NOBEL LECTURES

PHYSIOLOGY OR MEDICINE

生理学或医学诺贝尔奖讲演集

1981-1990

World Scientific
世界图书出版公司

NOBEL LECTURES

INCLUDING PRESENTATION SPEECHES
AND LAUREATES' BIOGRAPHIES

PHYSIOLOGY OR MEDICINE

1981–1990

TORE FRÄNGSMYR
Uppsala University
Uppsala, Sweden

EDITOR

JAN LINDSTEN
The Karolinska Medico-Chirurgical Institute
Stockholm, Sweden

World Scientific
世界图书出版公司

Published for the Nobel Foundation in 1993 by

World Scientific Publishing Co. Pte. Ltd.
P O Box 128, Farrer Road, Singapore 9128
USA office: Suite 1B, 1060 Main Street, River Edge, NJ 07661
UK office: 73 Lynton Mead, Totteridge, London N20 8DH

NOBEL LECTURES IN PHYSIOLOGY OR MEDICINE (1981–1990)

ISBN 981-02-0792-1
ISBN 981-02-0793-X (pbk)

书　　名：Nobel Lectures in Physiology or Medicine 1981-1990
作　　者：J. Lindsten (ed.)
中 译 名：生理学或医学诺贝尔讲演集 1981-1990
出 版 者：世界图书出版公司北京公司
印 刷 者：北京世图印刷厂
发　　行：世界图书出版公司北京公司 (北京朝内大街 137 号　100010)
联系电话：010-64015659, 64038347
电子信箱：kjsk@vip.sina.com
开　　本：24
印　　张：25
出版年代：2003 年 10 月
书　　号：7-5062-6566-4/ Q・15
版权登记：图字:01-2003-6294
定　　价：76.00 元

Foreword

Since 1901 the Nobel Foundation has published annually "Les Prix Nobel" with reports from the Nobel Award Ceremonies in Stockholm and Oslo as well as the biographies and Nobel lectures of the laureates. In order to make the lectures available to people with special interests in the different prize fields the Foundation gave Elsevier Publishing Company the right to publish in English the lectures for 1901–1970, which were published in 1964–1972 through the following volumes:

Physics 1901–1970	4 vols.
Chemistry 1901–1970	4 vols.
Physiology or Medicine 1901–1970	4 vols.
Literature 1901–1967	1 vol.
Peace 1901–1970	3 vols.

Elsevier decided later not to continue the Nobel project. It is therefore with great satisfaction that the Nobel Foundation has given World Scientific Publishing Company the right to bring the series up to date beginning with the Prize lectures in Economics in 2 volumes 1969–1990. Thereafter the lectures in all the other prize fields will follow.

The Nobel Foundation is very pleased that the intellectual and spiritual message to the world laid down in the laureates' lectures, thanks to the efforts of World Scientific, will reach new readers all over the world.

Lars Gyllensten
Chairman of the Board

Stig Ramel
Executive Director

Stockholm, June 1991

Preface

The Nobel Week is an annual, international event the highlight of which is the Nobel Prize Award Ceremony in the Concert Hall of Stockholm on December 10th, that is on the death-day of Alfred Nobel. It is a fascinating occurrence from both the scientific and social points of view, mainly because it puts the significance of science for society into bright focus. Only one item on the entire agenda is compulsory for the Laureates during this week, the Nobel Lecture. Thus, each Laureate has to deliver a lecture on the topic for which the prize has been awarded. The lectures are generally given on December 8th, that is before the Prize Award Ceremony, so that the Laureates can enjoy the festivities in a more relaxed way.

The Laureates in Physiology or Medicine present their lectures at the Karolinska Institute, that is on the ground of the Prize Awarding Institution. This gives the scientists and students at the Institute a unique possibility to enjoy presentations of some of the most significant contributions to biomedical science and also to meet the Laureates personally. That is why these lectures have such a special atmosphere (video tape recordings of the lectures are kept in the Nobel Archives at the Karolinska Institute).

