Cerebellar Isolation, Parcellation, and Conformal Surface Mapping

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Abstract
The topographic organization of motor, sensory and cognitive functions in the human cerebellum is poorly understood, and, owing to its anatomical organization, most of the folial surface is hidden from view. In order to facilitate surface-based analysis of functional activation within the cerebellar cortex, we constructed a "pipeline" for extracting, labelling and conformally mapping the cortical surface.

Methods
The pipeline utilizes a cerebellar template volume isolated from a high-resolution, high-contrast-to-noise T1-weighted MRI brain volume [1] and parcellated according to Schmahmann *et al*. [2]. See **Figure 1**.

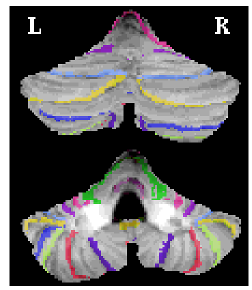

Figure 1. Cerebellar template with fissure labels. **Top**,posterior view (**L,R** indicate object left and right); **Bottom**,anterior view.

Isolation of a cerebellar subvolume was landmark driven; the posterior commissure, obex and apex of the fourth ventricle defined a standard orientation [3]. A template-to-source warp facilitiated removal of the cerebrum. The brainstem was then removed from the cerebellum by a computerized cut-plane that stepped though the volume until it reached the lingula, sparing wrap-around cerebellar tissue. The final perimeter of the cut surface served as the boundary for flat-mapping to a plane.

Parcellation was effected by warping the template cerebellum to a source subvolume, applying the resulting transform to the template parcellation, and editing the labels to correct errors due to poorly resolved fissures and/or variable fissuration.

Marching Cubes was used to extract an isovalue surface from individual cerebellar subvolumes; however, these surfaces commonly exhibited undesirable local topological defects (including handles, "pinched" vertices and fins), which had to be manually corrected. PET activation volumes were aligned to their corresponding anatomical MRI volumes, and activated voxels were projected onto the nearest vertex of the surface mesh. Surfaces bearing activation labels were conformally flattened using CirclePack software [5] and visualized in the Euclidean and hyperbolic planes and on a sphere.

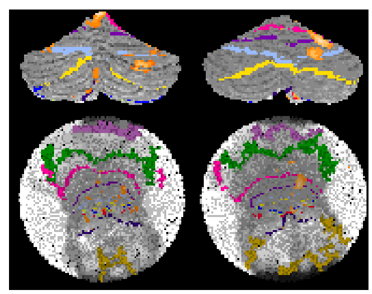

Figure 2. Cerebellar surfaces with PET activation data and fissure labels.

Results
Rendered views and hyperbolic flat maps of the cerebellar cortex from two subjects who performed a static force experiment [4] are illustrated in **Figure 2**. Suprathreshold voxels within 5 mm of the cortical surface were projected onto the surface mesh and labelled using a hot-metal colorscale. The cerebella are displayed in our standard orientation (not co-registered); the flat maps share two landmarks but are not in a common space.

References
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