **Because** of its muteness, the right hemisphere **has** been completely inaccessible for experimental studies, and also, as a consequence of **this**, **has** been considered as being entirely subordinate to the left hemisphere. Through his investigations, Sperry **has** revealed that the right hemisphere, contrary to what one previously thought, is clearly superior to the left hemisphere in many respects. **This** is especially true regarding the capacity for concrete thinking, spatial consciousness and comprehension of complex relationships. **It** is **also** the superior hemisphere when it comes to interpreting auditory impressions and in comprehension of music; it can better recognize melodies and better distinguish voices and intonations. In other respects, **however**, the right hemisphere is clearly inferior to the left. It lacks almost entirely the ability to calculate and can only perform simple additions up to 20. It lacks the power to subtract, multiply or divide. It can read and comprehend the meaning of simple, mono-syllabic nouns **but** cannot perceive the import of adjectives or verbs. **It** cannot write **but** is entirely superior to the left hemisphere in space perception and three-dimensional pictures reproduction. Many years ago the great Russian physiologist Ivan Pavlov concluded that mankind can be divided into thinkers and artists. Perhaps the left hemisphere is the dominant **one** in thinkers and the right hemisphere in artists. **In short**, Sperry **has** provided us with an insight into the inner world of the brain, which **had** been almost completely hidden from us.

David H. Hubel and Torsten N. Wiesel

At the time Hubel and Wiesel began their studies of the visual system, knowledge of the functional organization of the cerebral cortex was fragmentary. **By** tapping nerve-cell impulses in the various layers of the visual cortex, Hubel and Wiesel **have** been able to demonstrate that the message reaching the brain from the eyes undergoes an analysis in which the various components of the retinal image are interpreted with respect to **their** contrasts, linear patterns and the movement of the image across the retina. This analysis occurs in a rigid sequence from one nerve cell to another in which each nerve cell is responsible for a certain detail in the image pattern. To put **it** extremely simply, one can say that the visual cortex's analysis of the coded message from the retina proceeds as if certain cells read the simple letters in the message and compile them into syllables that are subsequently read by other cells, which, in turn, compile the syllables into words, and **these** are finally read by other cells that compile words into sentences that are sent to the higher centers in the brain, where the visual impression originates and the memory of the image is stored.

Hubel and Wiesel found in their studies of the visual cortex that the cells are arranged in a regular manner in columns, **and** that the cells within each such column **have** the same functions in interpreting the impulse message from the eyes. **These columns** **make up**, in turn, so-called hypercolumns, and each such hypercolumn occupies a portion of the cerebral cortex about two-by-two millimeters in area. Within each such area the information arriving from a correspondingly small region of each eye is analyzed.

Hubel and Wiesel were also able to show by **their** experiments that the ability of the cells in the visual cortex to interpret the code of the impulse message from the retina is developed directly after birth. A prerequisite for this development to take place is that the eye be exposed to visual stimuli. **If** one eye is closed for only a few days during this period, permanent functional changes will take place in the visual cortex. Hubel and Wiesel were able to show that light stimulation in **itself** was insufficient to **bring about** normal development of the visual cortex, and that **it** was necessary for the retinal image to **have** a pattern and many contours.

This discovery illustrates, **first**, the brain's high degree of plasticity immediately following birth and, **second**, how important **it** is that the brain receive a rich variety of visual stimuli during this period. In some way the perception of the visual world around us depends on the visual experiences that we **had** during the first stages of our lives. **If** the visual impressions are dull or distorted -- for example, through errors in the lens system of the eye -- **this** may lead to a permanent impairment of the ability of the brain to analyze visual impressions. **These discoveries** represent a breakthrough in research into the ability of the brain to interpret the code of the impulse message from the eyes.