Mapping the adolescent brain.

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Structural images are but color-coded representations of magnetic resonance (MR) signal measured throughout the brain and localized into individual 3D elements of the brain image (i.e. voxels). It is therefore relatively straightforward to apply various computational approaches to analyze such 3D matrices. For example, the following morphometric features can be quantified in each individual using fully automatic procedures: volumes of grey and white matter in the whole brain and its main subdivisions (e.g. frontal lobe); size/volume of well-demarcated brain regions (e.g. corpus callosum or caudate nucleus); variations in the shape of large (e.g. frontal pole) or small (e.g. central sulcus) morphological entities or those in cortical thickness. The latter two types of analyses are typically carried out throughout the brain, i.e. on a voxel-wise basis. Such voxel-wise comparisons of various age (or clinical) groups are also used to assess the "density" of grey and white matter. In my presentation, I will describe the basic principles of MR-based morphometry and provide examples of its use in studies of structural maturation of the human brain. I will conclude by describing the design of two developmental studies under way in our laboratory: (1) the Saguenay Youth Study, which is aimed at investigating the role of genes and environment on brain development during adolescence; (2) the Santa Fe Institute Consortium study, which is aimed at investigating structural and physiological underpinnings of inter-individual variations in social cognition and language during childhood and adolescence.

Suggested reading:

Paus, T., Zijdenbos, A., Worsley, K., D. Collins, D.L., Blumenthal, J., Giedd, J.N., Rapoport, J.L., Evans, A.C. Structural maturation of neural pathways in children and adolescents: in vivo study. Science 283:1908-1911, 1999.

Paus T, Collins DL, Evans AC, Leonard G, Pike B, Zijdenbos A. Maturation of white matter in the human brain: a review of magnetic-resonance studies. Brain Research Bulletin 54:255-266, 2001.