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Relationship between receptor covariance and functional connectivity in macaque somatosensory areas

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Introduction:
Sensory information is processed in a hierarchical way across different areas of the somatosensory cortex. In primates, the sensory signal first arrives at the primary somatosensory cortex (SI), and then at the secondary somatosensory cortex (SII), finally at the association cortex, which consists of areas that are located on the superior (SPL), inferior parietal lobes (IPL), and intraparietal sulcus (ips). Neurotransmitter receptors are a key element of information processing. To understand how somatosensory information is processed between brain areas, we analyzed the multiple receptor covariance (RC) patterns of distinct somatosensory areas. Furthermore, we examined functional connectivity (FC) patterns of each area and explore the shared and specific characteristics between RC and FC.
Methods:
In the present study, we defined 118 areas throughout the macaque brain, 36 of which are somatosensory-related areas located within SI, SII, and parietal association areas. The densities of 14 different receptors in each of the 118 areas had been quantified by means of in vitro receptor autoradiography. To construct the RC of each somatosensory-related area with the remaining areas across the cortex, we calculated a representative feature vector consisting of 14 receptor densities for each area. Statistical similarity between two areas was measured by computing the Pearson correlation. Furthermore, we reconstructed the resting-state FC of the somatosensory cortex using fMRI data from the PRIME-DE dataset. A principal components analysis was performed on the BOLD activity time courses across all vertices within each area, where the first principal component was taken as the representative activity time course for this area. The representative time courses were subsequently correlated with the activity time courses for each vertex across the brain.
Results:
RC patterns are similar for areas that are 1) anatomically adjacent to each other; or 2) at the same level of hierarchical organization. All SI areas showed consistent correlations with caudal SII, rostral and ventral ips, rostral IPL and higher visual areas. SII areas displayed stronger correlations with rostroventral IPL and cingulate areas, but relatively weaker correlations with ips and visual areas. Regarding SPL, there is a clear segregation between areas located on the lateral surface and the areas located within the cingulate sulcus. Within IPL and ips, the RC patterns changed gradually from rostral to caudal. As in RC patterns, the strongest FC was found between neighbouring areas. Likewise, early and higher sensory areas could also be separated by their FC patterns. The FC and RC also have some differences. For example, FC patterns of SI show more consistent connections to the primary motor cortex instead of to higher visual areas.
Conclusions:
Our results show that areas belonging to SI, SII or the somatosensory association cortex have distinct connectivity patterns in both RC and FC. Furthermore, despite comparable features, there are also important differences between the RC and FC of the somatosensory cortex. More broadly, our findings provide a link between the chemoarchitectonic and functional organization of the macaque somatosensory cortex and thus a novel direction for a multiscale understanding of brain structure and function.

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