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Abstract:

Topographic organization is one of the main principles of organization in the human brain. Specifically, whole-brain topographic mapping using spectral analysis is responsible for one of the greatest advances in vision research. Thus, it is intriguing that although topography is a key feature also in the motor system, whole-body somatosensory-motor mapping using spectral analysis has not been conducted in humans outside M1/SMA. Here, using this method, we were able to map a homunculus in the globus pallidus, a key target area for deep brain stimulation, which has not been mapped noninvasively or in healthy subjects. The analysis clarifies contradictory and partial results regarding somatotopy in the caudal-cingulate zone and rostral-cingulate zone in the medial wall and in the putamen. Most of the results were confirmed at the single-subject level and were found to be compatible with results from animal studies. Using multivoxel pattern analysis, we could predict movements of individual body parts in these homunculi, thus confirming that they contain somatotopic information. Using functional connectivity, we demonstrate interhemispheric functional somatotopic connectivity of these homunculi, such that the somatotopy in one hemisphere could have been found given the connectivity pattern of the corresponding regions of interest in the other hemisphere. When inspecting the somatotopic and nonsomatotopic connectivity patterns, a similarity index indicated that the pattern of connected and nonconnected regions of interest across different homunculi is similar for different body parts and hemispheres. The results show that topographical gradients are even more widespread than previously assumed in the somatosensory-motor system. Spectral analysis can thus potentially serve as a gold standard for defining somatosensory-motor system areas for basic research and clinical applications.

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