Abstract

Two-photon vision is based on the perception of a pulsed laser beam as a result of two-photon absorption of near-infrared light in the visual pigments.. This phenomenon is characterized by the lower susceptibility to scattering and quadratic dependence of brightness on intensity, which potentially offers greater potential for precise stimulation of the retina. Due to the different process underlying two-photon vision compared to normal vision, the design of optics for psychophysical testing requires defining new optimal conditions for retinal stimulation.

The aim of this dissertation was to experimentally verify four research problems comparing two-photon and single-photon vision: measuring the pupillary response to a two-photon stimulus, evaluating the effect of beam size and convergence on visual thresholds, assessing the relative difference in sensitivity between cones and rods, and determining the spectral range of two-photon perception. This required the construction of a prototype laboratory measurement system for psychophysical experiments, the development of control software, and the design and execution of experiments. The results showed that a two-photon perceived infrared beam causes a weaker pupil response. It has also been found that in two-photon vision, the size and level of convergence of the stimulus beam have a greater effect on visual thresholds than in single-photon vision. Analyzing the course of dark adaptation, the relative difference in the response of cones and rods was shown to be smaller for two-photon vision. The spectral range of this mode of perception was also determined to be 830 nm - 1300 nm and a spectral sensitivity curve for two-photon vision was obtained.

The results of the research presented in this dissertation have expanded the knowledge of infrared beam stimulation perceived in the two-photon vision process, and provide an important step towards defining optimal stimulation conditions for the visual system based on this nonlinear mechanism.