

# In Celebration of SPL's 25th Reunion

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April 9, 2016







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## 1987 – Ron and I meet Ferenc

### Ron

Post-doctoral Fellowship with Ferenc?

Meeting Ferenc – Wow!

### Marty

Submit a K Award?

Don't submit a K Award.

Talk to Ferenc.

Sitting in the bowels of BWH waiting outside his office to see Ferenc.

Meeting Ferenc – Wow!



Ferenc Jolesz

## 1988 – Ron and I meet

### Ron

Receives *Nachwuchsförderungsstipendium*, equivalent to a K Award.

Comes to BWH to work with Ferenc.

### Marty

K01 Award is funded by NIMH.

Ferenc proclaims that nothing will be found in schizophrenia.

Ferenc introduces me to Ron.

Ron and I begin work in Thomas Sandor's Lab. Teaches me neuroanatomy as seen in MR.

This is 1988, pre-Surgical Planning Laboratory.





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## “Forever Young,” by Bob Dylan

**1988** to the Present

28 years

His “oldest collaborator”

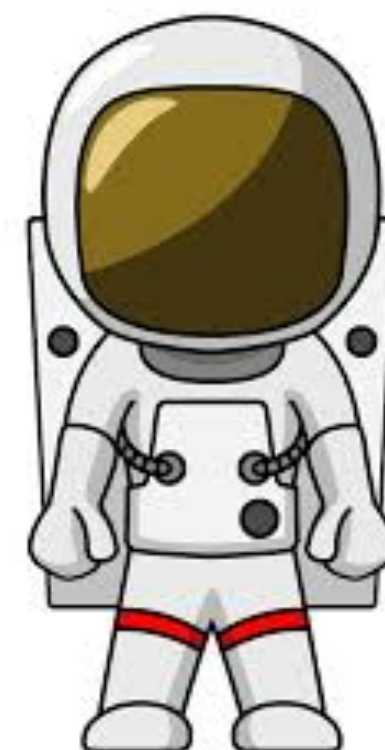
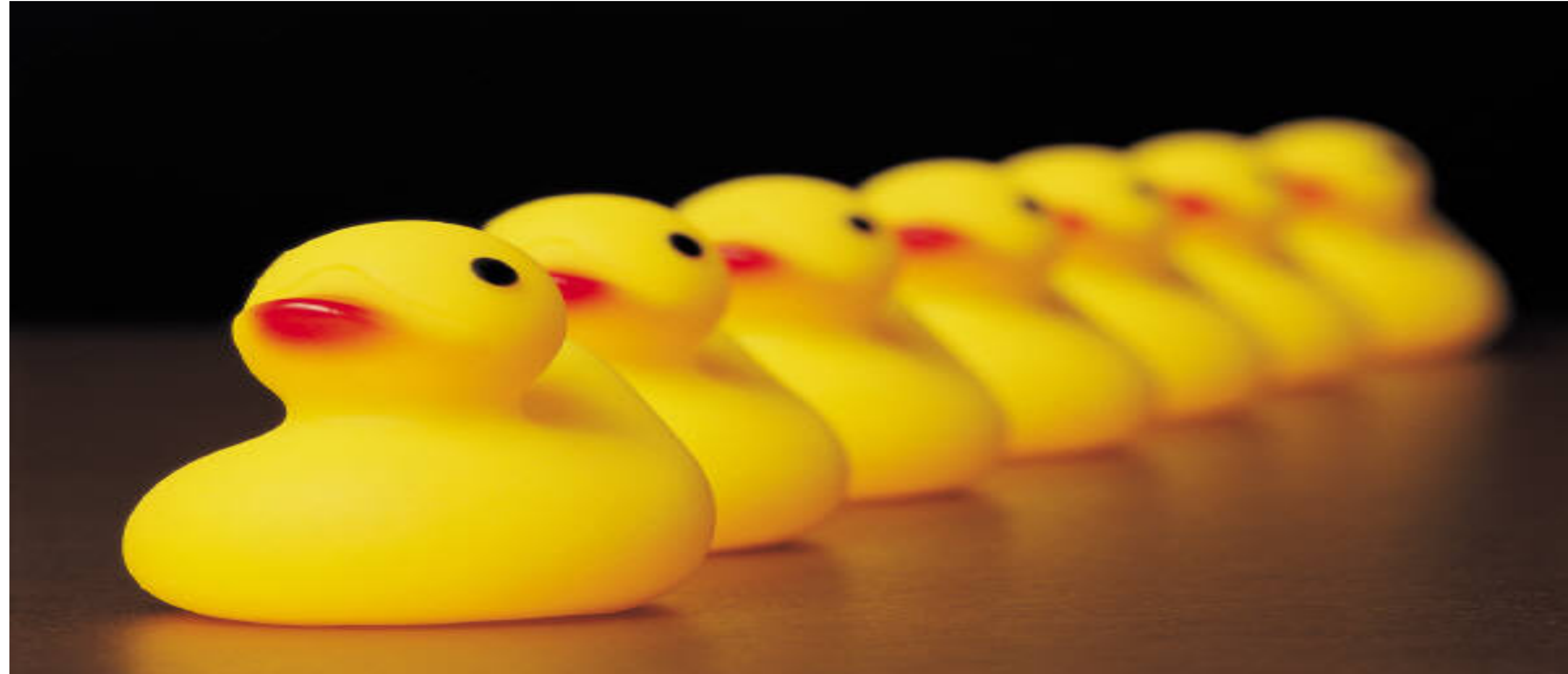