The Nobel Lectures are published in an annual book series, "Les Prix Nobel". Each volume in this series contains, in addition to the lectures given by all Laureates for a specific year, short biographical notes and portraits of the Laureates as well as reports on the prize presentation ceremonies in Stockholm and Oslo.

In the present two volumes the Nobel Lectures given by the Laureates in Physiology or Medicine for the years 1971–1990 have been reprinted. Since these lectures are time bound documents, only minor changes, for instance of printing errors, have been made.

As a member of the Nobel Assembly and secretary-general of the Nobel Assembly and the Nobel Committee at the Karolinska Institute during the years 1979–1990, I have had the pleasure of meeting most of the Laureates from the time period covered in these two volumes. It has indeed been a pleasure to reread their lectures with the perspective that time now has given them.

Jan Lindsten
M.D., Professor
September 1992

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Physiology or Medicine

ROGER W. SPERRY

"for his discoveries concerning the functional specialization of the cerebral hemispheres"

and

DAVID H. HUBEL & TORSTEN N. WIESEL

"for their discoveries concerning information processing in the visual system"

THE NOBEL PRIZE FOR PHYSIOLOGY OR MEDICINE

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.

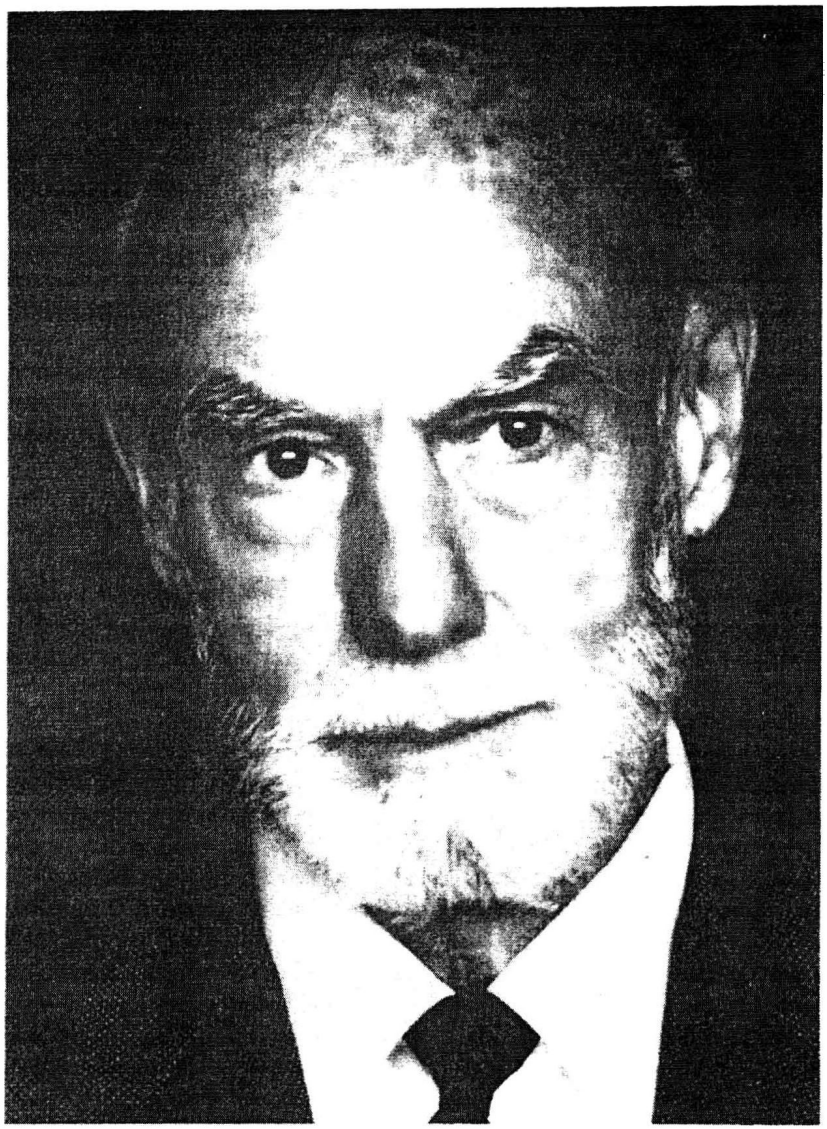
Hubel and Wiesel in their investigations were also able to show that the ability of the cortical cells to interpret the code of the impulse message from the retina develops early during a period directly after birth. A prerequisite for this development to take place is that the eye is subjected to visual 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.



