A RESILIENT NEURAL CODE IN V1 TO PROCESS NATURAL IMAGES

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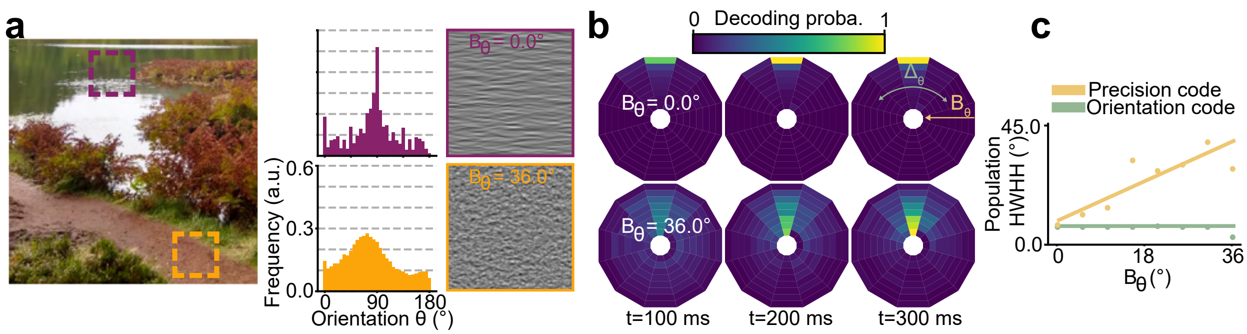
On a daily basis, the primary visual cortex (V1) detects oriented elements from sensory inputs made of orientation distributions. To remain selective to a large variety of possible input configurations, V1 has to account for the precision of these inputs [1]. Here, we decode the population activity of V1 to uncover a neural code which achieves invariance to input precision.



Extracellular recordings were made from 247 V1 neurons in anesthetized cats in response to visually presented naturalistic textures (a). These textures were generated from two parameters : orientation θ and orientation precision B_θ. Using multinomial logistic regression [2], we were able to recover these two parameters from the population activity.

We report two previously unknown types of neurons in V1 : predominantly infragranular neurons that encode solely orientation, and predominantly supragranular neurons which co-encode both orientation and its precision. Using a simple mean-rate population model, we observed that recurrent cortical inhibition can single-handedly account for the existence of these two types of neurons. At the overall population level, the structure of the neural code shows that the orientation error Δ_θ (b) is invariant to precision B_θ. This results in V1 achieving robust orientation selectivity to all possible configurations of oriented inputs (c). Furthermore, we found that precision dictates the temporality of the response, with lower precision textures eliciting slower responses in V1, which can explain the non-canonical dynamics elicited by natural images in V1 [3]. Overall, these results shed additional light not only on the processing of natural images, but also on Bayesian processing in the brain, in which precision modulates prior/posterior integration [4].

References

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