ABSTARCT

In mammals light detection occurs in the back of the eye in the specialized neuronal tissue called the retina. It possesses two light detecting systems from which the first one is mainly responsible for pattern vision and is based on the rod - cone photoreception, whereas the second depends on melanopsin and controls 'non-image forming' visual responses, such as circadian rhythms, pupillary light reflex and hormone secretion. Despite being morphologically different, all three types of photoreceptors: rods, cones and intrinsically photosensitive retinal ganglion cells (ipRGCs) are required to mediate the full effect of light on circadian and visual systems. Due to that, most of retinocipient structures in the subcortical visual system receive information from both systems.

The main aim of the present thesis was to determine contribution of particular photoreceptors: rods, cones and ipRGCs to slow oscillatory activity (SOA) generation / modulation within the subcortical visual system of rodents. Two structures were investigated in details: the olivary pretectal nucleus (OPN), which is responsible for pupillary light reflex and lateral geniculate nucleus (LGN), mainly engaged in vision formation.

Two different experimental approaches were used to achieve this goal: (I) extracellular single-unit recordings on rats combined with intravitreal injections of selective photoreceptors blockers and (II) extracellular multi-channel, multi-unit recordings on genetically modified mice lacking either melanopsin or rods and cones.

The results provide the evidence that photoreceptors strongly modulate SOA in the OPN, however are not responsible for its generation, as previously suggested. Moreover, their engagement in SOA modulation depends on the background lighting conditions, and thus reflects their selective activation. Melanopsin blockade caused abolition of SOA under photopic conditions, whereas rod-cone blockade resulted in rhythm disappearance under mesopic light. Furthermore, obtained results suggest that SOA generation depends on the maintained retina activity as its chemical desynchronization causes disturbances of the rhythm in the OPN. This further explains the occurrence of oscillatory activity in the OPN, LGN and suprachiasmatic nucleus in darkness.

This study is the first to show the existence of slow oscillatory activity in mice OPN and LGN, where 30% of neurons generated action potentials in an oscillatory mode with the period of approximately four minutes.

Experiments on genetically modified mice without rods and cones or melanopsin confirmed results acquired on rats, that functional presence of photoreceptors is not required to observe SOA in the OPN and LGN. The major differences occurred in melanopsin knockout mice, where oscillations were the fastest and the least frequent. Importantly, the percentage and period of SOA neurons were very similar in the OPN and LGN in different genotypes implying that they have a common input, most probably located in the retina. Moreover, obtained results strongly suggest that at least some of SOA neurons in the LGN are able to code light intensity and take part in contrast detection. Surprisingly, only contrast detection seems to be controlled by melanopsin, as melanopsin knockouts mice are able to track irradiance similarly to wild type animals.