

Past and present of the Department of Neurophysiology in the Nencki Institute

Bogusław Żernicki *

Department of Neurophysiology, Nencki Institute of Experimental Biology, 3 Pasteur St.,
02-093 Warsaw, Poland

The Department of Neurophysiology was founded in the Nencki Institute in 1946. At that time the Institute was located in Łódź, since Warsaw had been destroyed during the war. The founders of the Department were Jerzy Konorski and Liliana Lubińska, the pre-war Institute's workers. Konorski, the head of the Department, was a pioneer in investigations on instrumental conditioning. Within a few years he was joined by a group of about 15, mostly very young collaborators: a second generation of the Department's workers. The first Konorski's associates were: Zofia Afelt, Stefan Brutkowski, Elżbieta Fonberg, Włodzimierz Kozak, Waclawa Ławicka, Irena Łukaszewska, Irena Stępień, Genowefa Szwejkowska (a pre-war Institute's worker), Wanda Wyrwicka and Andrzej Zbrożyna. Their research was mainly devoted to various aspects of conditioning in dogs. This fitted the name of the Department since according to Pavlovian tradition, the conditioned-reflex investigations represent a part of physiological research.

In the middle fifties the Institute moved back to Warsaw, to a new, large building. About the same time the iron curtain was cracked in Poland and our west frontier became more open. Simultaneously the east frontier also became easier to cross. We began traveling frequently and many foreign scientists visited us. In consequence, the Department gradually lost its monolithic, conditioned-reflex profile, reacting rapidly to new tendencies in the international neuroscience. Visual, motor, psychophysiological and developmental investigations were introduced. In addition, the ethological group and later on the Laboratory of Neurochemistry (headed by Stella Niemierko, a pre-war Institute's worker) joined us from other departments of the Institute.

In the early seventies Polish authorities offered more money for science and for the second time after the war many new positions became available in the Institute. Konorski's pupils were joined by about 20 young researchers: a third generation of workers appeared in the Department. Some of them (Anna Grabowska, Małgorzata Kossut, Andrzej Wróbel, Jolanta Zagrodzka) are at present the heads of laboratories in the Department.

In 1973 Jerzy Konorski died and I succeeded him as the head of the Department. It was rather difficult to succeed a great leader and to direct the Department which was rapidly changing. However, I was fortunate to receive the help of several colleagues. I especially owe much to Irena Stępień and later to Jolanta Zagrodzka. I have also received important encouragement from two distinguished foreign colleagues, Jerzy Rose and Eliot Stellar.

Although large, the Department has remained well integrated. Our common roots are certainly one

* Prof. B. Żernicki has led the Department of Neurophysiology for almost thirty years (1973-2001). His contribution to the scientific development of the Department was memorized after his death (2002) in vol. 62, issue 2 of *Acta Neurobiologiae Experimentalis*.

of the important reasons of integration. The Department's Wednesday seminars are excellent forum for discussion of our results. Last but not least we help each other in many respects. For example, Anna Kosmal is always ready to help in neuroanatomy and Kazimierz Zieliński in statistics.

We are fortunate that our Department is a part of the Nencki Institute. First, the development of various biological techniques in the Department make important contacts with three remaining Institute's departments: the Department of Cellular Biochemistry, the Department of Muscle Biochemistry and the Department of Cell Biology. Second, the Institute provides outstanding facilities for our work. In particular, we have an excellent animal house (headed by Maria Walkowska, previous Department's member) and library with almost all neuroscience journals.

The Department has always maintained vivid contacts with other neuroscience laboratories in Poland. Moreover, in some fields it has played an integrative role, e.g., we coordinated a number of large neuroscience programs in Poland. We have maintained particularly close cooperation with the Department of Neurosurgery, Medical Research Centre (headed by Lucjan Stepień, who was also the member of our Department, and later by Eugeniusz Mempel), the Department of Bionics, Institute of Biocybernetics and Biomedical Engineering (headed by Ryszard Gawroński and later by Wojciech Zmysłowski), the Department of Anatomy, Medical Academy in Gdańsk (headed by Olgierd Narkiewicz) and the Department of Animal Physiology, University of Łódź (headed by Andrzej Romaniuk).

