

Development and evaluation of high-resolution gray matter labels for the MIITRA atlas

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Abstract

Background: High resolution gray matter labels were constructed for the Multichannel Illinois Institute of Technology & Rush university Aging (MIITRA) atlas based on manually edited gray matter labels of the older adults included in the atlas. The performance of the new labels in labeling the gray matter of a separate group of older adults was evaluated.

Method: T1w images (400 images, 1mm isotropic) from the older adults included in the MIITRA atlas (50% male; 64.9–98.9 age-range; 54% white, 43% black) were processed with Freesurfer's standard recon-all pipeline, which segmented subcortical and cortical gray matter into 84 regions according to the Desikan-Killiany atlas. The Freesurfer output for all images was manually edited. The ANTs-derived transformations applied on individual T1w images to build the MIITRA T1w template were used to map the corresponding gray matter labels from raw space to exact physical locations in the final MIITRA space. The label in a 0.5mm isotropic voxel in MIITRA space was calculated using majority voting among all the labels that were mapped to that voxel. The performance of the MIITRA gray matter labels in segmentation of the gray matter of a separate group of 100 older adult individuals was evaluated in terms of label overlap, geometry, and dissimilarity when comparing the MIITRA labels warped to each individual's space, to the respective manually edited reference labels.

Result: Examples of the MIITRA gray matter labels and corresponding confidence maps are shown in Figure 1. The measures of overlap were generally high, with an average Dice coefficient of 0.82 ± 0.10 , Jaccard coefficient of 0.70 ± 0.13 (Fig. 2), sensitivity of 0.77 ± 0.13 , and specificity of 0.89 ± 0.09 (Fig. 3). There was a high correlation in label geometry both in terms of the average volume (correlation coefficient = 0.997, p-value $< 10^{-10}$) and in terms of the average surface area (correlation coefficient = 0.988, p-value $< 10^{-10}$) (Fig. 4). The values of dissimilarity were low, with an average volume error of 0.18 ± 0.18 and an average Hausdorff distance of 8.69 ± 8.78 (Fig. 5).

Conclusion: The MIITRA gray matter labels, in combination with the high-resolution T1w template of the atlas, allow segmentation of the gray matter of older adults that is in good agreement with the manually-edited Freesurfer-based segmentation.

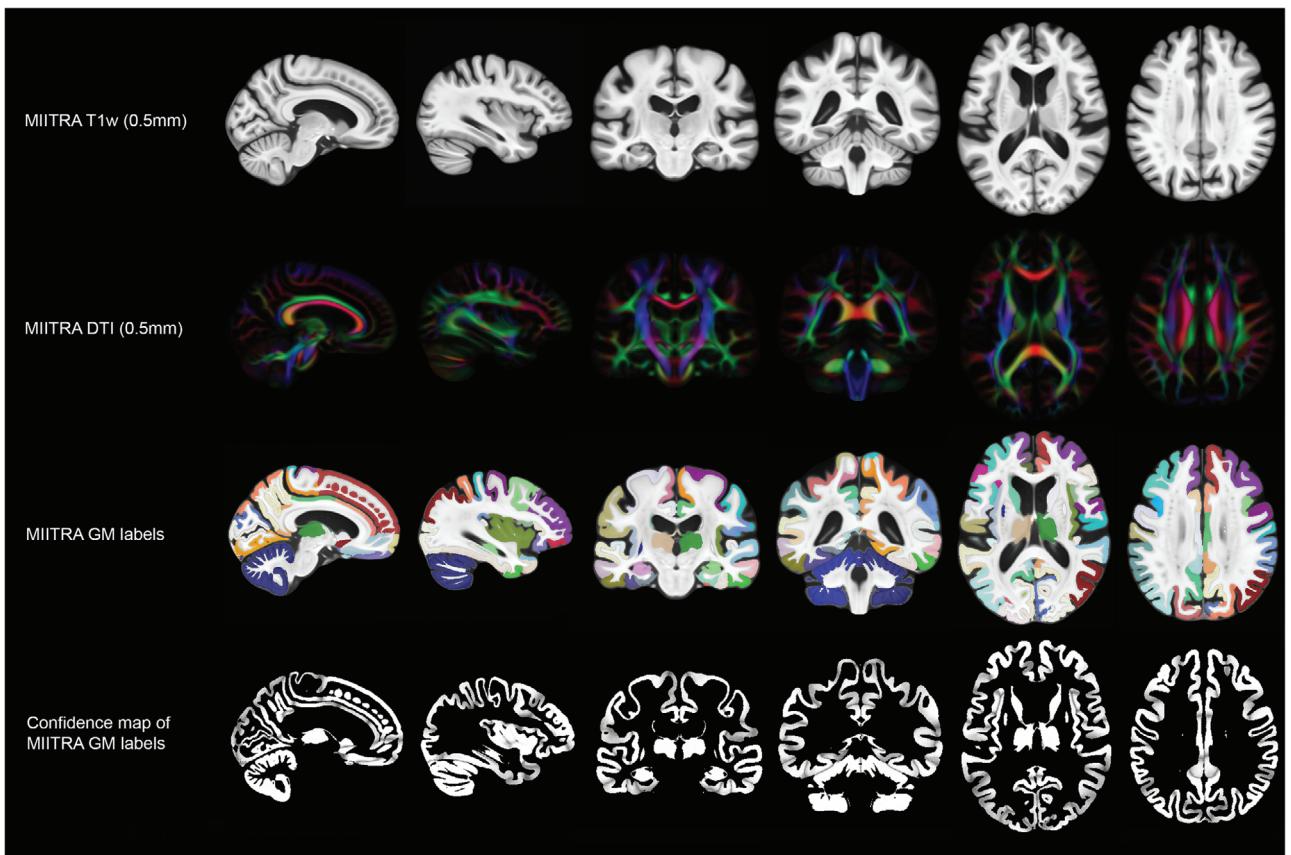
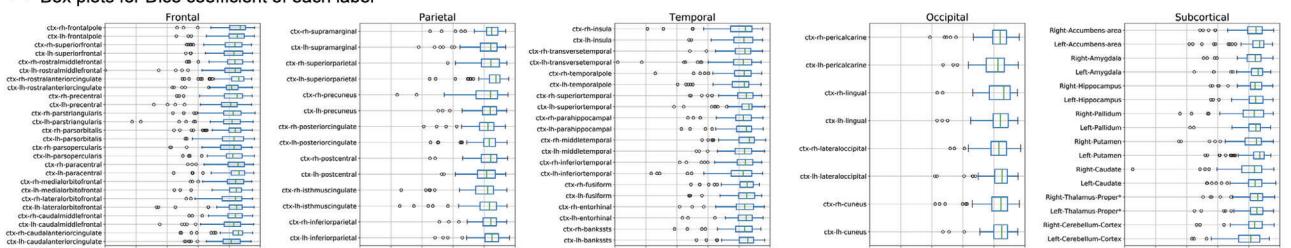