**1992** Stanley Award Winners: Drs. Ron Kikinis and Martha Shenton use satellite technology to study brain abnormalities in schizophrenia.





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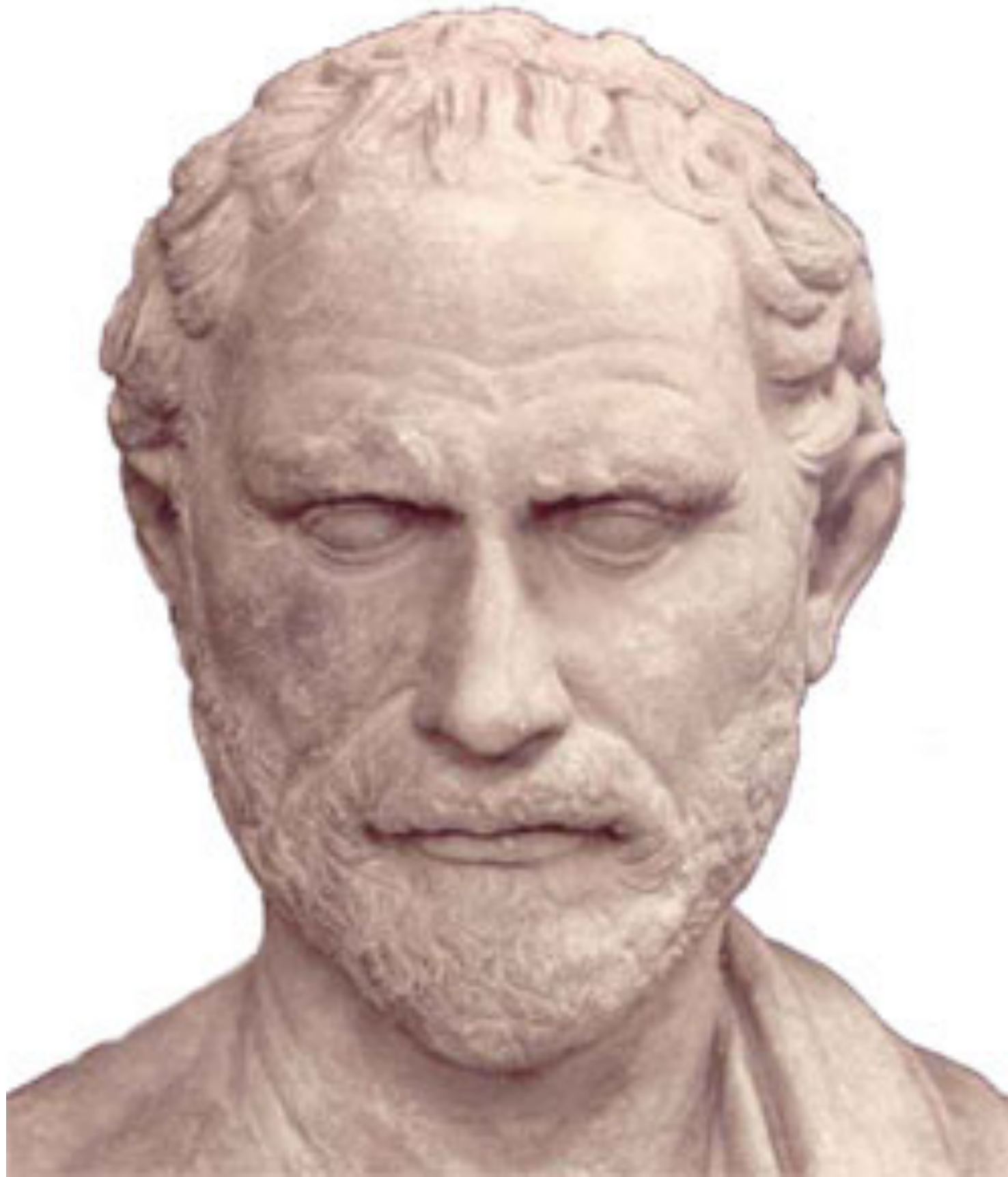