We have also been collaborating with many foreign laboratories. About 250 foreign guests presented their results in the Department, some of them visit us every few years. We had about 50 foreign visitors, from East and West, working in the Department for at least three months. Some of our long-term and/or frequent visitors influenced strongly our work. Among these are: Jim Brennan, Ivan Divac, George Gerstein, Pawel Hnik, Adrian Morrison, Tomasz Radil, Guy Santibanez and Jeffrey Wilson. We also owe a lot to some other foreign friends: Giorgio Bignami, Roberst Brush, Jan Bureš, Pierre Buser, Robert W. Doty, Giuseppe Moruzzi, Giancarlo Pepeu, Steve Rose, Pavel Simonov, Jim Sprague, Michael Stewart, Holger Ursin and Clinton Woolsey. Many collaborations and the participation of many our workers in the international conferences were sponsored by international organizations, in particular by IBRQ and the European Training Programme in Brain and Behaviour Research. The Department publishes a well established international journal *Acta Neurobiologiae Experimentalis* (until 1970, its title was *Acta Biologiae Experimentalis*).

We have very close relations with the Laboratory of Neuropsychology in Bethesda and the Institute of Neurological Sciences in Philadelphia. A number of NIH projects with these institutions (in Bethesda the project officers were H. Enger Rosvold, Patricia Goldman-Rakic and Mortimer Mishkin, and in Philadelphia, William Chambers and Eliot Stellar) had an important mutual impact. In the years 1958-1988 working conferences were organized every three years by our Department, the Institute of Higher Nervous Activity and Neurophysiology in Moscow and the Institute of Physiology in Prague. Jerzy Konorski, Ezras Asratyan and Ernest Gutmann were the organizers of the first conference held in Poland.

The Department is a place where Western and Eastern neuroscientists meet frequently. This particularly happens during international symposia organized by the Department. A good example is "The Warsaw colloquium on instrumental conditioning and brain research" (see Żernicki and Zieliński 1979), where half of the participants were from Eastern and half from Western countries. Many of our workers moved abroad for various reasons, not only scientific, but also political, personal and financial as the funds for conducting research are scarce and the wages of scientists ridiculously low in Poland. The majority of these colleagues remained scientifically active and stay in close contact with us. These are: Marek Celiński, Jan Bruner, Jolanta Chmielowska, Bogdan Dreher, Bella Harutiunian-Kozak, Krystyna Jabłonowska-Ciesielski, Elżbieta Jankowska, Paweł Jastreboff, Lech Kiedrowski, Ewa Kostarczyk, Włodzimierz Kozak, Grażyna Markow-Rajkowska, Alicja Markowska, Zygmunt Pizło,

Anna Potempska, Janusz Rajkowski, Ewa Rożkowska-Ruttiman, Stanisław Sobótka, Stefan Sołtysik, Bolek Srebro, Iwona Stępniewska, Jolanta Ułas, Klaudiusz Weiss, Andrzej Wieraszko, Wanda Wyrwicka and Andrzej Zbrożyna. At the 75th anniversary of the Institute we were not in the position to invite our numerous foreign friends because of financial limitations. However, we invited previous members of the Institute and many of them could attend the anniversary conference.

A number of Department's workers died. It was particularly difficult to accept the death of these who left as young persons. These were Stefan Brutkowski, Jadwiga Dąbrowska and Renard Korczyński.

The Department has obtained important results in the majority of fields of neuroscience, but it is concentrated on various aspects of neural plasticity (learning and memory, development driven by sensory stimulation, recovery of function after brain damage). It is beyond the scope of this article to review systematically the Department's achievements. I will only mention some representative results, characterizing the past and the present lines of research. Many of our papers were published in *Acta Neurobiologiae Experimentalis*; some are in the proceedings of symposia organized by the Department (Konorski et al. 1972, Doty et al. 1973/1974, Żernicki and Zieliński 1979/1980, Oderfeld-Nowak et al. 1990). Some of our results were described in detail in Konorski's monograph (1967) and in review papers (Brutkowski 1965, Konorski 1968, Fonberg 1986, Żernicki 1986, 1991, Kossut 1992).

