SFB 874 / IGSN
CONFERENCE

Molecular and Neural Correlates of Memory and Cognition

April 9 - 10, 2019   Veranstaltungszentrum, Ruhr University Bochum

Wednesday   April 10, 14:00 – 16:00

Session 4   **Cortical plasticity and information processing as an orchestrator of cognitive flexibility, memory and cognition**

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The neural basis of depth perception: how binocular disparity is encoded in the primary visual cortex

Primate stereopsis is remarkably precise and can break camouflage, revealing structures that are monocularly invisible. This ability depends on matching up the two eyes' images, a process which begins with disparity-sensitive neurons in primary visual cortex, V1. The currently accepted model of these neurons is a 3-layer linear/nonlinear neural network. The weights from the input layer to the hidden layer represent binocular simple-cell receptive fields. These simple cells then converge onto a single V1 complex cell.

With the right parameters, this model can reproduce many general properties of V1 neurons, notably their attenuated responses to anticorrelated images. Here, contrast is inverted in one eye, meaning there are many false local matches but no global depth. However, attempts to fit these models to V1 neurons using spike-triggered covariance have not shown this attenuation. Thus it is unclear whether this model really describes how V1 works.

We have used a new machine learning approach to train models on correlated, uncorrelated and anti-correlated random-line patterns with a range of disparities. Despite being given only raw images – not disparity or correlation – as input, the model predicts disparity tuning curves well for all three correlations. This shows for the first time that these models can describe individual V1 neurons. However, many neurons show very high activity for one preferred disparity, which the models cannot capture. This suggests that the real puzzle of V1 neurons may not be how they attenuate their response to false matches, but how they boost their signal for one preferred disparity.