

## **Detecting brain growth patterns in normal children using tensor-based morphometry**

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Previous magnetic resonance imaging (MRI)-based volumetric studies have shown age-related increases in the volume of total white matter and decreases in total gray matter volume in normal children. However, detailed maps of dynamic growth patterns in the human brain are not yet available. We studied serial structural MRI scans (1.92 to 4.52 year scan interval) from twelve healthy children between the ages of 6 and 19. The follow-up scan of each subject was first rigidly aligned to the baseline scan. Both scans were then aligned to the standard space as defined by the International Consortium for Brain Mapping (ICBM) using a nine parameter affine linear transformation. A non-linear elastic intensity-based registration algorithm was used to deform the source image to the target by maximizing the mutual information between the deforming source and target. Based on the Jacobian map of the deformation field, an annualized tissue change map was then computed for each individual. An example tissue change map for an eight-year-old boy (initial scan conducted at age six), showed an averaged white matter growth in the frontal lobe (1% increase in the left inferior frontal lobe, 1.3% in the left middle frontal lobe, and 1% in the left superior frontal region). The right frontal white matter followed the same growth pattern with a slightly lower rate of increase. We also detected up to 5% tissue growth in the somatosensory and motor cortices. To study the growth pattern in this age group, we conducted voxel-wise one-sample t-tests of the twelve annualized Jacobian maps. The result revealed a significant tissue growth in frontal and parietal lobe white matter ( $P < 0.05$ ). We also examined the age effect by fitting a linear model, and the result suggested slowing down of the growth rate over time in regions with the greatest white matter growth. We demonstrated that a tensor-based Jacobian map is a reliable method to detect regional tissue changes during development.

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