FIGURE 1

A Box plots for Dice coefficient of each label



B Box plots for Jaccard coefficient of each label

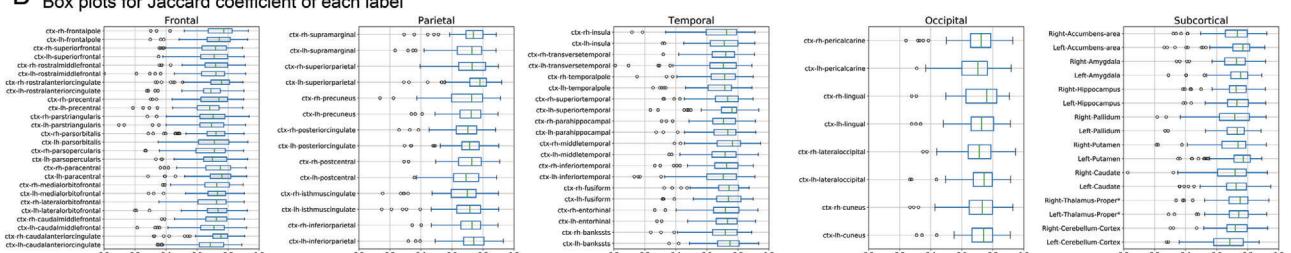
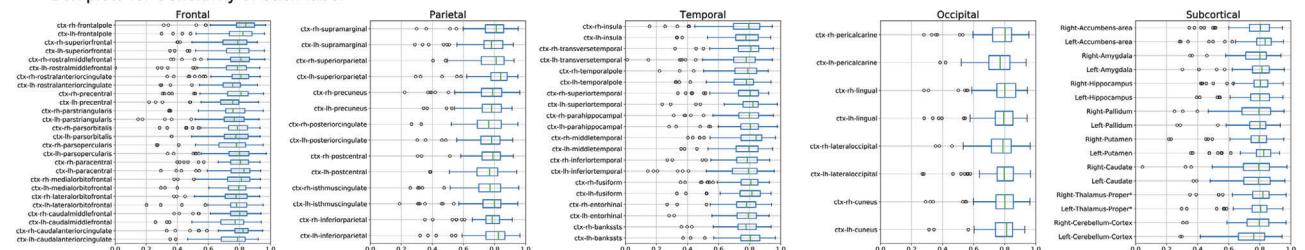
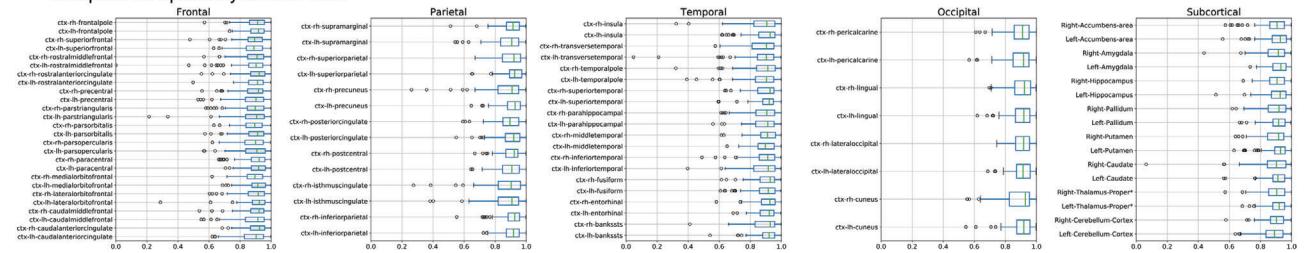
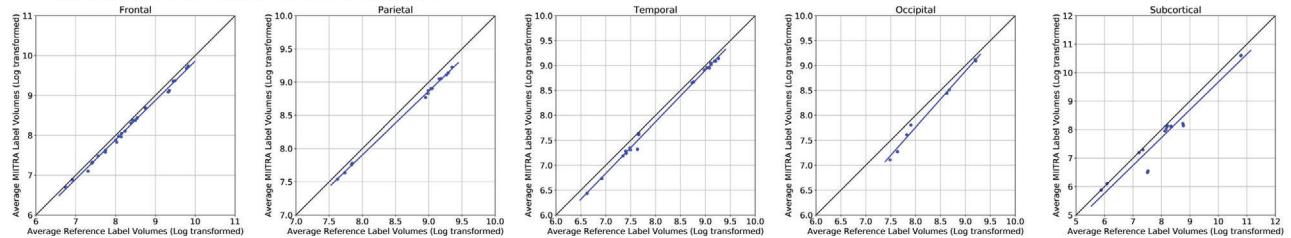
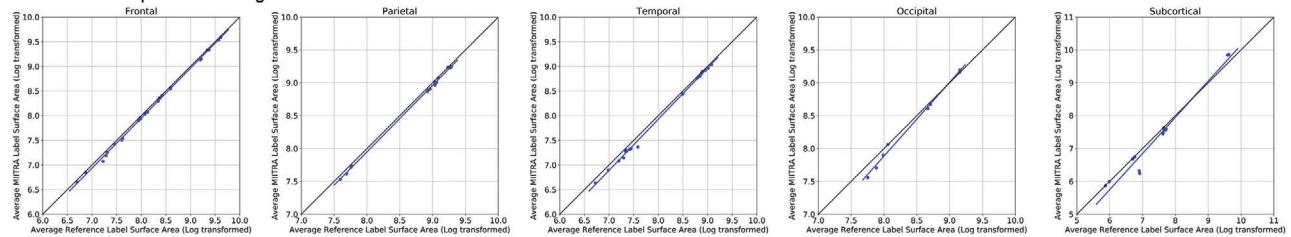
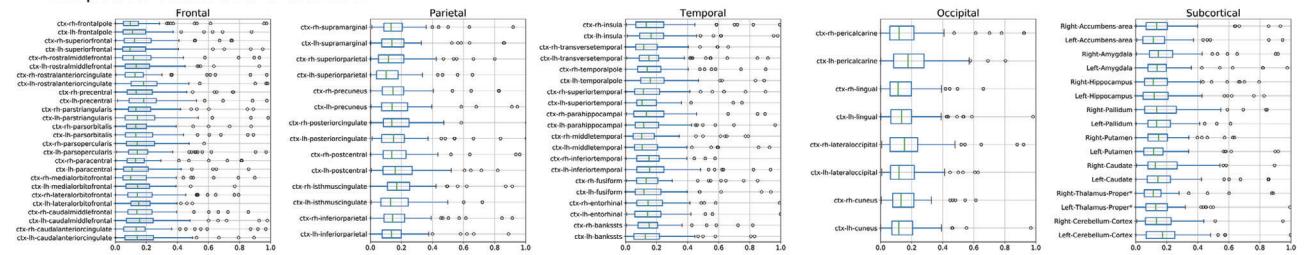