Conditioning. Konorski (1948) presented a concept of neuronal plasticity and a concept that the mechanism of conditioned reflexes is based on the Sherringtonian principles of functioning of the central nervous system. Konorski and Szwejkowska (1952) described the principle of the primacy of the first conditioned-reflex training. Wyrwicka (1952) provided evidence that there are double connections linking the "center" of the conditioned stimulus with the "center" of the instrumental motor act; one of them is indirect, through the drive "center". Tarnecki (1962) demonstrated that it is easy to instrumentalize a movement elicited by electrical stimulation of the sensory cortex but not the motor cortex. Sołtysik and Kowalska (1960) determined the relations between classical and instrumental components in defensive conditioning. Górska and Jankowska (1961) found that proprioceptive feedback plays a minimal role in the instrumental conditioned reflex. Walasek et al. (in press) found a bidirectional effect of novel stimuli on the bar pressing response in rats. Łukaszewska and Niewiadomska (in press) found that discrimination learning is better in spontaneously hypertensive rats than in normotensive controls. Dobrzańska (1978) described social learning in ants and Godzińska et al. (1992) rapid escape learning in bumblebees.

Prefrontal cortex. It was found that after prefrontal lesions in dogs the inhibitory conditioned reflexes are disinhibited (Brutkowski et al. 1956, Dąbrowska 1972, Brennan et al. 1976). Zieliński (1972) showed that the short-latency avoidance responses are severely impaired in prefrontal cats. Stępień (1974) found that in prefrontal dogs the response to the conditioned stimulus location is enhanced. Dreher and Żernicki (1969) described the impairment of habituation of the ocular orienting reflex in prefrontal cats. Ławicka and Konorski (1959) and Stasiak and Ławicka (1990) found, respectively, that following prefrontal lesions in dogs the delayed responses and responses in the Konorski Test for short-term memory are impaired. Kosmal and associates (Kosmal 1981, Markow-Rajkowska and Kosmal 1987) described the distribution of afferents to frontal cortex in dogs.

Memory. Konorski (1967) presented a concept of gnostic units. Budohoska et al. (1973) described different mechanisms for immediate and short-term memory in man. Łukaszewska (1985) determined properties of the short-term memory of a visual change in rats. Nikolaev et al. (1992) documented increased expression of the c-fos mRNA in rat brain in learning-related phenomena and Kaczmarek (1993) formulated a hypothesis that gene regulatory regions play an important role in the integration of information during long-term memory formation.

Limbic system. Fonberg (1958) presented a concept on the role of fear in neurotic states. Fonberg and associates (see Fonberg 1986) discovered the inhibitory and excitatory role of two antagonistic parts of amygdala in motivation, emotional disorders and conditioned responses. Zagrodzka and Fonberg (1978) determined neural mechanism of the predatory behavior in cats. Kostarczyk and Fonberg (1982) determined the role of autonomic changes in the mechanisms of alimentary and social rewards in dogs. Werka and Marek (1990) found that amygdala is strongly involved in the control of post-stress analgesia. Srebro et al. (1973) showed that the destruction of specific septal nuclei evoked the degeneration of cholinergic fibers in the hippocampus.

Sensory systems. Using behavioural and electrophysiological methods Grabowska (1983) and Sobótka et al. (1984) showed in man that visual information is differently processed and stored in the left and right hemispheres. Walerjan and Tarnecki (1991) developed a new mapping technique for analysis of cerebral electrical activity in man. Harutiunian et al. (1970) and Turlejski (1975) described visual single unit responses in the tecto-pretectal region and in the lateral suprasylvian cortex, respectively, in the awake cat's cerebrum. Dec et al. (1978) described visual responses in cat's isolated midbrain. Wróbel (1982) proposed a new model for the circuitry of the lateral geniculate body and Wróbel et al. (1994) found the specific activity within beta frequency band (about 20 Hz) appearing in the cat's visual cortex and lateral geniculate nucleus during attentive visual behaviour. Dobrzecka et al. (1965) found direct sensori-motor pathway in dog's cerebral cortex for the "specific tactile stimulus". Chmielowska et al. (1986) mapped the vibrissal projections to the first somatosensory cortex of mice with 2-deoxyglucose and with this technique Kossut and Siucińska (1993) discovered reversible changes in the cortical body maps of vibrissal receptors resulting from classical conditioning training that involved stimulation of vibrissae. Korda (1974) described critical factors determining parental behavior in dogs. Chmurzyński (1964) identified mechanisms underlying stages of spatial orientation in the digger wasp *Bembix rostrata*.

