FORUM

Robust Representation of Stable Object values in the Oculomotor Basal Ganglia

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Abstract

We are surrounded by so many visual objects, yet we can find valuable ones quickly and effortlessly. Such an efficient choice should require the memory of many objects' value. Also, the memory should be stably retained because you may encounter valuable objects only occasionally. Where in the brain does stably store the high capacity memory of visual objects? We hypothesized that a major output structure of basal ganglia, substantia nigra pars reticulata (SNr) is a key structure for the everyday choice mechanism. Anatomical studies suggest that the SNr may receive visual object information from the inferotemporal cortical areas through the tail of the caudate nucleus. Furthermore, the SNr controls the initiation of saccadic eye movements through its inhibitory connections to the superior colliculus (SC).

We first let two monkeys experience many computer-generated fractal objects. Importantly, half of objects were associated with a large reward (high valued object) and the other half were associated with a small reward (low valued object). The object-reward association was fixed throughout the learning session. New object-reward associations were introduced across more than half a year, so that the two monkeys have experienced many reward-biased objects (n=696 and 648, respectively). We then identified SNr neurons that project to the ipsilateral SC (identified by antidromic activation) and examined their responses to the experienced fractal objects.

After across-day learning of object-reward association, SNr neurons gradually showed a response bias to many visual objects: an inhibition and excitation, respectively, to high and low valued objects. This neuronal bias remained intact even after >100 days without further learning. In parallel with the neuronal bias, the monkeys tended to look at high valued objects.

These results suggest that SNr neurons bias the gaze toward objects that were consistently associated with high values in one's history.

Host: Hiro. Nakahara Lab for Integrated Theoretical Neuroscience