



MICCAI SEPTEMBER 20-24, 2010
BEIJING · CHINA



Diffusion MRI: Tools and Applications

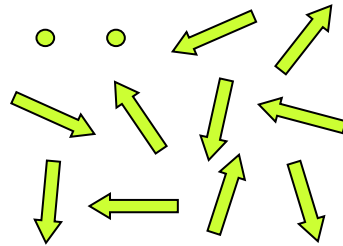


Sonia Pujol, Ph.D.
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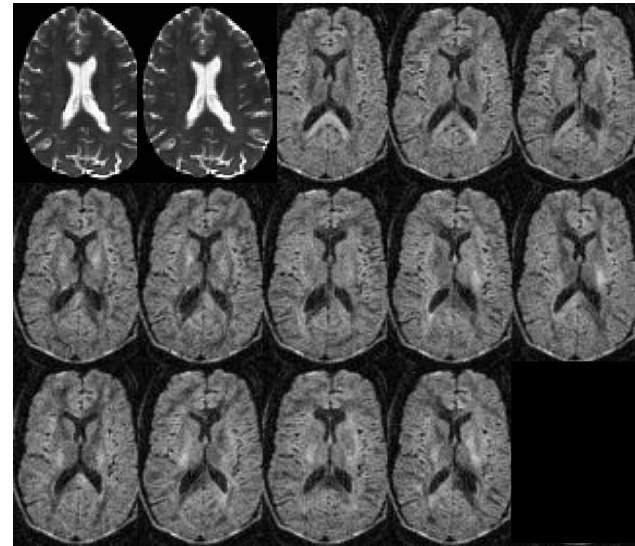




Diffusion Weighted Imaging

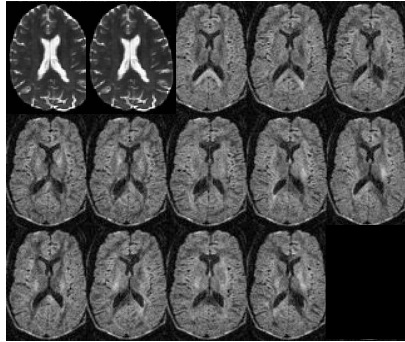


Diffusion
Sensitizing
Gradients





Diffusion Weighted Imaging



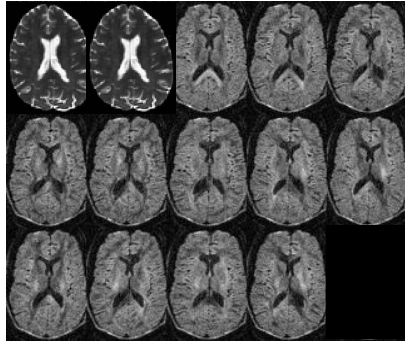
Diffusion
Weighted
Images

$$S_i = S_0 e^{-b \hat{g}_i^T \underline{D} \hat{g}_i}$$

(Stejskal and Tanner 1965, Basser 1994)



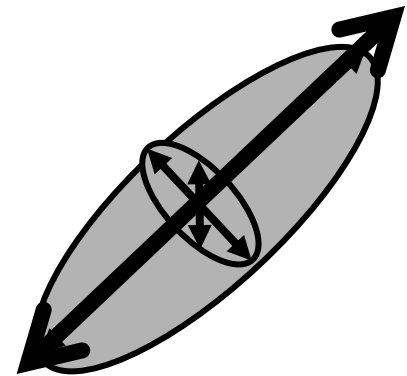
Diffusion Tensor Imaging



Diffusion
Weighted
Images

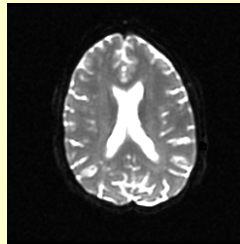
$$S_i = S_0 e^{-b \hat{g}_i^T \underline{D} \hat{g}_i}$$

$$\underline{D} = \begin{bmatrix} D_{xx} & D_{xy} & D_{xz} \\ D_{yx} & D_{yy} & D_{yz} \\ D_{zx} & D_{zy} & D_{zz} \end{bmatrix}$$

