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Natural switches in sensory attention rapidly modulate hippocampal spatial codes

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During natural behavior animals dynamically switch between different behaviors, yet little is known about how the brain performs behavioral-switches. Navigation is a complex dynamic behavior that enables testing these kind of behavioral switches: It requires the animal to know its own allocentric (world-centered) location within the environment, while also paying attention to incoming sudden events such as obstacles or other conspecifics – and therefore the animal may need to rapidly switch from representing its own allocentric position to egocentrically representing 'things out-there'. Here we used an ethological task where two bats flew together in a very large environment (130 meters), and had to switch between two behaviors: (i) navigation, and (ii) obstacle-avoidance during 'cross-over' events with the other bat. Bats increased their echolocation click-rate before a cross-over, indicating spatial attention to the other bat. Hippocampal CA1 neurons represented the bat's own position when flying alone (allocentric place-coding); surprisingly, when meeting the other bat, neurons switched very rapidly to jointly representing the inter-bat distance × position (egocentric × allocentric coding). This switching to a neuronal representation of the other bat was correlated on a trial-by-trial basis with the attention signal, as indexed by the bat's echolocation calls – suggesting that sensory attention is controlling these major switches in neural coding. Interestingly, we found that in place-cells, the different place-fields of the same neuron could exhibit very different tuning to inter-bat distance – creating a non-separable coding of allocentric position × egocentric distance. Together, our results suggest that attentional switches during navigation – which in bats can be measured directly based on their echolocation signals – elicit rapid dynamics of hippocampal spatial coding. More broadly, this study demonstrates that during natural behavior, when animals often switch between different behaviors, neural circuits can rapidly and flexibly switch their core computations.

Event link:

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