Roger Sperry

ROGER SPERRY

Birthplace and Family: Born August 20, 1913, in Hartford, Connecticut to Francis Bushnell and Florence Kraemer Sperry of Elmwood, a small suburb. Father was in banking; mother trained in business school and after dad's death, when I was 11 years old, she became assistant to the principal in the local high school. One brother, Russell Loomis, a year younger, went into chemistry. I was married to Norma Gay Deupree, December 28, 1949. We have one son, Glenn Michael (Tad), born October 13, 1953 and one daughter, Janeth Hope, born August 18, 1963.

Education: My early schooling was in Elmwood, Connecticut and William Hall High School in West Hartford, Connecticut. I attended Oberlin College on a 4 year Amos C. Miller Scholarship. After receiving the AB in English in 1935, I stayed on 2 years more in Oberlin for an MA in Psychology, 1937, under Professor R.H. Stetson. I then took an additional third year at-large at Oberlin to prepare for a switch to Zoology for Ph.D. work under Professor Paul A. Weiss at the University of Chicago. After receiving the Ph.D. at Chicago in 1941, I did a year of postdoctoral research as a National Research Council Fellow at Harvard University under Professor Karl S. Lashley.

Professional positions: Biology research fellow, Harvard University, at Yerkes Laboratories of Primate Biology (1942–46); Assistant professor, Department of Anatomy, University of Chicago (1946–52); Associate professor of psychology, University of Chicago (1952–53); Section Chief, Neurological Diseases and Blindness, National Institutes of Health (1952–53); Hixon professor of psychobiology, California Institute of Technology (1954–present).

Awards and Honors: Amos C. Miller Scholarship, Oberlin College (1931–35); National Research Council Fellowship (1941–42); Distinguished Alumni Citation; Oberlin College (1954); Elected National Academy of Sciences (1960); Elected American Academy of Arts and Sciences (1963); Howard Crosby Warren Medal, Society of Experimental Psychologists (1969); Distinguished Scientific Contribution Award, American Psychological Association (1971); California Scientist of the Year Award (1972); Co-recipient William Thomson Wakeman Research Award, National Paraplegia Foundation (1972); Honorary Doctor of Science degree, Cambridge University (1972); Passano Award in Medical Science (1973); Elected American Philosophical Society (1974); Elected Honorary Member American Neurological Association (1974); Co-recipient Claude Bernard Science Journalism Award (1975); Karl Lashley Award of American Philosophical Society (1976); Elected Foreign Member of Royal Society (1976); Honorary Doctor of Science Degree, University of Chicago (1976); Elected member of Pontifical Academy of Sciences (1978); Honorary

Doctor of Science Degree, Kenyon College (1979); Wolf Prize in Medicine (1979); Ralph Gerard Award of the Society of Neurosciences (1979); International Visual Literacy Association Special Award (1979); Albert Lasker Medical Research Award (1979); Honorary Doctor of Science Degree, The Rockefeller University (1980); American Academy of Achievement Golden Plate Award (1980).

A vocational and anti-brain-strain: Collected and raised large American moths in grade school. Ran trap line and collected live wild pets during junior high school years. Three-letter man in varsity athletics in high school and college. Through middle life continued evening and weekend diversionary activities including sculpture, ceramics, figure drawing, sports, American folk dance, boating, fishing, snorkeling, water colors, and collecting unusual fossils—among which we have a contender for the world's 3rd largest ammonite.

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