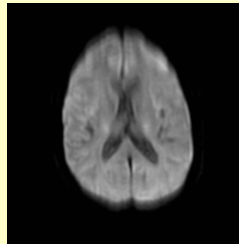




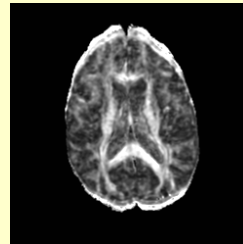
DTI Analysis



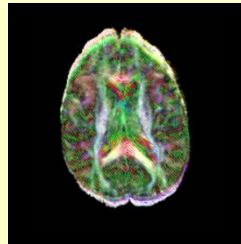
DWI



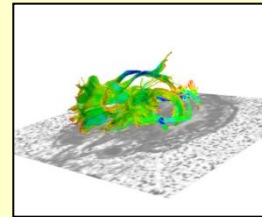
DTI



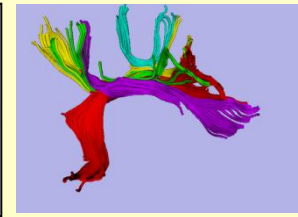
Scalar Maps



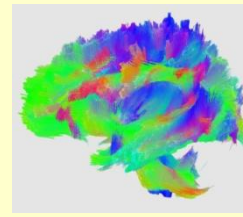
Glyphs



Tracts



Clusters



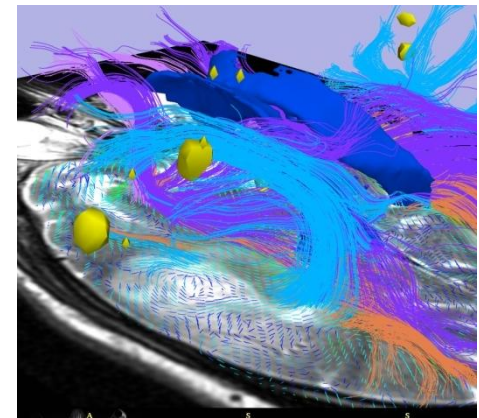
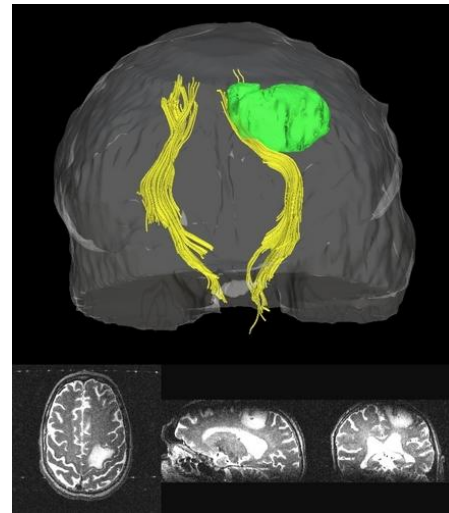
Atlas

- Algorithms
- Tools
- Applications



Clinical Application: Neurosurgical Planning

- Incision and trajectory planning to preserve function
- 3D Visualization of tumor mass effect on white matter structures

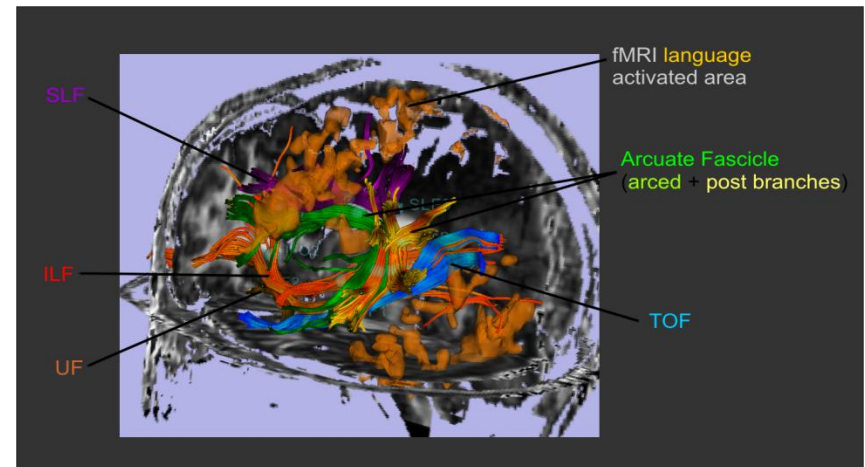
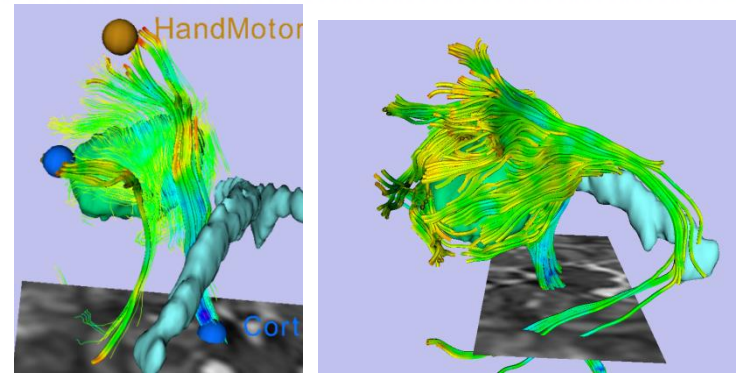


