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In memoriam

Werner Reichardt

1924–1992

Werner Reichardt, the Editor-in-Chief and founder of this journal, which carries the same name as the Max-Planck-Institut he created and directed, died in Tübingen on 18 September 1992. He had had a stroke, from which he did not recover consciousness, at the very end of a day of celebration and lectures by his close friends and coworkers on the occasion of his retirement.

It is very difficult for me to write about him as a scientist, since he was first and foremost a very close friend and a wonderful person. He was a man of integrity and courage who stood behind his convictions and was always ready to sacrifice his personal interests. He was a loyal friend whose word could always be fully trusted. He was a kind, courtly gentleman of science educated in the prewar tradition of the great German schools. He was "Uncle Werner" to my children, and his visits to Boston were always an occasion for happiness.

Werner was born in 1924 in Berlin. During his school years, he worked in the laboratory of Dr. Hans Heinrich Hollmann, one of the pioneers of the electronics of the day. At the beginning of World War II, Werner was called up the air force and assigned to work on radio and radar projects. He was 19 years old when both of his parents were killed in an air attack on Berlin. He became a member of a resistance group and risked his life trying to establish radio contact with the Allied Forces. Shortly thereafter, Werner was arrested by the Gestapo; a few weeks later, condemned to be executed, he was able to escape from jail in a small battle between prisoners and SS forces. These were the last days of the war. In postwar Berlin Werner, managed to set up a radio repair shop, do some work for Professor Kallmann at the Fritz-Haber-Institut and, with Kallmann's help, continue his studies and obtain his master's degree and Ph.D. at the Technische Universität in Berlin.

From 1952 to 1955, Werner was research assistant at the Fritz-Haber-Institut of the Max-Planck-Gesellschaft in Berlin, where he had among his teachers and advisors Dr. von Laue, who had received a Nobel prize for physics, and Dr. Ruska, who was destined to be awarded a Nobel prize many years later in recognition of his contribution to the development of the electron microscope. At this time Werner was working with Dr. Bernhardt Hassenstein, whom he had met during the war, on the motion detection papers describing the correlation models and related experiments. In 1954, Dr. Max Delbrück offered Werner a postdoctoral position at the California Institute of Technology and convinced him to work as a physicist in biology.

At CalTech, in 1955, Werner worked with Delbrück on the growth-induced photoresponse of a one-cell organ of the fungus *Phycomyces*; at about the same time, Dr. James Watson and Dr. Niels Jerne were also postdoctoral associates of Delbrück. It was with Jerne (who recently received a Nobel prize for his work in immunology) that Werner made an adventurous coast-to-coast automobile trip at the end of his postdoctoral period, punctuated by breakdowns of their car and impromptu lectures given at local colleges to help pay for fuel and repairs. They offered a package of two lectures, one on horses – on which Niels Jerne had done his experiments on the clonal theory of immunology – and one on beetles – the experimental subjects of Werner's theory of the optomotor response.

Back in Germany Karl Friedrich Bonhoeffer offered Werner a position at the Max-Planck-Institut für physikalische Chemie in Göttingen. Shortly afterwards, in 1958, Werner became head, together with Hans Wenking and Bernhardt Hassenstein, of the Forschungsgruppe Kybernetik within the Max-Planck-Institut für Biologie in Tübingen. In 1956 Werner had decided to leave his research on *Phycomyces* and start to work on the central nervous system of insects. By around 1958 the work on motion perception of the beetle *Clorophanus* had found such agreement between theory and experimental results that Werner and his coworkers – mainly B. Hassenstein and D. Varju – considered the problem solved. Thus Werner started to work on lateral inhibition in the *Limulus* eye, following the lead of Hartline and Ratliff. In the meantime offers by CalTech, MIT and Bell Labs triggered in 1960 a counteroffer by the Max-Planck-Gesellschaft that Werner accepted: in 1963 he started his own department in the Max-Planck-Institut für Biologie. In 1968 this department became, with the nomination of three other directors – V. Braitenberg, K. Goetz and K. Kirschfeld – the Max-Planck-Institut für Biologische Kybernetik.

Early on, Werner had decided to choose a system for studying visual information processing that was neither too simple – like *Phycomyces* – nor too complex – like the human brain. The choice was obvious: the fly's brain, with its 10^6 neurons, is halfway on a logarithmic scale between unicellular organisms and man.

I was fortunate enough to participate at a quite early stage in the work on the fly in Werner Reichardt's group. The experimental work on the fly's visual system, mainly using behavioural and physiological techniques, led to theories and models at three levels: the phenomenological theory of flight behaviour, the algorithms for detection of motion and relative motion, and the underlying neural circuitry. Werner had discovered that flies fixate, that is fly towards, small dark objects. He had used a sophisticated flight simulator in which a flying fly could be held fixed while its torque, measured by a very sensitive device, developed by his longtime friend and colleague Karl Goetz, controlled the visual environment, thereby simulating a free flight situation. In this way Werner was able to experimentally study and quantify the fixation behaviour. He had also developed a model of it which we further extended into a quantitative description of a control system capable of accounting for the main features of fixation, tracking and chasing in flies. The equations could, in fact, predict in a satisfactory way the free-flight trajectory of one fly chasing another! Werner had also discovered experimentally that flies could detect discontinuities in the motion field and thereby distinguish figure from ground on the basis of relative motion. Part of the theoretical and experimental work between 1984 and 1988 was devoted to characterizing the properties of the algorithm used by the fly's visual system to detect relative motion, in a way similar to what Werner had done 35 years earlier in the case of motion detection. The interplay of experiments and theory led to a class of models that were of a higher nonlinear order than the motion detection models and could be characterized as a special form of nonlinear lateral inhibition between motion detectors. Once this work was more or less concluded, the obvious next stage was to study the actual neural circuitry and biophysical mechanisms responsible for the detection of motion discontinuities, beyond the description we already had in terms of functional blocks. A model describing the basic skeleton of a neural circuitry was derived from experimental data and further refined through quantitative experiments. It led to remarkable physiological experiments which are still under way in the hands of Werner's collaborators and that have substantiated several of the basic predictions of the original model while revealing its precise actual features.

I believe that Werner Reichardt's many experimental and theoretical discoveries add up to one of the most elegant contributions to modern neurobiology and represent one of the very few success stories of computational neurobiology. Mainly because of its focus on insects, Werner's work was not in the mainstream of neuroscience and is not as widely known as it deserves. He and the institute he founded, however, had a profound influence in forming a new generation of researchers in Europe and even in the US. Werner had old and deep connections with the main neuroscience laboratories at times when the word neuroscience was almost unknown. He was an early member of Frank Schmitt's Neuroscience Research Program, which had a lasting influence in shaping the emerging field of neuroscience and in bringing together some of its creators. He was member of many academies in Germany, member of the prestigious order "Pour le mérite", foreign member of the National Academy of Sciences and of the American Philosophical Society, and recipient (with his friend B. Julesz) of the Heineken prize of the Royal Dutch Academy in 1985. Werner Reichardt's most lasting legacy is his emphasis on coupling experimental and theoretical work in the neurosciences: without close interaction with experiments, theory is very likely to be sterile. This is a lesson that we should not forget.

For me and for others, Werner Reichardt was a very close and precious friend. I always admired his intellectual honesty and his courage; he was somebody you could always trust in the small and the great needs of life. Science as a whole, not only this journal, has lost one of its great personalities. Werner's many friends have lost a wonderful human being whom they will never forget.

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