Motor system. Afelt et al. (1975) and Górska et al. (1993) described postural and locomotor deficits in cats with spinal lesions. Using a new recording technique Błaszczuk and Dobrzecka (1989) determined principles of limb coordination in dogs. Kasicki et al. (1991) described two locomotor strips in cat's diencephalon. Czarkowska-Bauch (1990) found common spinal mechanism of the tactile placing and stumbling in cat. Kałużny and Tarnecki (1993) developed a new method for the analysis of dynamics of spike trains in neuronal networks of cat's cerebellum and red nucleus.

Development. Jabłonowska and Budohoska (1976), Kołtuska and Grabowska (1992) and Szeląg et al. (1992) provided evidence that brain lateralization develops in ontogenesis and can be influenced by individual experience. Wyrwicka (1959) and Ławicka (1989) described impairment of the detour behaviour and delayed response learning, respectively, in cage-reared animals. Zabłocka et al. (1980) found that in cats deprived visually in the early period of life, the role of the superior colliculus in visual learning is increased. Michalski et al. (1984) found that one of the ways in which visual deprivation affects neuronal responses is by altering the interneuronal connectivity in primary visual cortex. Głazewski et al. (1992) found a correlation between functional plasticity of the barrel cortex and the development of mature activity of voltage dependent calcium channels and NMDA receptors. Dobrzański (1971) described rapid manipulatory learning in young ants.

Recovery from brain damage. Ślósarska and Żernicki (1971) found that the sleep-waking cycle recovers in chronic pretrigeminal and cerveau isolé cats. Oderfeld-Nowak et al. (1984) found in rats that administration of exogenous gangliosides facilitates recovery from brain damage.

Peripheral nervous system. Lubińska, Niemierko and associates (Lubińska et al. 1963, Lubińska and Niemierko 1971) discovered bidirectional flow of the axoplasm. Skangiel-Kramaska and Niemierko (1975) found the soluble form of acetylcholinesterase in peripheral nerves.

TABLE 1

 Current research of the Department's members with Ph.D.

BŁASZCZYK Janusz	Long term potentiation, brain slices.
BUDOHOSKA Wanda	Hemispheric differences in visual perception in man.
CHMURZYŃSKI Jerzy	Spatial and sexual orientation in insects. General ethology. Biological roots of culture, esp. aesthetic phenomena.
CZARKOWSKA Julita	Segmental cutaneous reflexes. Hoffmann reflex in awake animals. Plasticity of the monosynaptic reflex.
DJAVADJAN Rouzanna	Connections of visual areas in cat. Serotonin in development.
DEC Krystyna	Electrophysiological investigations of the visual system in cats.
FONBERG Elżbieta	The role of amygdala and hypothalamus in alimentary and social behavior, aggression and experimental neuroses. Pharmacological investigations.
GODZIŃSKA Ewa	Ethological analysis of learning processes in social insects (ants and bumblebees).
GÓRSKA Teresa	Locomotion after spinal lesions.
GRABOWSKA Anna	Psychophysiology of vision in man. Neurosurgical patients. Hemispheric differences.
KACZMAREK Leszek	Molecular basis of neuronal plasticity. Learning and memory.
KALUŻNY Paweł	Computational neuroscience, neural networks, electrophysiology.
KASICKI Stefan	Locomotion, EMG and EEG investigations.
KOSMAL Anna	Neuroanatomical and histochemical investigations of the associative cortex and limbic system.
KOSSUT Małgorzata	Cortical plasticity in visual and somatosensory systems.
KOWALSKA Danuta	Cerebral structures involved in recognition memory.
ŁAWICKA Wacława	Prefrontal cortex. Short-term memory. Auditory targeting reflexes.
ŁUKASZEWSKA Irena	Learning and memory. Cholinergic system.
MICHALSKI Andrzej	Single neuron recording from the visual cortex.
NIEMIERKO Stella	Acetylcholinesterase in peripheral nerves and in CNS.
NIEWIADOMSKA G.	Neurochemical and morphological correlates of the basal forebrain cholinergic system in adult and ageing brain.
NOWICKA Anna	Visual evoked potentials, interhemisphere transmission of information, hemispheric specialization.
ODERFELD-NOWAK B.	Biochemical aspects of recovery from brain damage; neuron-glial interactions; effects of gangliosides and neurotrophic factors.
SKANGIEL-KRAMSKA J.	Neurochemical correlates of brain plasticity. Neurotransmitter receptors. Quantitative auto-radiography.
SKUP Małgorzata	
STASIAK Maciej	Neuronal death and recovery after brain damage: mechanism of trophic responses.
SZELAĞ Elżbieta	Neurogenesis in the adult brain.
TARNECKI Remigiusz	Memory, behavioral tests; prefrontal and temporal cortex. Visual deprivation. Time perception, speech disorders, hemispheric differences.
TURLEJSKI Krzysztof	Visuomotor coordination, electrophysiological investigations. Computer techniques in electrophysiology.
WALASEK Grażyna	
WERKA Tomasz	Cortical development and plasticity. Serotonin in development. Evolution of the CNS. Interrelations between alimentary and defensive stimuli.
WĘSIERSKA Małgorzata	Functional recovery from cerebral lesions. The role of limbic system in defensive behavior.
WRÓBEL Andrzej	Antagonism between fear and alimentary drive in the CER method. Conditioned inhibitor. Strategies of responding.
ZABŁOCKA Teresa	Visual system, electrophysiological investigations.
ZAGRODZKA Jolanta	Visual deprivation, behavioral investigations.
ŻERNICKI Bogusław	Predatory and aggressive behavior in cats and rats; pharmacological and chirurgical manipulations.
ZIELIŃSKI Kazimierz	Visual deprivation. Pretrigeminal preparation. Ocular-fixation reflex. Strategies of conditioning. Defensive conditioning. Stimulus control. Prefrontal cortex.

