Invited Lecture I
Human Will and Cerebral Potentials, Organization of Voluntary Movement, and Exercise and Health
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When I came to neuropsychology, a deterministic philosophy prevailed in consequence of behaviorism and Freudism. The concept of will was eliminated from psychology and jurisprudence. Physiologists investigated man as a passive system, looking at cerebral responses evoked by sensory stimuli. Believing in freedom, however, in the positive sense of creativity and reasoned will, I searched for physiological signs of volition. This way, using an electric method with high time resolution, the Bereitschaftspotential was discovered which precedes voluntary movements. The potential originates in the supplementary motor cortex (SMA) and pre-SMA. When we compare voluntary self-paced finger movements with similar movements triggered by external auditory stimuli using functional MRI it turns out that in the case of the self-paced movement, besides the SMA and the contralateral motor cortex, the basal ganglia are activated, while in the externally triggered movement this is not so. In accord with this, lesions of the basal ganglia impair spontaneous movements while movements triggered by external stimuli are still possible. Voluntary movements, furthermore, require the cerebellum for exact timing, the somatosensory cortex for tactile regulation, the Wernicke cortex for speech, visual areas for eye movements, and the frontal lobe for planning and decisions (which enables man to improve himself throughout life).

The importance of motor activity for health is still underestimated today. Physical activity is not only necessary to maintain muscles, bones and joints, but also the nervous system: to maintain neurons and synapses, improve programs and repair lesions by neurotrophic factors, training with active movements is necessary. Most of all, however, it is impossible to maintain health over a longer time without daily physical activity in the free time. In western societies nowadays obesity and the associated metabolic syndrome (with insulin resistance, hyperlipemia and high blood pressure) is the most common disease. Consequences are ischemic heart disease, stroke and dementia. To avoid this by a restriction of intake only does not work because a qualitative undernutrition is the result with micronutrients such as antioxidants, trace elements etc. Take for example zinc, an essential component of many enzymes. Even with "normal" caloric intake many people suffer from marginal deficiency of zinc and are therefore depressed and at increased risk for infections. When young women diet to be leaner, some become seriously ill, because zinc deficiency may cause anorexia, a vicious circle.

Through millions of years man could not exist without a daily lot of activity. Therefore he could afford eating more calories (not empty calories such as refined sugar or saturated fatty acids), thereby enough micronutrients of all kinds. It is hopeless to compensate this in today's sedentary society just by taking vitamin pills; for our nutritional knowledge is incomplete. Young women, however, the part of the population most at risk for inadequate nutrient intake, are also the mothers of children. Undernutrition with micronutrients such as zinc, selenium and so on increases the risk of infections during pregnancy and thereby the risk of subtle cerebral malformations which later in life the children may result in attention deficit hyperactivity and even schizophrenia.

Today our society is not only aging but also increasingly ill because of a lack of physical activity. Enough movement in the leisure time is as important for cardiovascular health as smoking and high blood pressure. Even moderate daily activity has significant beneficial effects on body mass, blood pressure etc. It is an urgent task to educate people in such a way that daily free time physical activity becomes a lifelong habit. Obviously competitive sports such as soccer are not the solution because of the high risk of injuries. It will work only when movement is associated with joy. A way is outdoor activity: walking, hiking, bicycling, swimming, etc. because it associates motion with nature and light. Solar light has antidepressive and even anti-cancer effects. Not only cardiovascular, but all-cause mortality is reduced by regular physical activity. Thus, the mountains of Japan could become an important source of health for the nation.