*But  
Ron had a Vision*





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*Small opportunities are often  
the beginning of great enterprises.*

*- Demosthenes*





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## From Humble Beginnings

Maintenance  
Closet

*One day in **1990***

Surgical Planning  
Laboratory

Ron, Mark Anderson, Marianna Jakab,  
Diane Doolin, Marty

Now More than  
1,000 Members or  
Associate Members





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## **Ron's Vision for the SPL**

- While extracting information from images for clinical purposes may be difficult, the challenge becomes more difficult in attempting to learn about diseases such as schizophrenia, multiple sclerosis, or cancer by examining anatomical changes in thousands of patients. Without proper computational tools, medicine cannot fully leverage the potential of imaging for improving the understanding and treatment of diseases that humanity continues to face.
- The SPL was founded on the belief that often science, discovery, and new treatments for disease come from the development of advanced tools without which important questions can not be answered, and without which our knowledge of diseases and their improved treatment can not go forward.





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## Time for Fun – 1990-1991

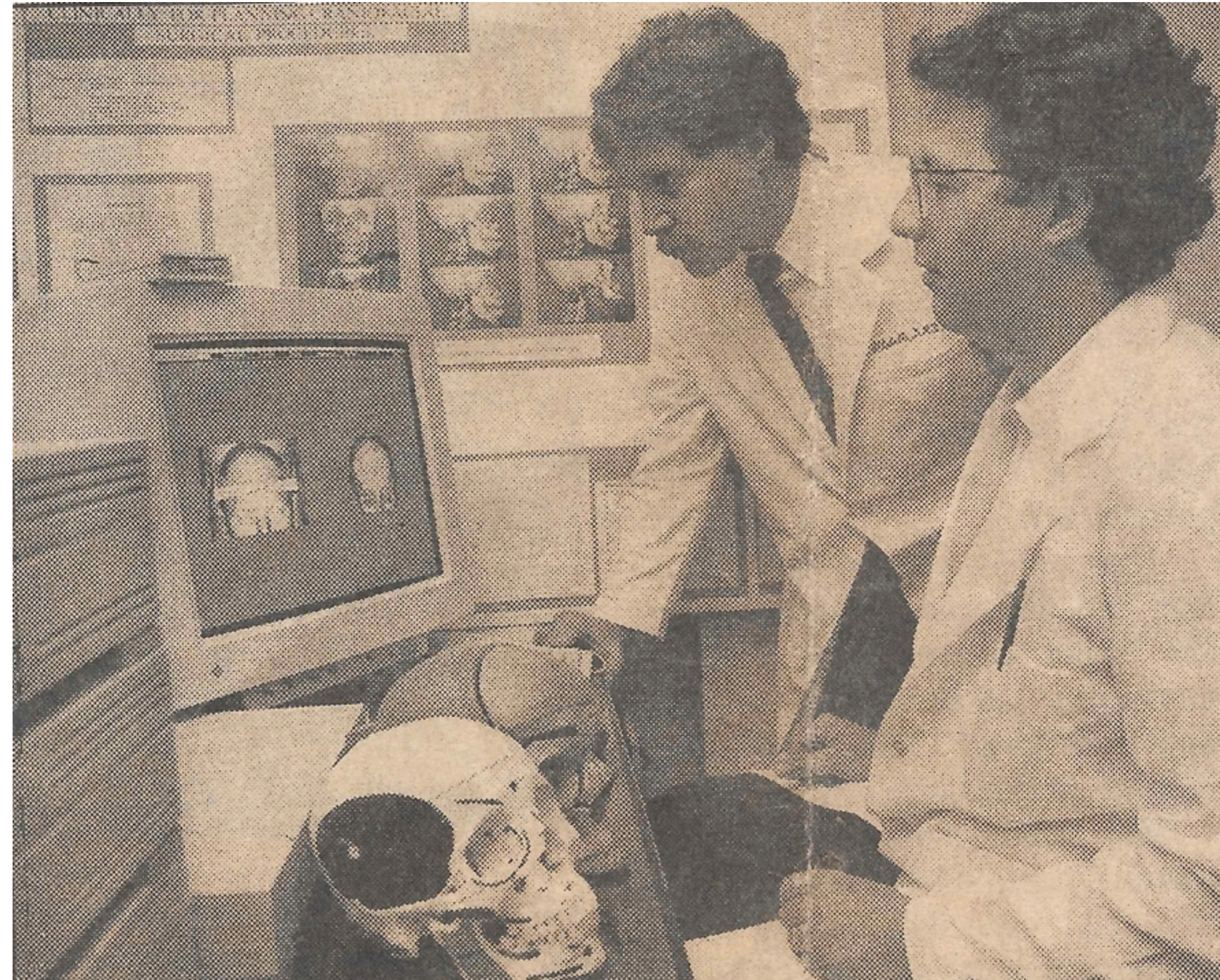






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## 1992 – Boston Globe Article