The current research interests of individual Department's members can be found in Table I. A few of these researchers and 15 not listed young fellows working for the Ph.D. constitute a fourth generation of researchers of the Department.

A large group of highly experienced and devoted technical workers contributed greatly to the progress of the Department. A few of them are: the late Antoni Rosiak, animal caretaker, the late engineer Józef Folga, the late Ewa Stajudowa, the managing editor of *Acta Neurobiologiae Experimentalis* and Maria Rauowicz, the retired worker of the surgery room.

At present 12 laboratories constitute the Department of Neurophysiology: Laboratory of Visual Perception (head, Bogusław Żernicki), Laboratory of Afferent Systems (head, Remigiusz Tarnecki), Laboratory of Psychophysiology (head, Anna Grabowska), Laboratory of Defensive Conditioned Reflexes (head, Kazimierz Zieliński), Laboratory of Cortical Plasticity (head, Małgorzata Kossut), Laboratory of the Limbic System (head, Jolanta Zagrodzka), Laboratory of Motor Control (head, Teresa Górka), Laboratory of Neurochemistry (head, Barbara Oderfeld-Nowak), Laboratory of Ethology (head, Jerzy Chmurzyński), Laboratory of Neuroanatomy (head, Anna Kosmal), Laboratory of Visual System (head, Andrzej Wróbel) and Laboratory of Molecular Basis of Brain Plasticity (head, Jolanta Skangiel-Kramaska). In addition, Tissue Culture Unit (head, Leszek Kaczmarek) is scientifically a part of the Department.

The Department is a large, interdisciplinary and active neuroscience center. The presence of various lines of neurobiological research in the Department as well as a large and experienced group of researchers in other Institute's departments form a fertile ground for cross-breeding of ideas and borrowing of techniques. The new generation of neuroscientists grows in this unique multidisciplinary environment that is most suitable for modern neuroscience.

I thank Wacława Ławicka, Krzysztof Turlejski and Kazimierz Zieliński for comments.

