

Poster presentation

Open Access

Activity-dependent bidirectional plasticity and homeostasis regulation governing structure formation in a model of layered visual memory

Jenia Jitsev*^{1,2} and Christoph von der Malsburg¹Address: ¹Frankfurt Institute for Advanced Studies, Germany and ²Johann Wolfgang Goethe University, Germany

Email: Jenia Jitsev* - jitsev@fias.uni-frankfurt.de

* Corresponding author

from Eighteenth Annual Computational Neuroscience Meeting: CNS*2009
Berlin, Germany. 18–23 July 2009

Published: 13 July 2009

BMC Neuroscience 2009, **10**(Suppl 1):P207 doi:10.1186/1471-2202-10-S1-P207This abstract is available from: <http://www.biomedcentral.com/1471-2202/10/S1/P207>

© 2009 Jitsev and Malsburg; licensee BioMed Central Ltd.

Our work deals with the self-organization [1] of a memory structure that includes multiple hierarchical levels with massive recurrent communication within and between them. Such structure has to provide a representational basis for the relevant objects to be stored and recalled in a rapid and efficient way. Assuming that the object patterns consist of many spatially distributed local features, a problem of parts-based learning is posed. We speculate on the neural mechanisms governing the process of the structure formation and demonstrate their functionality on the task of human face recognition.

The model we propose is based on two consecutive layers of distributed cortical modules, which in turn contain subunits receiving common afferents and bounded by common lateral inhibition (Figure 1). In the initial state, the connectivity between and within the layers is homogeneous, all types of synapses – bottom-up, lateral and top-down – being plastic. During the iterative learning, the lower layer of the system is exposed to the Gabor filter banks extracted from local points on the face images. Facing an unsupervised learning problem, the system is able to develop synaptic structure capturing local features and their relations on the lower level, as well as the global identity of the person at the higher level of processing, improving gradually its recognition performance with learning time.

The structure formation relies on the activity-dependent bidirectional plasticity [2] and the homeostatic regulation of unit's activity. While these occur on the slow time scale, the fast acting neural dynamics with strong competitive

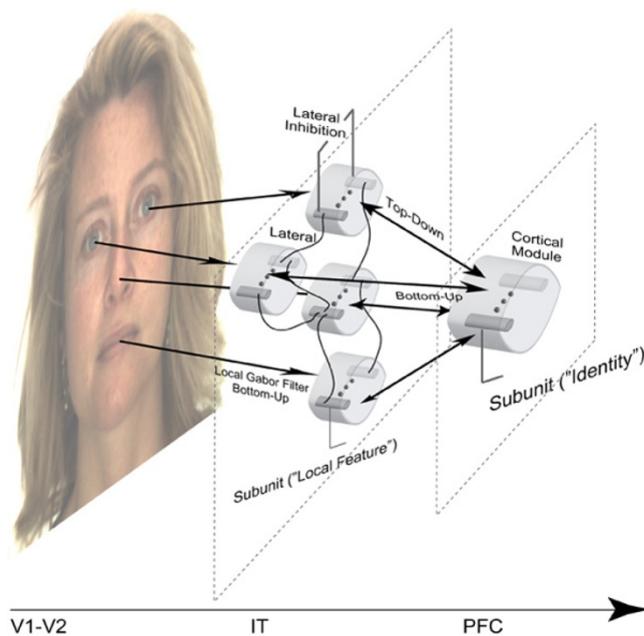


Figure 1
A model of layered visual memory.

character ensures that only a small subset of units may update their synapses during a decision cycle spanned by oscillatory inhibition and excitation in the gamma range. This repetitive selection triggered by certain face images leads to amplification of the memory trace for the respective person. Acting together, homeostatic constraint and bidirectional plasticity work on reducing the overlap between different memory traces, segregating them in the memory structure.

The ongoing modification of the memory's structure conditions the system for more and more coherent communication between the bottom-up and top-down signals. The binding of the local features via lateral and top-down connections into a global identity enhances the generalization capability of the memory, and renders the system to reliably recognize novel face images of different views not presented before. The proposed mechanisms of learning reveal thus basic principles behind the self-organization of successful subsystem coordination.

Acknowledgements

This work was supported by the EU project DAISY, FP6-2005-015803.

References

1. Malsburg C von der: **Self-organization and the brain.** In *The handbook of brain theory and neural networks* 2nd edition. Edited by: Arbib MA. Cambridge, Massachusetts: MIT Press; 2003:1002-1005.
2. Artola A, Singer W: **Long-term depression of excitatory synaptic transmission and its relationship to long-term potentiation.** *Trends Neurosci* 1993, **16**:480-487.

Publish with **BioMed Central** and every scientist can read your work free of charge

"BioMed Central will be the most significant development for disseminating the results of biomedical research in our lifetime."

Sir Paul Nurse, Cancer Research UK

Your research papers will be:

- available free of charge to the entire biomedical community
- peer reviewed and published immediately upon acceptance
- cited in PubMed and archived on PubMed Central
- yours — you keep the copyright

Submit your manuscript here:
http://www.biomedcentral.com/info/publishing_adv.asp