Images courtesy of Lauren O'Donnell, PhD and
Alex Golby, MD



Virtual Probing

- Movable seed point
- Interactive probing of peritumoral fiber bundles
- fMRI display in context with structural and DTI volumes



Slide courtesy of Ron Kikinis, MD and Jean-Jacques Lemaire, MD, PhD



Clinical Application: Autism Research

- A key diagnostic feature of autism is impairment in communication
- DTI analysis of the arcuate fasciculus showed that white matter microstructure is affected in autism

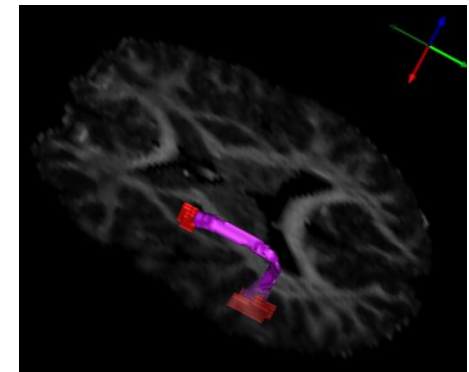
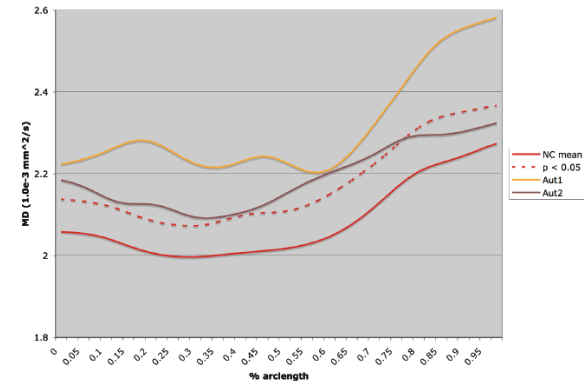
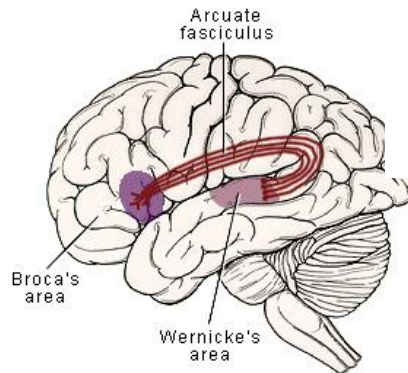


