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Organization of neuronal structures for binocular vision and the dynamics of their im-pairments in the case of amblyopia

Statement of the Problem: One of the important tasks performed by a binocular system is reconstruction of 3-D visual space from two 2-D retinal images. This task is performed by the analysis of abso-lute and relative disparity of retinal images by binocular neurons in the visual cortex. It is known that abnormal binocular expe-rience during early childhood may produce amblyopia reducing visual acuity and ste-reovision, changing visuo-motor behaviour due to impaired formation of neuronal connections. The dynamics of these pro-cesses is not well understood yet. The purpose of our study was to investigate devel-opment of impairments in crossed and un-crossed pathways originating from each retina in feline experimental models of deprivation and dis-binocular amblyopia.

Method: Using histochemical staining for cytochrome oxidase–a mitochondrial enzyme involved in energy production – the functional activity in eye-specific layers of lateral geniculate nucleus (LGN) of both hemispheres was estimated in unilaterally convergent strabismic kittens (SK) and monocularly deprived kittens (MDK) at ages of one to five months.

Results: We found alterations of LGN layers activity in the projection of the en-tire visual field in MDK, but only in the projection of central 10-15 degrees in SK. In both experimental groups a relative de-crease of activity in layers innervated by uncrossed pathways from impaired eye was observed earlier than in layers inner-vated by crossed pathways from the same eye. Moreover, these changes were found in MDK at the age of two months while in SK they were found at the age of three months.

Conclusion: The observed differences in development of deprivation and dis-binocular amblyopia strongly suggest the different mechanisms implicated in them. We speculate that intense stimulation of nasal visual hemi-field of the impaired eye in pre-surgical period of corrections might be useful to delay the impairments in un-crossed pathway.

Recent Publications

1. Alekseenko S and Shkorbatova P (2017) Development of functional impairments in the lateral geniculate nucleus of different hemispheres following early monocular deprivation. Sensory Systems 31:183–190.
2. Alekseenko S and Shkorbatova P (2016) The time course of abnormalities in the brain subcortical visual center following early impairment of binocular experience. Almanac of Clinical Medicine 44: 351–357.
3. Toporova S, Shkorbatova P and Ale-kseenko S (2016) Layer wise organization of neurons providing inter-hemisphere connections in the visual cortex of cats with impaired binocular vision. Neurosci Behav Physiol. 46:219-223.
4. Alekseenko S (2015) Neuronal representa-tion of 3-D space in the primary visual cortex and control of eye movements. Per-ception 44:995-1006.
5. Alekseenko S, Shkorbatova P and To-porova S (2014) The influence of strabis-mus and monocular deprivation on the size of callosal cells in areas 17 and 18 of the cat. Neurosci Behav Physiol 44:479-487.

Biography

Svetlana V Alekseenko is an expert in Binocular Vision. Originally a Biophysicist, till 1992 she investigated the directional and orientation selectivity of visual cortical neurons in the cat at University of Vilnius, where she completed her PhD degree. Then she moved to Pavlov Institute of Physiology in St. Petersburg and switched to morphological studies of the neu-ronal connections which are providing the binocular vision in cats. On the basis of neuroana-tomical data, she has built the map of three-dimensional visual space representation in the primary cortex, which allows the understanding of absolute disparity coding in this area. She became Habilitated Scientist in 2004. Her further research was studying the postnatal plastici-ty of neuronal connections especially during the development of disbinocular and deprivation amblyopia.

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