The Geometry of Map-Like Representations under Dynamic Cognitive Control

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Abstract

Recent work has shown that the brain organizes abstract, non-spatial relationships between entities into map-like representations. However, an animal's objectives often depend on only a subset of the features of the environment. Under these circumstances, cognitive control – the capacity to flexibly select the features most relevant in the current context – becomes paramount. Here, we explore the relationship between cognitive control and the geometry of map-like representations by combining fMRI with neural network modeling. We find that brain areas including hippocampus and entorhinal cortex spontaneously organize pairwise relationships into 2D map-like representations, and that this 2D structure was controlled by compressing task-irrelevant dimensions in areas of prefrontal and parietal cortex. Our neural network model reproduced these findings and additionally predicted warping in the geometry along a context-invariant axis. This prediction was confirmed with fMRI, which showed that the degree of warping was correlated with individual differences in cognitive control.

In J. Culbertson, A. Perfors, H. Rabagliati & V. Ramenzoni (Eds.), *Proceedings of the 44th Annual Conference of the Cognitive Science Society*.