# The Nobel Prize in Physiology or Medicine 1981

# Presentation Speech

Presentation Speech by Professor David Ottoson of the Karolinska Institute

*Translation from the Swedish text*

Your Majesties, Your Royal Highnesses, Ladies and Gentlemen,

One day in October 1649, René Descartes, the French philosopher and mathematician acknowledged as the greatest brain researcher of the period, arrived in Stockholm at the pressing invitation of Queen Christina. It was with much hesitation that Descartes went to Sweden as he wrote "the land of bears between rocks and ice". In the letters to his friends, he complained bitterly that he was obliged to present himself at the Royal Palace at five o'clock each morning to instruct the young queen in philosophy, so avid was she for knowledge. Modern brain research scientists and followers in the Cartesian footsteps are not faced with the same demands as winners of the Nobel Prize, but they are met with other tribulations - and expectations.

Descartes, with the help of philosophy, sought to find the answer to his questions of the functions of the mind. Later research has had other means at its disposal and has tried to feel its way forward by other methods. Sperry has succeeded with sophisticated methods to extract from the brain some of its best guarded secrets and has allowed us to look into a world which until now has been nearly completely closed to us. Hubel and Wiesel have succeeded in breaking the code of the message which the eyes send to the brain and have thereby given us insight into the neuronal processes underlying our visual experiences.

The brain consists of two halves, hemispheres, which are structurally identical. Does this mean that we have two brains or that the two hemispheres have different tasks? The answer to this question can appear impossible to find because the brain halves are united by millions of nerve threads and, therefore, work in a complete functional harmony. However, it has been known for more than a hundred years that despite their similarity and close linkage the two hemispheres have in part different tasks to fulfill. The left hemisphere is specialized for speech and has, therefore, been considered absolutely superior to the right hemisphere. For the right hemisphere it has been difficult to find a role and it has generally been regarded as a "sleeping partner" of its left companion. In a

way the roles of the two hemispheres were somewhat like those of man and wife of an old-time marriage.

In the beginning of the 1960s Sperry had the occasion to study some patients in whom the connections between the two hemispheres had been severed. The surgical intervention had been undertaken as a last resort to alleviate the epileptic seizures from which the patients suffered. In most of them an improvement occurred and there was a decrease in the frequency of their epileptic fits. Otherwise, the operation did not appear to be accompanied by any changes in the personality of the patients. However, Sperry was able, using brilliantly designed test methods to demonstrate that the two hemispheres in these patients had each its own stream of conscious awareness, perceptions, thoughts, ideas and memories, all of which were cut off from the corresponding experiences in the opposite hemisphere.

The left brain half is, as Sperry was able to show, superior to the right in abstract thinking, interpretation of symbolic relationships and in carrying out detailed analysis. It can speak, write, carry out mathematical calculations and in its general function is rather reminiscent of a computer. Furthermore, it is the leading hemisphere in the control of the motor system, the executive and in some respects the aggressive brain half. It is with this brain half that we communicate. The right cerebral hemisphere on the other hand is mute and in essence lacks the possibility to reach the outside world. It cannot write and can only read and understand the meaning of simple words in noun form and does not grasp the meaning of adjective or verb. It almost entirely lacks the ability to count and can only carry out simple additions up to 20. It completely lacks the ability to subtract, multiply and divide. Because of its muteness, the right brain half gives the impression of being inferior to the left. However, Sperry in his investigations was able to reveal that the right hemisphere in many ways is clearly superior to the left. Foremost, this concerns the capacity for concrete thinking, the apprehension and processing of spatial patterns, relations and transformations. It is superior to the left hemisphere in the perception of complex sounds and in the appreciation of music; it recognizes melodies more readily and also can accurately distinguish voices and tones. It is, too, absolutely superior to the left hemisphere in perception of nondescript patterns. It is with the right hemisphere we recognize the face of an acquaintance, the topography of a town or landscape earlier seen.

It is soon 50 years since Pavlov, the great Russian physiologist, put forward the suggestions that mankind can be divided into thinkers and artists. Pavlov was perhaps not entirely wrong in making this proposal. Today we know from Sperry's work that the left hemisphere is cool and logical in its thinking, while the right hemisphere is the imaginative, artistically creative half of the brain. Perhaps it is so that in thinkers the left hemisphere is dominant whereas in artists it is the right.

Hubel and Wiesel came in the mid-50s to the laboratory of the neurophysiologist S.W. Kuffler in Baltimore. Kuffler had at this time completed a series of investigations marked by an extraordinary experimental elegance in which he demonstrated how the picture that falls into the eyes is processed by the cells of the retina. Kuffler, who passed away a year ago, had by his work indicated the lines on which to continue analysis of the information

processing of the visual system. This is, therefore, a fitting occasion on which to pay tribute to the memory of Kuffler for his important contribution.

The signal message that the eye sends to the brain can be regarded as a secret code to which only the brain possesses the key and can interpret the message. Hubel and Wiesel have succeeded in breaking the code. This they have achieved by tapping the signals from the nerve cells in the various cell layers of the brain cortex. Thus, they have been able to show how the various components of the retinal image are read out and interpreted by the cortical cells in respect to contrast, linear patterns and movement of the picture over the retina. The cells are arranged in columns, and the analysis takes place in a strictly ordered sequence from one nerve cell to another and every nerve cell is responsible for one particular detail in the picture pattern.

Hubel and Wiesel in their investigations were also able to show that the ability of the cortical cells to interpret the code of the impulse message from the retina develops early during a period directly after birth. A prerequisite for this development to take place is that the eye is subjected to visual experiences. If during this period one eye is sutured even for a few days, this can result in permanently impaired vision because the capacity of the brain to interpret the picture has not developed normally. For this to take place it is not only essential that the eye is reached by light but also that a sharp image is formed on the retina and that retinal image has a pattern of contours and contrasts. This discovery reveals that the brain has a high degree of plasticity at an early stage immediately after birth.

Hubel and Wiesel have disclosed one of the most well guarded secrets of the brain: the way by which its cells decode the message which the brain receives from the eyes. Thanks to Hubel and Wiesel we now begin to understand the inner language of the brain. Their discovery of the plasticity of the brain cortex during an early period of our life has implications reaching far beyond the field of visual physiology and proves the importance of a richly varied sensory input for the development of the higher functions of the brain.

Dr. Sperry, Dr. Hubel and Dr. Wiesel,

You have with your discoveries written one of the most fascinating chapters in the history of brain research. You, Dr. Sperry, have given us more profound insights into the higher functions of the brain than all the knowledge acquired in the twentieth century. You, Dr. Hubel and Dr. Wiesel, have translated the symbolic calligraphy of the brain cortex. The deciphering of the hieroglyphic characters of the ancient Egyptians has been denoted as one of the greatest advances in the history of philology. By breaking the code of the enigmatic signals of the visual system you have made an achievement which for all time will stand out as one of the most important in the history of brain research.

It is a privilege and pleasure for me to convey to you the warmest congratulations of the Nobel Assembly of the Karolinska Institute and to invite you to receive your Nobel Prize from the hands of His Majesty the King.

From *Nobel Lectures, Physiology or Medicine 1981-1990*, Editor-in-Charge Tore Frängsmyr, Editor Jan Lindsten, World Scientific Publishing Co., Singapore, 1993