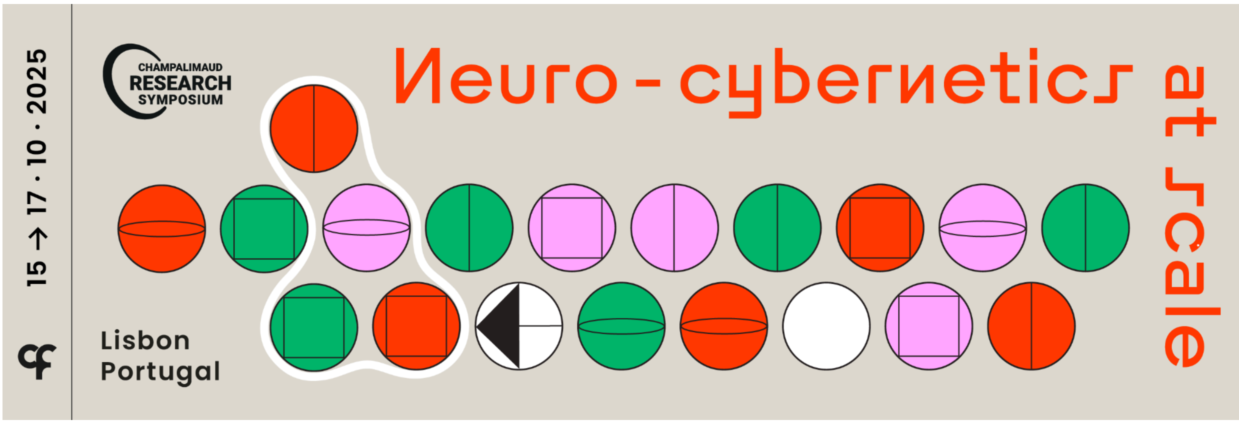

Contextual reconfiguration of mouse V1 representations driven by top-down input

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Neural circuits adapt rapidly to sensory stimuli through experience and ongoing learning in a non-trivial manner. Extensive experimental evidence suggests that they operate in distinct processing modes based on contextual information characterised by differential responses to the same stimuli. In early sensory cortices, different neuronal subtypes contribute differentially to gating sensory information. In early sensory cortices, different neuronal subtypes are thought to have specialized functional roles in controlling sensory information flow through the cortical hierarchy. Specifically, in mouse primary visual cortex (V1), populations of pyramidal and vasoactive-intestinal-peptide-expressing (VIP) cells
show pronounced responses to novel and unexpected visual stimuli, while they rapidly adapt to elicit moderate responses to familiar or expected ones. However, the exact mechanisms
that establish these distinct responses are not yet fully characterised. Local recurrent plasticity within V1 has been proposed as the origin of these context-dependent representations [1, 2], but the full range of mechanisms remains unclear.

Here, we explore an alternative explanation for these differential representations based on feedback-driven interactions from adjacent visual areas to V1. We analysed electrophysiological recordings from primary visual cortex and adjacent visual areas of mice performing a sequential change detection task that establishes contextual stimulus expectations. Our analyses identified distinct inter-area communication patterns, based on stimulus condition, suggesting selective, context-driven information routing to V1.
To test whether such feedback is sufficient to explain the experimentally observed response profiles, we built a multi-population firing-rate model receiving temporally resolved top-down input according to our empirical findings. We explore under which conditions feedback interactions suffice for explaining the experimentally observed context-dependent stimulus representations, and compare with a previous model of recurrently-driven changes that explains

the context-dependent response profiles. Our work provides an alternative mechanistic explanation of how cortical circuits adjust their activity in response to contextual cues and potential stimulus expectations, and provides a mechanistic link between contextual feedback and adaptive sensory processing.

computational neuroscience, modelling, top-down feedback, inter-area communication