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INSTITUTE OF MOLECULAR BIOLOGY AND BIOTECHNOLOGY

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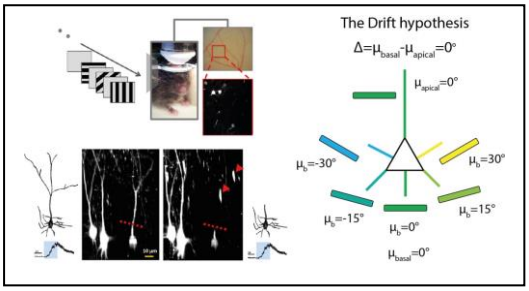
PRESS RELEASE

International scientific collaboration between IMBB researchers and scientists at the Harvard Medical School causally dissects the role of dendrites in sensory processing



The findings of the study, published in the scientific journal Nature Communications, demonstrated that sensory responses of single neurons of the visual cortex are robust to loss of dendritic input. IMBB Researchers, Dr. Athanasia Papoutsi and Dr. Panayiota Poirazi (Director of Research at IMBB/FORTH) in collaboration with the team of Prof. Stelios Smirnakis at Harvard Medical School (Dr. Jiyoung Park and Dr. Ryan Ash), showed that orientation tuning functions remains unchanged following removal of the apical tree, change only slightly upon loss of two primary basal dendrites and predicted a diverse input structure to the basal trees.

Dendrites are thin processes that sprout from the cell body of neurons and receive a plethora of inputs. Pyramidal neurons, the main excitatory neuronal cell type of the cortex, can be distinguished from other cell types due to their characteristic and complex dendritic morphology. A key feature is their anatomical compartmentalization into apical and basal dendritic trees, characterized by both distinct morphological properties and differences in their wiring diagram; the apical tuft typically integrates feedback information (internal representation of the world), while the basal dendrites receive primarily feedforward sensory input (sensory experience). Yet how inputs these trees co-operate towards specific functions remains in large part unexplored.

To address this issue the authors focused in orientation preference of pyramidal neurons of the visual cortex, that is the selective response to stimuli with specific orientations. Members of Smirnaki's lab developed a novel technique that allows for the ablation (cutting) of dendrites in vivo, while recording the neuron's orientation preference. This causal manipulation showed that removal of the whole apical tree does not affect orientation preference. Changes in preference started to emerge only after removing 2 primary basal dendrites.
The underlying structure that allows for robust tuning even after the massive loss of the apical tree inputs, as well as the sensitivity to basal input loss was investigated with a detail compartmental modelling in Dr. Poirazi's lab. By formulating and testing different hypotheses, the authors found that the 'drift hypothesis', could explain the experimental observations; that is each individual basal dendrite samples from a slightly different pool of by-passing axons and conveying a slightly different message to the cell-body. Effectively, this creates a repository of orientation preferences at the basal dendrites that can potentially by used to rapidly adjust single-neuron orientation preference.

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Dendritic morphology is dynamically regulated throughout life and is altered under pathological conditions, such as stress or schizophrenia. This study provides critical insights on how dendritic trees contribute to processes underlying cognition and has the potential to be applied to understand the mechanisms of relevant diseases.

Reference:
V1 Park J.**, Papoutsi A.**, Ash R.T., Marin M.A., Poirazi P.#, Smirnakis S.M. #. Contribution of Apical and Basal Dendrites of L2/3 Pyramidal Neurons to Orientation Encoding in Mouse Nature Communications, 10, Article number: 5372 (2019).

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Relevant link: https://www.nature.com/articles/s41467-019-13029-0

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