



## Presentation Abstract

Program#/Poster#: 737.06/II16

Presentation Title: Information processing by retinothalamic circuits contributes to contrast adaptation

Location: Halls B-H

Presentation time: Wednesday, Nov 13, 2013, 9:00 AM -10:00 AM

Topic: ++D.04.e. Subcortical visual pathways

Authors: **W. ZHANG**<sup>1,2</sup>, **S. WU**<sup>2</sup>, **F. T. SOMMER**<sup>3</sup>, **J. A. HIRSCH**<sup>4</sup>, **T. J. SEJNOWSKI**<sup>5,6</sup>,  
**\*X. WANG**<sup>7,5</sup>;

<sup>1</sup>Inst. of Neuroscience, Chinese Acad. of Sci., Shanghai, China; <sup>2</sup>State Key Lab. of Cognitive Neurosci. and Learning, Beijing Normal Univ., Beijing, China;  
<sup>3</sup>Redwood Ctr. for Theoretical Neurosci., Univ. of California at Berkeley, Berkeley, CA; <sup>4</sup>Dept. of Biol. Sci., USC, Los Angeles, CA; <sup>5</sup>Computat. Neurobio. Lab., Salk Inst. for Biol. Studies, La Jolla, CA; <sup>6</sup>Div. of Biol. Sci., Univ. of California at San Diego, La Jolla, CA; <sup>7</sup>Qualcomm Res., San Diego, CA

Abstract: Adaptive encoding is a universal strategy used by early sensory systems to process information contained in input signals that span a huge dynamic range. In the mammalian subcortical visual pathway, it is well known that both retinal ganglion cells (RGCs) and relay cells in the lateral geniculate nucleus (LGN) actively adapt their encoding mechanisms, i.e. spatio-temporal receptive fields and input-output function, in response to changes in stimulus contrast, such as magnitude of fluctuations around a mean luminance value. However, it remains an open question whether the contrast-adaptive capability of LGN relay neurons is merely inherited from their afferent retinal inputs, or if the retinothalamic neural circuits play an active role in shaping contrast adaptation.

To address this question, we recorded activity of relay cells from the A/A1 layers of the cat LGN by using patch electrodes in cell-attached mode, a technique that allowed us to record simultaneously spikes of the LGN neuron and the postsynaptic potentials (S-potentials) generated by the its dominant retinal input. Using Gaussian white noise stimuli of equalized luminance at three different levels of root-mean-square contrast, we characterized how coding changed in LGN relay

cells and their presynaptic RGCs. Consistent with previous studies, both the RGCs and LGN relay cells demonstrated contrast-adaptive behavior. As stimulus contrast was lowered, we observed (1) increasing temporal extent of receptive fields, (2) decreasing threshold, and (3) increasing input-output gain. Next, we made quantitative comparisons of the contrast-adaptive neural codes in the retina versus in the LGN by estimating information content conveyed by single spikes. Our analysis showed that information rates (i.e. bits per second) of LGN relay cells were less sensitive to changes in contrast than those of their presynaptic RGCs. Furthermore, we fitted general linear models (GLMs) to identify contributions to LGN responses from distinct input sources, namely (a) direct inputs (feedforward from retina) versus (b) indirect inputs (local inhibition and/or feedback). We found that the relative influence from the indirect (versus direct) inputs was stronger when adapted to lower contrast. In addition, the GLMs quantitatively predicted the differential contrast adaptation of information rate we observed. Our findings suggested that retinothalamic neural circuits played an active role in contrast adaptation of thalamocortical relay cells.

Disclosures: **W. Zhang:** None. **S. Wu:** None. **F.T. Sommer:** None. **J.A. Hirsch:** None. **T.J. Sejnowski:** None. **X. Wang:** A. Employment/Salary (full or part-time);; Qualcomm Research.

Keyword(s): RETINOTHALAMIC  
CONTRAST ADAPTATION  
NEURAL CODE

Support: NIH grant EY009593  
NSF grant IIS-0713657  
Howard Hughes Medical Institute  
Qualcomm Research