1. Research project objectives/Research hypothesis – One fundamental approach to evoke plastic changes in the visual system is repetitive sensory stimulation, known as a visual training. It has been proposed as a method which contribute to improvement of some visual functions such as enlargement of visual field and reduction of response time to the stimulus in hemianopic patients. In animal study we have examined that 3 hours of visual training induced the increase of visual evoked potential (VEP) amplitudes both at the cortical and subcortical level. The question, which still remains to be answered in this study, is primarily what kind of mechanism is responsible for increasing the VEPs amplitude during the training. In primary visual cortex (VCx) found that the repetitive exposure (few days) to visual stimuli can induce long term potentiation (LTP) in the VCx in *in vivo* experiments, and the LTP is dependent on NMDA receptor activation. At the subcortical level in the superior colliculus (SC) the increase of VEP amplitudes may be result of two different inputs: through the synapse from retina to SC and by the projection from the VCx to SC following cortical enhancement. In the present project I am going to explain whether the reinforcement of visual response is an NMDA receptor-dependent process and how long this effect persists. Additionally, I plan to study whether the enhancement of visual response in the SC occurs mainly through retino-tectal synapses or also via projection from the VCx to SC. Another issue which needs explanation is how the brain state during visual training affects on training results, that is, an increase of the cortical and subcortical responses. Our, and other studies shows that the magnitude of VEP amplitudes, recorded under urethane anaesthesia, depends on cyclic and spontaneous alternations of brain states. Therefore, I intend to conduct experiments which enable to explain whether and to what extent the effects of training depends on the global brain state. The last aspect which I plan to examine in this project is the influence of the visual training on the other visual functions such as contrast and temporal and spatial resolution. Investigation of this issue seems to be crucial if such a scheme of training would be applied as a form of rehabilitation of visual function in humans.

2. Research project methodology – The experiemnts will be performed on rats. The visual training will consist of 300 light flashes (2 ms, with 0.5 Hz frequency) presented every 15 minutes through 3 hours. During training the visual evoked potentials will be recorded from the visual cortex, superior colliculus and dorsal lateral geniculate nucleus. Peak to peak VEP amplitudes will be measured both before, during and after visual training. In order to verify whether the reinforcement of visual response is an NMDA receptor-dependent process I plan to administrate NMDA receptor antagonist (CPP, 5 mg/kg) dissolved in physiological saline by intraperitoneal injection 2.5 h before visual training starting. Selective inactivation of each SC input will enable us to explain whether the observed increase of visual response in the SC occurs independently of the VCx. For this purpose I plan to 1) pharmacologically block cortical activity with xylocaine solution (blocker of sodium channels) before visual training will started and 2) suppress of synaptic transmission in the retino-tectal pathway after visual training by optogenetic tools. Intravitreal injection of AAV2-CMV-eNpHR-EYFP will be performed 2-3 weeks before visual training. To investigate the influence of brain states on training effects, I plan to conduct electrophysiological experiments during 1) spontaneous changes of brain states in the cortical EEG 2) activated state evoked by continuous tail pinch or systemic amphetamine administration and 3) deactivated state evoked by additional doses of urethane administration. To examine the effect of training on visual perception properties, I plan toperform the optical imaging of cortical intrinsic signal. Both before and after visual training I intend to study the intensity of the hemodynamic response to stimuli of different contrast, temporal and spatial frequencies.

3. Expected impact of the research project on the development of science - I expect that the results of this study may help to understand the mechanisms responsible for enhancing process of the VEPs amplitude in the visual structures resulting from visual training. Especially, it will enable to explain whether the reinforcement effect is dependent on NMDA receptor which may be related to the plastic changes occurring in the visual system. The proposed experiments should also answer the question whether the observed increase of visual response in the SC occurs independently of the VCx through retino-tectal synapses or depending on the projection from the VCx to SC, which is still unknown. A separate analysis of individual brain states during visual training will provide the information on whether plastic changes can be induced independently of the brain states. The results of this project will answer the question whether the visual training contributes to improvement of visual perception (improvement of stimulus detection judged from the broader range of visual stimulus parameters). Understanding of these can be crucial if such a scheme of training would be applied as a form of rehabilitation of visual function in humans.