Streszczenie po angielsku

Steady State Visually Evoked Potentials (SSVEPs) are the brain responses to a periodically flashing visual stimulus. They are measured in electroencephalographic (EEG) signals and their oscillation rate corresponds to the rate of stimulation and its harmonics and subharmonics. SSVEPs are used in two areas of science. First, they are used in psychological research as an indicator of attention. Secondly, they are used in brain-computer interfaces - devices that allow paralyzed people to communicate with the world. Despite the wide application in these fields, many aspects of SSVEPs are not well described. The dissertation presents four experiments, the aim of which was to obtain a better understanding of the elementary properties of SSVEP potentials. The most commonly used stimuli to generate SSVEPs are periodic signals with rectangular envelope. While the power spectrum of a sinusoidal stimulus contains only the maximum located in the stimulation frequency, the spectrum of a rectangular periodic function also contains odd multiples of its frequency. Thus, the question arises whether the presence of harmonics in the SSVEP potential can be caused, at least in part, by their presence in the stimulus itself. In the first experiment presented in the dissertation, brain responses to periodic light stimuli with two types of signal envelopes, rectangular and sinusoidal, were compared. It was shown that the influence of the stimulus envelope on the harmonic content in SSVEP exists, but is small. Specifically, there are both odd and even harmonics in the SSVEP evoked by a sinusoidal stimulus. This result excludes the possibility of harmonics originating only from the input signal and proves the non-linear operation of the visual system. The next three experiments, constituting an essential part of the dissertation, concerned the time evolution of SSVEPs. In psychological applications, it is still commonly assumed that SSVEPs are, as their name suggests, stable and their amplitude does not change over time and can only be modulated by attention. This assumption is crucial for their proper application. In the second experiment, responses to 1 minute flashing light stimulation at 15 Hz were examined with repeated measurements to reduce the effects of fluctuations in the EEG signal. It has been shown that for many subjects there are significant changes in the amplitude of the SSVEP. Both a decrease in signal amplitude, i.e., habituation, and a slight increase in amplitude during stimulation were observed. For some of the subjects, SSVEP potentials remained stable over time. Instances of different behavior of the fundamental component and the second harmonic were also observed. In the data from individual subjects, the amplitude of the second harmonic could increase while the amplitude of the fundamental component simultaneously decreased. In the following experiment, the experimental procedure was extended to multiple stimulation frequencies, i.e., 5 Hz, 10 Hz, 15 Hz, 20 Hz and 40 Hz. It has been shown that SSVEPs evoked by stimuli of different frequency can evolve differently. In response to 5 Hz stimulation, an increase in amplitude was observed throughout the 60-second stimulation period, and for stimuli of 15 Hz or more, a decrease in amplitude predominated. Based on these results, a hypothesis was put forward that the differences in the processing of stimuli at different stimulation frequencies may result from the participation of two visual pathways (magno- and parvocellular) and their different neuronal properties. The obtained results are crucial for the correct design and interpretation of the results of psychological experiments using SSVEP potentials. They can also contribute to an improvement of procedures used in brain-computer interfaces, leading to an increase in their effectiveness.