REFERENCES

- Afelt Z., Kasicki S., Sybirska E., Zagrodzka J. (1975) Limb coordination during locomotion in amygdalar, rubral and funicular preparations. *Acta Neurobiol. Exp.* 35: 379-388.
- Błaszczak J., Dobrzecka C. (1989) Speed control in quadrupedal locomotion: principles of limb coordination in the dog. *Acta Neurobiol. Exp.* 49:105-124.
- Brennan J., Kowalska D., Zieliński K. (1976) Auditory frequency generalization with differing extinction influences in normal and prefrontal dogs trained in instrumental alimentary reflexes. *Acta Neurobiol. Exp.* 36: 475-516.
- Brutkowski S. (1965) Functions of prefrontal cortex in animals. *Physiol. Rev.* 45: 721-746.
- Brutkowski S., Konorski J., Ławicka W., Stępień L. (1956) The effect of removal of frontal lobes of the cerebral cortex on motor conditioned reflexes. *Acta Biol. Exp.* 17: 167-188.
- Budohoska W., Czachowska-Małycha B., Jarymowicz J., Szymański L. (1973) Immediate and short memory: recall of simple auditory stimuli. *Acta Psychol.* 37: 341-349.
- Chmielowska J., Kossut M., Chmielowski M. (1986) Single vibrissal cortical column in the mouse labeled with 2-deoxyglucose. *Exp. Brain Res.* 63: 607-619.
- Chmurzyński J. (1964) Studies on the stages of spatial orientation in female *Bernbex rostrata* (Linné 1758) returning to their nests (Hymenoptera, Sphegidae). *Acta Biol. Exp.* 24: 103-132.
- Czarkowska-Bauch J. (1990) Movement and muscle activity during contact placing of the forelimb and their relations to other postural reactions in the cat. *Exp. Brain Res.* 79: 373-382.
- Dąbrowska J. (1972) On the mechanism of go-no go symmetrically reinforced task in dogs. *Acta Neurobiol. Exp.* 32: 345-359.
- Dec K., Tarnecki R., Żernicki B. (1978) Single unit responses to moving spots in the superior colliculus of the cat's isolated midbrain. *Acta Neurobiol. Exp.* 38: 289-303.
- Dobrzańska J. (1978) Problem of behavioral plasticity in slave-making amazon-ant *Polvergus rufescens* Latr. and in its slave-ants *Formica fusca* L. and *Formica cinerea* Mayr. *Acta Neurobiol. Exp.* 38: 113-132.

