Brain Imaging Studies: High throughput by Automatic Processing Pipeline

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INTRODUCTION

We have collected 711 neonate brain MR images from an ongoing autism study (Autism Centers of Excellence - Infant Brain Imaging Study ACE-IBIS) . Each infant gets 3 scans at 6month, 1year and 2 years of age in order to characterize brain growth trajetories.

Since the same child gets repeated scans over time, we can combine the image processing of all three time points into a joint analysis step, which increases robustness and improves consistency of measures over the age range.

We have developed a fully automatic image processing pipeline to register serial scans of each subject, to provide tissue and brain lobe segmentation, and to segment major subcortical structures.

OBJECTIVES

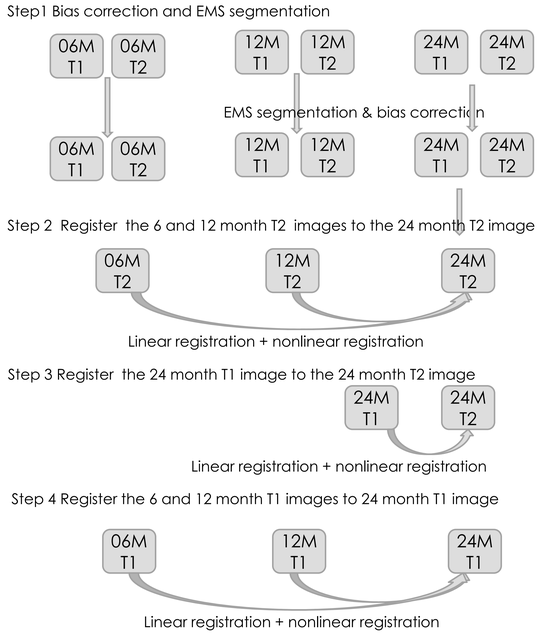
1. Register the images scanned at 6, 12 and 24 months all to 24 months for all 711 cases.
2. Use this longitudinal registration information for segmentation:
    1. White matter, Gray matter, CSF
    2. Hemisphere segmentation
    3. Brain parcellation segmentation
    4. Subcortical segmentation
3. Volume computing on based on the segmentation results listed above.
4. Cortical thickness computations on white matter and gray matter.
5. Segmentation of a set of subcortical structures.

T1:

The images above show the longitude registration result for one case on T1 modality. The images obtained at different times are transformed to the same position and size, enabling us to compare the intensity changes at a particular position.

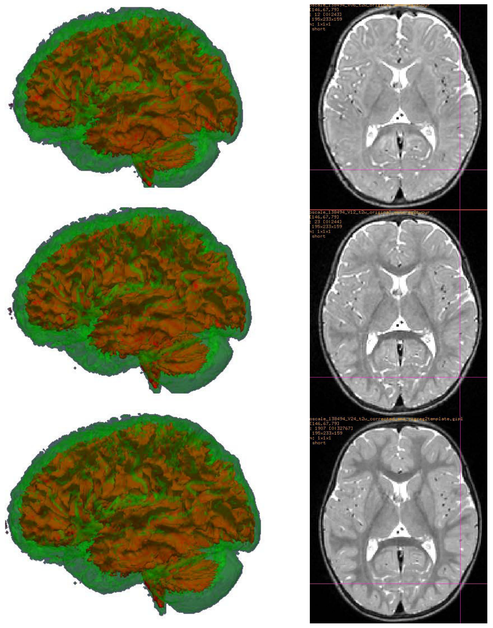
METHODS

Longitudinal Registration Pipeline



White and Gray Matter Segmentation

T2:

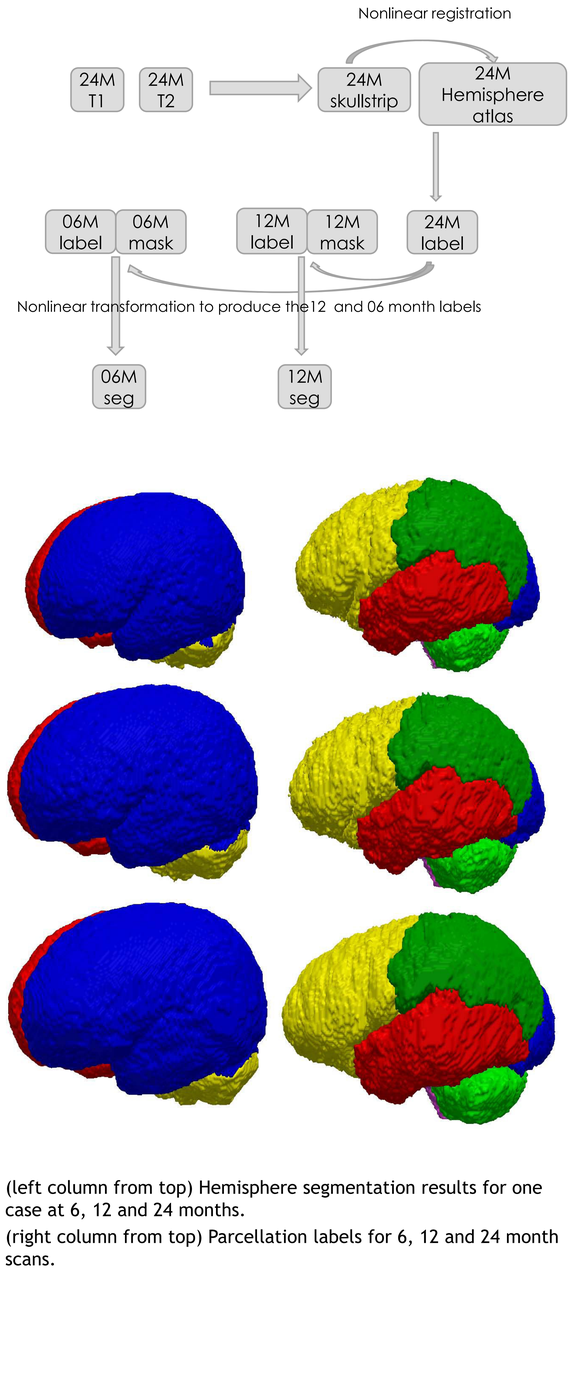


(left column from top) By using the processing pipeline above, we can get the WM (red) and GM (green) segmentation results for one case at 6, 12 and 24 months.

(right column from top) Registered T2 images obtained at 6, 12 and 24 months.

METHODS

Hemisphere and Parcellation Segmentation

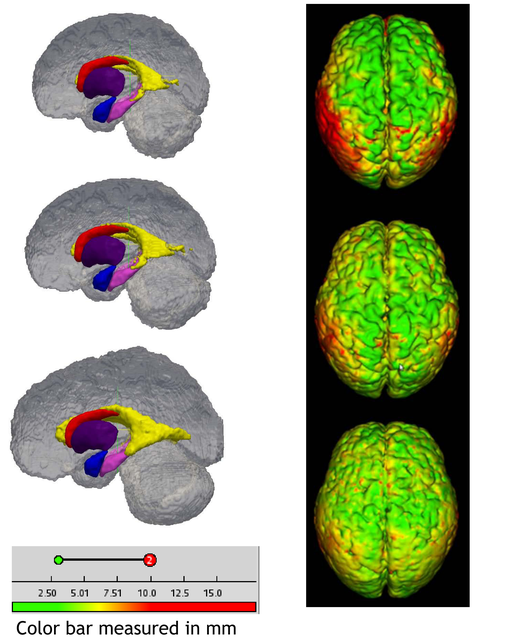


(left column from top) Hemisphere segmentation results for one case at 6, 12 and 24 months.

(right column from top) Parcellation labels for 6, 12 and 24 month scans.

RESULTS

Subcortical Segmentation and Cortical Thickness



Color bar measured in mm

(left column from top) Subcortical segmentation results for one case at 6, 12 and 24 months.

(right column from top) Gray matter thickness for one case at 6, 12 and 24 months. The green to red color transitions represent the cortical thickness from thin to thick.

CONCLUSION

The pipeline presented was used to parallel process all 711 cases on a 251 core HPC for several days and calculated the volume of WM, GM, CSF , left and right hemispheres, parcellation, and sub-cortical structures in mm^3. The segmentation results were also used in computing the cortical thickness on WM and GM.

In the future, we will model the intensity changes over time and use this model to further refine the segmentation and registration.

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