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**From Pavlov to EEG Biofeedback**

The achievements of Polish scientists who have undertaken the subject of the conditioning processes underlying the operation of the therapeutic method known as biofeedback, have been enormous; particularly the biologists from the Nencki Institute in Warsaw.

The very word biofeedback means a biological return loop, which is to say, providing human beings with information about the physiological state of the world they experience. Of course we carry out on-going measurements of physiological parameters using so-called psycho-physiological sensors, e.g. those for measuring: body temperature, respiratory rate, skin conductivity, muscle tone, heart rate, or brainwaves. Thanks to the advances in technology and computation, such measurement is now widely available. Biofeedback as a therapeutic method comprises of the administration to the patient of feedback signals, in the form of rewards, for obtaining the desired physiological states. Thanks to the process of operant conditioning (learning) this state becomes fixed in the memory of a human. The rewarding of neutral stimulus becomes a conditioned factor – a learned reaction to a stimulus that was originally neutral to us – or else learned (so-called psycho-physiological) state that we want to exercise, such as attention span.

When speaking today about the processes of conditioning (including the inhibiting and promoting of bioelectrical brain waves on which EEG biofeedback is based) we most usually reference the scientific achievements of American brain researchers. Not much is said about our fellow Poles who, through their research, have made significant contributions to the creation of the therapeutic method of biofeedback. I am thinking here of two scientists from the Nencki Institute in Warsaw, Prof. Jerzy Konorski and Prof. Wanda Wyrwicka.

The Nencki Institute of Experimental Biology of the Polish Academy of Sciences has great scientific traditions, particularly in the field of neurobiology. It was created in 1918, just after the First World War, when Poland had regained its independence from occupation, and the long and tragic years it rendered on the development of Polish science. In 1911, the Management Board of the Warsaw Scientific Society decided to create an Institute of Biology named after Marcel Nencki. Even then the Institute had a neurobiology laboratory, headed by the memorable Prof. Edward Flatau. The

undisputed heyday of the laboratory came in the years after World War II, when its director was prof. Jerzy Konorski. Although during the Second World War, the Germans completely destroyed the institute, even tearing down the building, all the activities were taken up again, with full determination, from scratch. From 1947, the institute temporarily began new research in the city of Łódź. Prof. Konorski, who at the beginning of his professional career had studied psychology and medicine, directed the work of the neurobiology laboratory. As early as the third year of his medical studies, Professor Jacob Segal was conducting independent experiments at the Warsaw laboratory of psychology with his colleague Stefan Miller. For example, on the 1<sup>st</sup> of February 1928, they conducted an interesting experiment. This consisted of conditioning a dog to react to the sound of a pump organ and the light of a lamp. Konorski and Miller then informed the world renowned Soviet physiologist Ivan Pavlov of the results of his experiment. Pavlov was very interested in the Poles' research and, in 1931, invited them to his laboratory in Leningrad. As a consequence, Prof. Konorski studied under Pavlov for three years and carried out research on the processes of conditioning at the Soviet Union Academy of Sciences. Only a few years later, after the outbreak of the Second World War, fate once again threw the professor into the territory of the USSR, where he and his wife (the biologist Liliana Lubińska) conducted research on the regeneration of nerve fibers. Nonetheless, we will concentrate on the research work of the professor, which concerned the physiological processes of conditioning. For in 1957, Prof. Konorski began intensive cooperation with neurophysiology research centres in the USA. Konorski and his students recorded spectacular achievements in the field of neurobiology during the years of scientific research carried out jointly with the Section on Neuropsychology at the National Institute of Mental Health (USA), directed by Dr. Halvord E. Rosvold, a neuropsychologist and later professor of neuroscience at the Yale School of Medicine.

One of the people to whom Prof. Konorski turned to for scientific cooperation with the Americans was the biologist Dr Wanda Wyrwicka. She would deal with biofeedback at the Nencki Institute under his leadership. The doctor, though inconspicuous and quiet in appearance, was known for her extraordinary creativity in the design of various types of experiments. For example, Prof. Wyrwicka (who received her title at the Nencki Institute), led an experiment (although now in California) to teach a cat to eat unusual food, by rewarding it with stimulation to the pleasure centre of the brain. In addition, she observed the behaviour of the subject cat's kittens, and whether they would emulate their mother's gastronomic example. Earlier, in the 1950s, while still at the Nencki Institute, Dr. Wyrwicka had conducted experiments on goats involving the formation of a conditioned digestive reflex when sated.

Owing to the great authority of Prof. Konorski in the scientific world, he and his students were repeatedly invited to collaborate with leading research institutes in the field of neurobiology and medicine, most often in the USA. At the end of 1962, it was Prof. Wyrwicka who first visited Yale University to conduct research with Dr. Neil E. Miller, an experimental psychologist, and biofeedback pioneer in America. In 1966, Prof. Wyrwicka returned to the US invited by the University of California in Los Angeles. While there (now to stay) she started collaboration with Dr. Maurice B. Sterman to prove that the human brain can be trained on the basis of instrumental conditioning and bioelectrical brain waves – the EEG Biofeedback method.

Dr. Sterman's experimental studies, and his cooperation with NASA in this area, are quite well known in Poland among those interested in the subject biofeedback.

The historical background behind the establishment of EEG Biofeedback clearly points to a multi-generational collaboration among researchers in the fields of biology, psychology, and medicine. Thanks to their uncommon commitment to scientific work, their openness and communication, and despite unfavourable external conditions (the period of Poland's isolation from the world) it became possible to develop the interdisciplinary practice of EEG Biofeedback. Today we must remember that many people of good will, therapists from around the world, have trained in this method in attempts to reliably help their patients using EEG biofeedback, the principle of which (the operant conditioning of bioelectrical brain waves) has a very solid scientific foundation directly related to the academic work of many prominent scientists. Many, as it turns out, from our homeland as well.

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## Abstract

The study presents achievements of Polish scientists in the field of EEG Biofeedback method. Thanks to them the interdisciplinary character of this method was developed. EEG Biofeedback method is based on solid scientific research of many outstanding academic scientists, also these from Poland. The rules of how EEG Biofeedback works are conditioned by science (operant conditioning of the brainwaves). Currently the method is used by many scientists, therapists and health care professionals all over the world in order to help patients and clients.

**Key words:** EEG Biofeedback, operant conditioning, cooperation

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