Brain Warping

The Incredible Technology that Ushered in the Modern Era of Neuroscience Neuroimaging Studies

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Seeing is **Everything**
Qualitative Art $\Rightarrow$ Quantitative Science
Where *Exactly* Are We?

- Esophageal cancer; brain metastasis
- Parietal lobe, corticospinal tract, motor function
Where *Exactly* Are We?

- Complex scene encoding experiment
- Occipital lobe, parahippocampal gyrus
Where *Exactly* Are We?

Localization *precision* will potentially have correspondingly greater *impact* on diagnosis and treatment.

- Frontotemporal lobar degeneration
- Temporal lobe
Atlases of Anatomy

www.bic.mni.mcgill.ca/brainweb/
GPS for the Brain

Template Image

Anatomic Atlas

Anatomic Labels

Subject

?
Normal Individuals Share a Common Anatomical Topology
Normal Individuals Share a Common Anatomical Topology

Reference
Establishing Correspondences between Points in Different Images
Establishing Correspondences between Points in Different Images
GPS for the Brain

Anatomic Atlas

Template Image

Anatomic Labels

REGISTER

Spatial Transformation

WARP

Individualized Atlas

OVERLAY

Subject

Atlas-based Localization
Dynamics of Brain Maturation in Schizophrenia
Irregular Lung Motion Patterns in Disease

IPF original lung showed less movement in middle-lateral direction presumably due to pulmonary fibrosis; transplanted lung also showed irregular motion pattern.
Spatial Transformations Quantify Local Shape and Size Change

Circle to Square Transformation

Shape Difference

Chimp to Human
Evolution of Brain and Language

Human
Chimp Warped to Human
Chimp

Red: Areas for which humans are relatively larger than chimps
Effects of Gestational Cocaine Exposure on Brain Development
Anatomic Normalization into Common Space

Anatomic Atlas

Template Image

Anatomic Coordinates

REGISTER

Spatial Transformation

NORMALIZE

Subject(s)

Structure Function Information
Corticospinal Tract Impairment in Amyotrophic Lateral Sclerosis
Brain White Matter Abnormality in Frontotemporal Dementia
Longitudinal Neuroimaging of Frontotemporal Dementia

Annualized Average FTD Progression:
Expansion and Compression Greater than 3% per Year
corpus callosum
corticospinal tract
inferior longitudinal fasciculus
superior longitudinal fasciculus
inferior fronto-occipital fasciculus
uncinate fasciculus