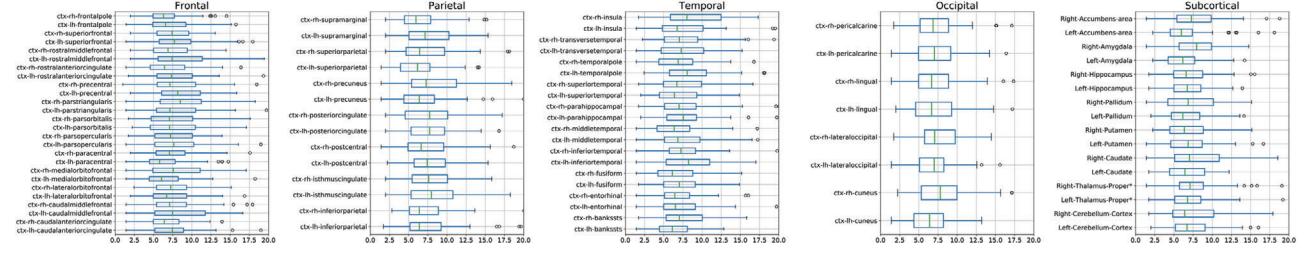


FIGURE 2

A Box plots for Sensitivity of each label**B Box plots for Specificity of each label****FIGURE 3****A Correlation plots for average volume of each label****B Correlation plots for average surface area of each label****FIGURE 4**

A Box plots for Volume error of each label**B** Box plots for Hausdorff distance of each label**FIGURE 5**