Talk 3.5

Attentional selection and perceptual organization

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Ernst Niebur
Johns Hopkins University

Rudiger von der Heydt
Johns Hopkins University

Gestalt psychologists early in the 20th century pointed out that conscious visual perception seems to emerge not from the image information directly, but from an intermediate stage of preattentive visual organization. An important aspect of this organization is figure-ground segregation. Because the eyes register only 2D images of a 3D world, the visual system needs to detect the contours of objects (the lines that separate an object region from its background) and assign them correctly to the object side. Our recent studies indicate that the assignment of "border ownership" occurs in cortical area V2. In a so far separate line of work, we have studied selective attention which is the mechanism by which the nervous system selects the most relevant information at any time. This is of crucial importance for perception and cognition because usually more information is available for the nervous system than can be processed in detail in the brain. We have found a strong correlation between the attentional state and the temporal structure of neural responses, viz. synchrony between neural spike trains. In the proposed work, we suggest that attention may be viewed as a mechanism that works at a level of intermediate vision and perceptual organization. Specifically, we propose that the neural substrate that is observed to generate the border ownership signals may also provide 'handles' for attentional selection. Central processes of selective attention may then rely on the visual data structure provided by this area. Our preliminary results indicate that attentional control may be exerted by employing synchrony structures akin to those seen in our previous work. We will study this hypothesis both by computational modelling and by recording in awake behaving monkeys. The hypothesis generates clear predictions, of which some have been confirmed in preliminary studies and others are to be tested in the proposed work.

Intellectual merit of the proposed activity: Understanding the interplay between selective attention and perceptual organization will contribute significantly to understanding the vision process in particular, and the principles of neural information processing in general. Originality: The observation of neural border ownership coding by the CoPI some years ago opened a new research field. This is the first time that a connection is established between this question and the related and (relative to many other cognitive phenomena)

well understood field of selective attention. Broader impacts of the proposed activity: Asking how the brain and mind work is one of the central questions of human existence. Outreach: Historically, it has been difficult to involve underrepresented minorities in primate neurophysiology because these groups frequently did not have the necessary background for these difficult experiments that require a longterm commitment. Computational and modeling work offers an entry point for such groups. This has been confirmed by the experience of

several African American students that worked successfully on yearlong computational neuroscience projects in the PI's lab.

Project (or PI) Website

http://vlab.mb.jhu.edu/projects/bo-transp

Publications

1. E Craft, H. Schutze, R. von der Heydt and E. Niebur, A physiologically inspired model of border ownership assignment, Journal of Vision 4 p 728 (2004).

2. Y. Dong, R. von der Heydt and E. Niebur. Synchrony and the binding problem in macaque visual cortex. Soc. for Neuroscience Abstracts 2006.