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Efficient decision-making is often hampered by a lack of information; at other times, it is an overabundance of information that poses challenges. In a rich environment, finding the relevant features hidden in a flurry of irrelevant information is key to making the right decision. In such situations, the key challenge for the brain is to devise a flexible mechanism that helps it select relevant information and reject irrelevant inputs.

In a collaborative work by the Computational Systems Neuroscience Group at HUN-REN Wigner RCP and the Golshani lab at the David Geffen School of Medicine, University of California, Los Angeles, USA, set out to identify the neural mechanisms underlying the selection of relevant information in a series of studies (Hajnal et al, 2023, Nat Comm; Hajnal et al, 2024, Nat Comm).

By recording neural activity in the primary visual cortex (V1) and anterior cingulate cortex (ACC) of mice the collaboration between the two labs yielded important discoveries. A multiplexed representation was shown to accommodate various task-relevant pieces of information in a manner that prevented interference between them. The geometry of this representation space of independent information could be visualized as a low-dimensional orthogonal coordinate system, where coordinates corresponded to these pieces of information. Individual neurons typically multiplex between various units of information, but on the population level the overall representation is remarkably orthogonal. This multiplexed orthogonal representation seemed to be present as early as V1. However, investigations revealed that it was the ACC where irrelevant information was dynamically suppressed; when a particular piece of information was relevant to reach the right decision, the information was safely guarded, but once the information became irrelevant, the information was washed out from the activity space of recorded neurons.

Analyses revealed that the orthogonal representation is particularly suited to suppress irrelevant information without interfering with relevant information. The latter study, first authored by Márton Hajnal, highlighted a computational mechanism, attention-gated suppression that they first identified in an artificial neural network trained to perform a task identical to the one trained to mice; and later came up with a signature of this computation that was also identified in ACC recordings. In summary, the paper argues that ACC effectively operates on low-dimensional neuronal subspaces to combine stimulus-related information with internal cues to drive actions under conflict by suppressing information irrelevant for the current task.

Figure 1. *A mouse in a tack room, staring at a set of winkers, a supplement on horse harness that helps filtering distracting visual information from the visual field of race horses. Illustration made with Copilot on Bing.*

References:

The pair of papers were published at Nature Communications (https://doi.org/10.1038/s41467-023-42441-w, https://doi.org/10.1038/s41467-024-49845-2).