- Dobrzański J. (1971) Manipulatory learning in ants. *Acta Neurobiol. Exp.* 31: 111-140.
- Dobrzecka C., Sychowa B., Konorski J. (1965) The effects of lesions within the sensori-motor cortex upon instrumental response to the "specific tactile stimulus". *Acta Biol. Exp.* 25: 61-69.
- Doty R.W., Konorski J., Żernicki B. (Eds.). *Brain and behavior. Acta Neurobiol. Exp. Part A* (1973) 33: 663-827. *Part B* (1974) 34: 5-2 14.
- Dreher B., Żernicki B. (1969) Studies on the visual fixation reflex. III. The effects of frontal lesions in the cat. *Acta Biol. Exp.* 29: 153-173.
- Fonberg E. (1958) The manifestation of the defensive reactions in neurotic states. *Acta Biol. Exp.* 18: 89-116.
- Fonberg E. (1986) Amygdala, emotions, motivation, and depressive states. In: *Emotion theory, and experience. Vol. 3 Biological functions of emotion* (Eds. R. Plutchik and H. Kellerman). Academic Press, Inc., Orlando, p. 301-331.
- Głazewski S., Skangiel-Kramska J., Pomorski P., Kossut M. (1992) Voltage-dependent L-type calcium channels in the development and plasticity of mouse barrel cortex. *Dev. Brain Res.* 67: 293-300.
- Godzińska E., Kieruzel M., Korczyńska J. (1992) Rapid escape learning in the bumblebee *Bombus lapidarius* L. *Acta Neurobiol. Exp.* 52: 173.
- Górska T., Bern T., Majczyński H., Zrnysłowski W. (1993) Unrestrained walking in cats with partial spinal lesions. *Brain Res. Bull.* 32: 24 1-249.
- Górska T., Jankowska E. (1961) The effect of deafferentation on instrumental (type II) conditioned reflexes in dogs. *Acta Biol. Exp.* 21: 219-234.
- Grabowska A. (1983) Lateral differences in the detection of stereoscopic depth. *Neuropsychologia* 21: 249-257.
- Harutiunian-Kozak B., Kozak W., Dec K. (1970) Analysis of visually evoked activity in the pretectal region of the cat. *Acta Neurobiol. Exp.* 30: 233-262.
- Jabłonowska K., Budohoska W. (1976) Hemispheric differences in the visual analysis of the verbal and non-verbal material in children. *Acta Neurobiol. Exp.* 36: 693-701.
- Kaczmarek L. (1993) Molecular biology of vertebrate learning: Is c-fos a new beginning? *J. Neurosci. Res.* 34: 377-381.
- Kałużny P., Tarnecki R. (1993) Recurrence plots of neuronal spike trains. *Biol. Cybern.* 68: 527-534.
- Kasicki S., Korczyński R., Romaniuk J.R., Sławińska U. (1991) Two locomotor strips in the diencephalon of thalamic cats. *Acta Neurobiol. Exp.* 51: 137-143.
- Kołoska B., Grabowska A. (1992) Instability of hemispheric asymmetry in dyslexic children. *Acta Neurobiol. Exp.* 52: 23-29
- Konorski J. (1948) *Conditioned reflexes and neuron organization.* Cambridge Univ. Press, Cambridge, 267 p.
- Konorski J. (1967) *Integrative activity of the brain. An interdisciplinary approach.* Univ. Chicago Press, Chicago, 531 p.
- Konorski J. (1968) A review of the brain research carried out in the Department of Neurophysiology of the Nencki Institute of Experimental Biology. *Acta Biol. Exp.* 28: 257-289.
- Konorski J., Szwejkowska G. (1952) Chronic extinction and restoration of conditioned reflexes. IV. The dependence of the course of extinction and restoration of conditioned reflexes on the "history" of the conditioned stimulus. (The principle of the primacy of first training). *Acta Biol. Exp.* 16: 95-113.
- Konorski J., Teuber H.-L., Żemicki B. (Eds) (1972) *The frontal granular cortex and behavior.* *Acta Neurobiol. Exp.* 32: 115-656.
- Korda P. (1974) Empimeletic (care-giving) vomiting in dogs: a study of the determining factors. *Acta Neurobiol. Exp.* 34: 277-300.
- Kosmal A. (1981) Subcortical connections of the prefrontal cortex in dogs: afferents to the medial cortex. *Acta Neurobiol. Exp.* 41: 339-356.
- Kossut M. (1992) Plasticity of the barrel cortex neurons. *Progr. Neurobiol.* 39: 389-422.
- Kossut M., Siucińska E. (1993) Short-lasting classical conditioning and extinction produce changes of body maps in somatosensory cortex of mice. *Soc. Neurosci. Abstr.* 19: 69.
- Kostarczyk E., Fonberg E. (1982) Heart rate mechanisms in instrumental conditioning reinforced by petting in dogs. *Physiol. Behav.* 1: 27-30.
- Ławicka W. (1989) Delayed response to light stimuli in binocularly deprived cats. *Acta Neurobiol. Exp.* 49: 73-92.
- Ławicka W., Konorski J. (1959) Physiological mechanism of delayed reactions. III. The effects of prefrontal ablations on delayed reactions in dogs. *Acta Biol. Exp.* 19: 221-231.
- Lubińska L. (1975) On axoplasmic flow. *Int. Rev. Neurobiol.* 17: 241-196.
- Lubińska L., Niemierko S. (1971) Velocity and intensity of bidirectional migration of acetylcholinesterase in transected nerves. *Brain Res.* 27: 329-342.
- Lubińska L., Niemierko S., Oderfeld B., Szwarz L., Zelená J. (1963) Bidirectional movements of axoplasm in peripheral nerve fibers. *Acta Biol. Exp.* 23: 239-247.
- Łukaszewska I., Dławichowska E. (1985) Scopolamine impairs the response-to-change following observation of the environment but not after its exploration by the rat. *Physiol. Behav.* 34: 625-629.