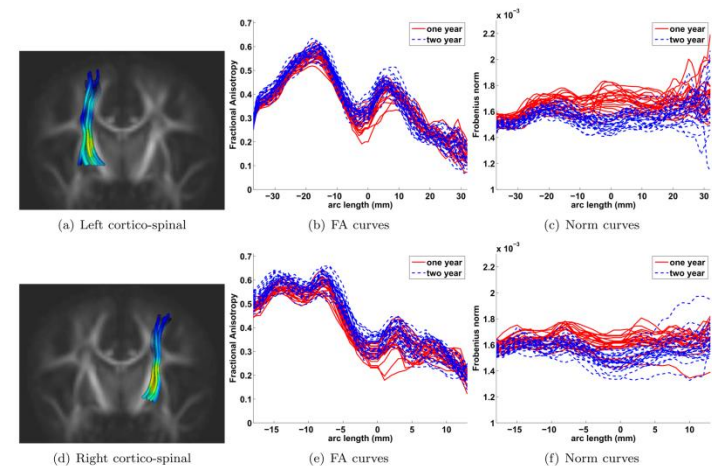
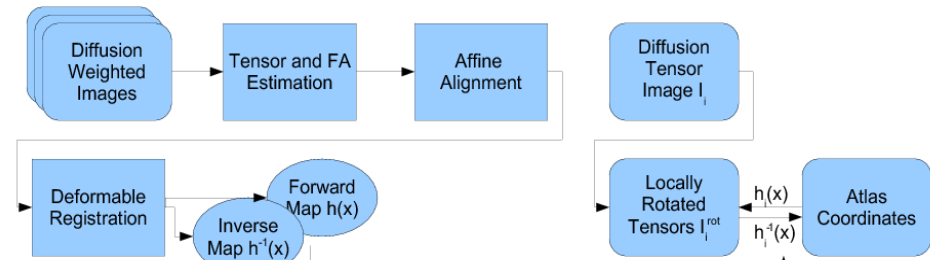
Image courtesy of Tom Fletcher, PhD

Fletcher P.T., Whitaker R.T., Tao R., DuBray M.B., Froehlich A., Ravichandran C., Alexander A.L., Bigler E.D., Lange N., Lainhart J.E.
Microstructural Connectivity of The Arcuate Fasciculus in Adolescents With High-Functioning Autism. Neuroimage. 2010 Jul 1;51(3):1117-25.



Population-based Analysis

- Non-rigid registration of a population to a common coordinate system
- Comparison of tensor features and fiber tract geometry
- Clinical Application: Neurodevelopment



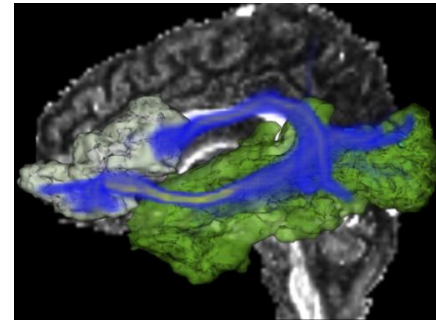
Images courtesy of Guido Gerig, PhD

Goodlett C., Fletcher P.T., Gilmore J.H., Gerig G. Group Analysis of DTI Fiber Tract Statistics with Application to Neurodevelopment. *Neuroimage* 2009 Mar;45(1 Suppl):S133-42.

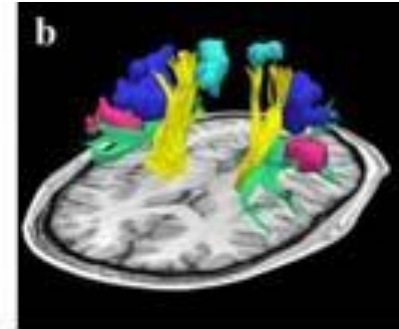


DTI Tractography Validation

- Pilot study on the quantitative evaluation of DTI tractography algorithms in the absence of ground truth
- Cross-comparison of different tractography approaches on five white matter fascicles



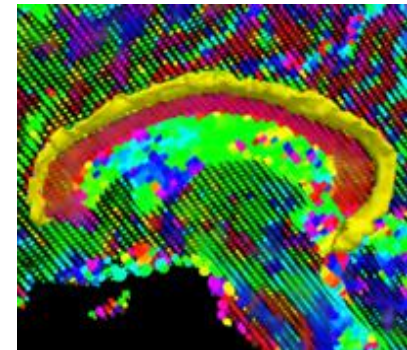
Courtesy of CF Westin, PhD



Courtesy of CF Westin, PhD



Courtesy of Tom Fletcher, PhD and Ross Whitaker, PhD



Courtesy of Allen Tannenbaum, PhD

S.Pujol, C-F Westin, R.Whitaker, G.Gerig, T.Fletcher, V.Magnotta, S.Bouix, R.Kikinis, W.Wells III, R.Gollub. Preliminary results on the use of STAPLE for evaluating DT-MRI tractography in the absence of ground truth. ISMRM 2009, Apr.18-24 2009, Honolulu, Hi



Acknowledgements



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