- Łukaszewska I., Niewiadomska G. (1994) The differences in learning abilities between spontaneously hypertensive (SHR) and Wistar normotensive rats are cue dependent. *Behav. Neurol. Biol.* (in press).
- Markow-Rajkowska G., Kosmal A. (1987) Organization of cortical afferents to the frontal association cortex in dogs. *Acta Neurobiol. Exp.* 47:137-161.
- Michalski A., Kossut M., Chmielowska J., Turlejski K. (1984) Cross-correlation analysis of intracolumnar neuronal connectivity in area 17 of binocularly deprived cats. *Acta Neurobiol. Exp.* 44:1-15.
- Nikolaev E., Kamińska B., Tischmeyer, Matthies H., Kaczmarek L. (1992) Induction of expression of genes encoding transcription factors in rat brain elicited by behavioral training. *Brain Res. Bull.* 28: 479-484.
- Oderfeld-Nowak B., Norton W., Pepeu G., Skup M., Zieliński K. (Eds.) (1990) Recovery from brain damage: behavioral and neurochemical approaches. *Acta Neurobiol. Exp.* 50: 95-532.
- Oderfeld-Nowak B., Skup M., Ułas J., Jezierska M., Grądkowska M., Zaremba M. (1984) Effect of GM I ganglioside treatment on postlesion responses of cholinergic neurons in rat hippocampus after various partial deafferentations. *J. Neurosci. Res.* 12: 409-420.
- Skangiel-Kramska J., Niemierko S. (1975) Soluble and particle bound acetylcholinesterase and its isoenzymes in peripheral nerves. *J. Neurochem.* 24: 1135-1141.
- Ślósarska M., Żernicki B. (1971) Wakefulness and sleep in the isolated cerebrum of the pretrigeminal cat. *Arch. Ital. Biol.* 109: 287-304.
- Sobótka S., Pizło Z., Budohoska W. (1984) Hemispheric differences in evoked potentials to pictures of faces in the left and right visual fields. *Electroencephalogr. Clin. Neurophysiol.* 58: 441-453.
- Sołtysik S., Kowalska M. (1960) Studies on the avoidance conditioning. I. Relations between cardiac (type I) and motor (type II) effects in the avoidance reflex. *Acta Biol. Exp.* 20: 157-170.
- Srebro B., Oderfeld-Nowak B., Kłodos I., Dąbrowska J., Narkiewicz O. Changes in acetylcholinesterase activity in hippocampus produced by septal lesions in the rat. *Life Sci.* 12: 261-270.
- Stasiak M., Ławicka W. (1990) Behavioral recovery on a spatial variant of the Konorski Test following prefrontal damage in dogs. *Acta Neurobiol. Exp.* 50: 201-212.
- Stępień L. (1974) The magnet reaction, a symptom of prefrontal ablation. *Acta Neurobiol. Exp.* 34:145-160.
- Szeląg E., Wasilewski R., Fersten E. (1992) Hemispheric differences in the perception of words and faces in deaf and hearing children. *Scand. J. Psychol.* 33: 1-11.
- Tarnecki R. (1962) The formation of instrumental conditioned reflexes by direct stimulation of sensory-motor cortex in cats. *Acta Biol. Exp.* 22: 114-124.
- Turlejski K. (1975) Visual responses of neurons in the Clare-Bishop area of the cat. *Acta Neurobiol. Exp.* 34: 189-208.
- Walasek G., Wesierska M., Zieliński K. (1994) Habituation of the orienting response to auditory and visual stimuli in rats trained to press a bar. *Acta Neurobiol. Exp.* 54: 133-141.
- Walerjan P., Tarnecki R. (1991) Computer mapping techniques for analysis of scalp potential distribution. *Biocyber. Biomed. Eng.* 11: 91-96.
- Werka T., Marek P. (1990) Post-stress analgesia after lesions to the central nucleus of the amygdala in rats. *Acta Neurobiol. Exp.* 50: 13-22.
- Wróbel A. (1982) Inhibitory mechanisms within the receptive fields of the lateral geniculate body of the cat. *Acta Neurobiol. Exp.* 42: 93-106.
- Wróbel A., Bekisz M., Kublik E., Waleszczyk W. (1994) 20Hz bursting beta activity in cortico-thalamic system of visually attending cats. *Acta Neurobiol. Exp.* 54: 95-107.
- Wyrwicka W. (1952) Studies on motor conditioned reflexes. V. On the mechanism of the motor conditioned reaction. *Acta Biol. Exp.* 18: 175-193.
- Wyrwicka W. (1959) Studies on detour behaviour. *Behaviour* 14: 240-264.
- Zabłocka T., Żernicki B., Kosmal A. (1980) Loss of object discrimination after ablation of the superior colliculus-prepectum in binocularly deprived cats. *Behav. Brain Res.* 1:521-531.
- Zagrodzka J., Fonberg E. (1978) Predatory versus alimentary behavior after amygdala lesions in cats. *Physiol. Behav.* 20: 523-531.
- Żernicki B. (1986) Pretrigeminal preparation. *Arch. Ital. Biol.* 124: 133-196.
- Żernicki B. (1991) Visual discrimination learning in binocularly deprived cats: 20 years of studies in the Nencki Institute. *Brain Res. Rev.* 16: 1-13.
- Żernicki B., Zieliński K. (Eds.) The Warsaw colloquium on instrumental conditioning and brain research. *Acta Neurobiol. Exp. Part A* (1979) 39: 373-707. *Part B.* (1980) 40: 5-449.
- Zieliński K. (1972) Effects of prefrontal lesion on avoidance and escape reflexes. *Acta Neurobiol. Exp.* 32: 393-415.