Ron and David Altobelli – Pre-Surgical Planning for Craniofacial Surgery



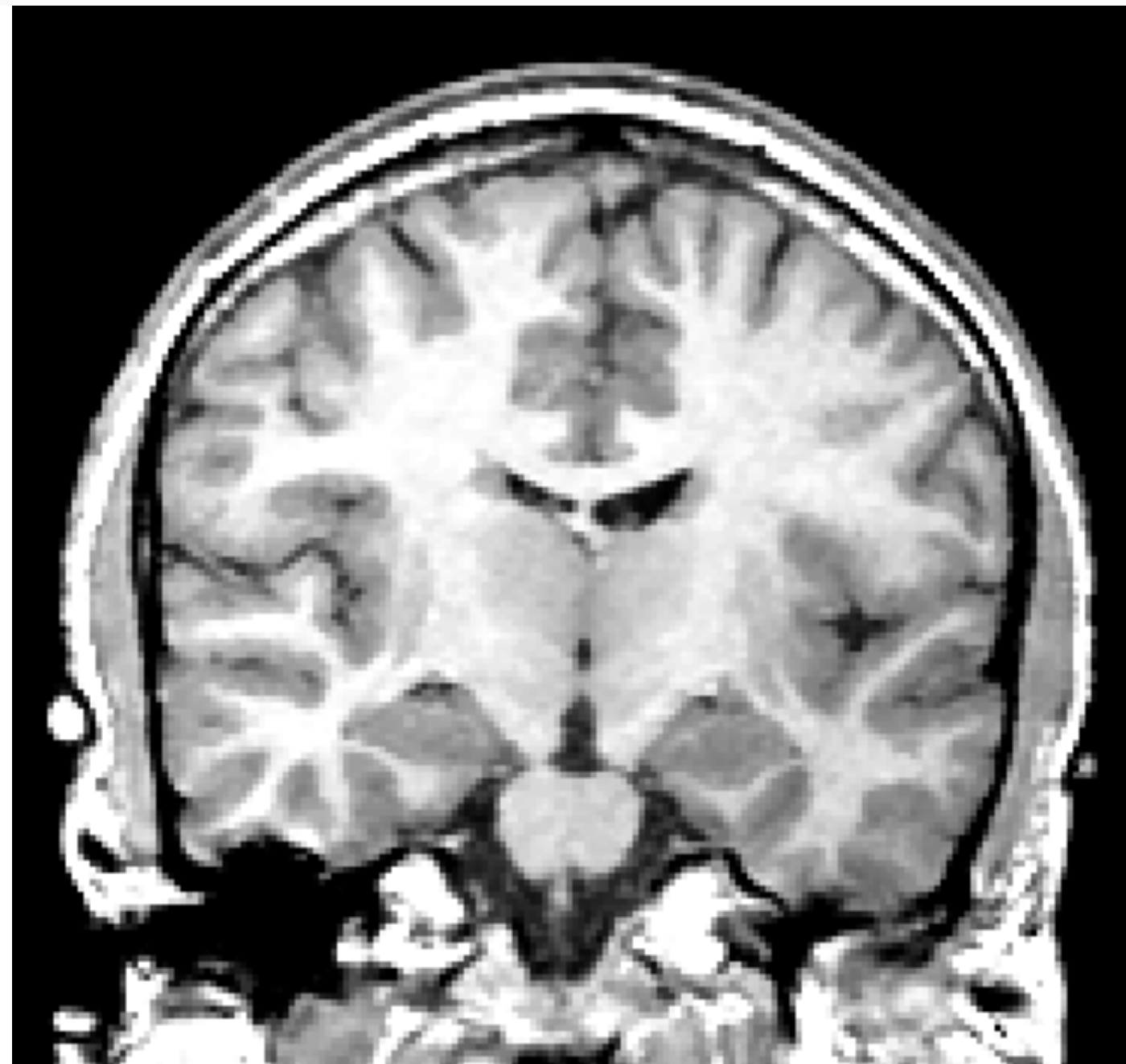


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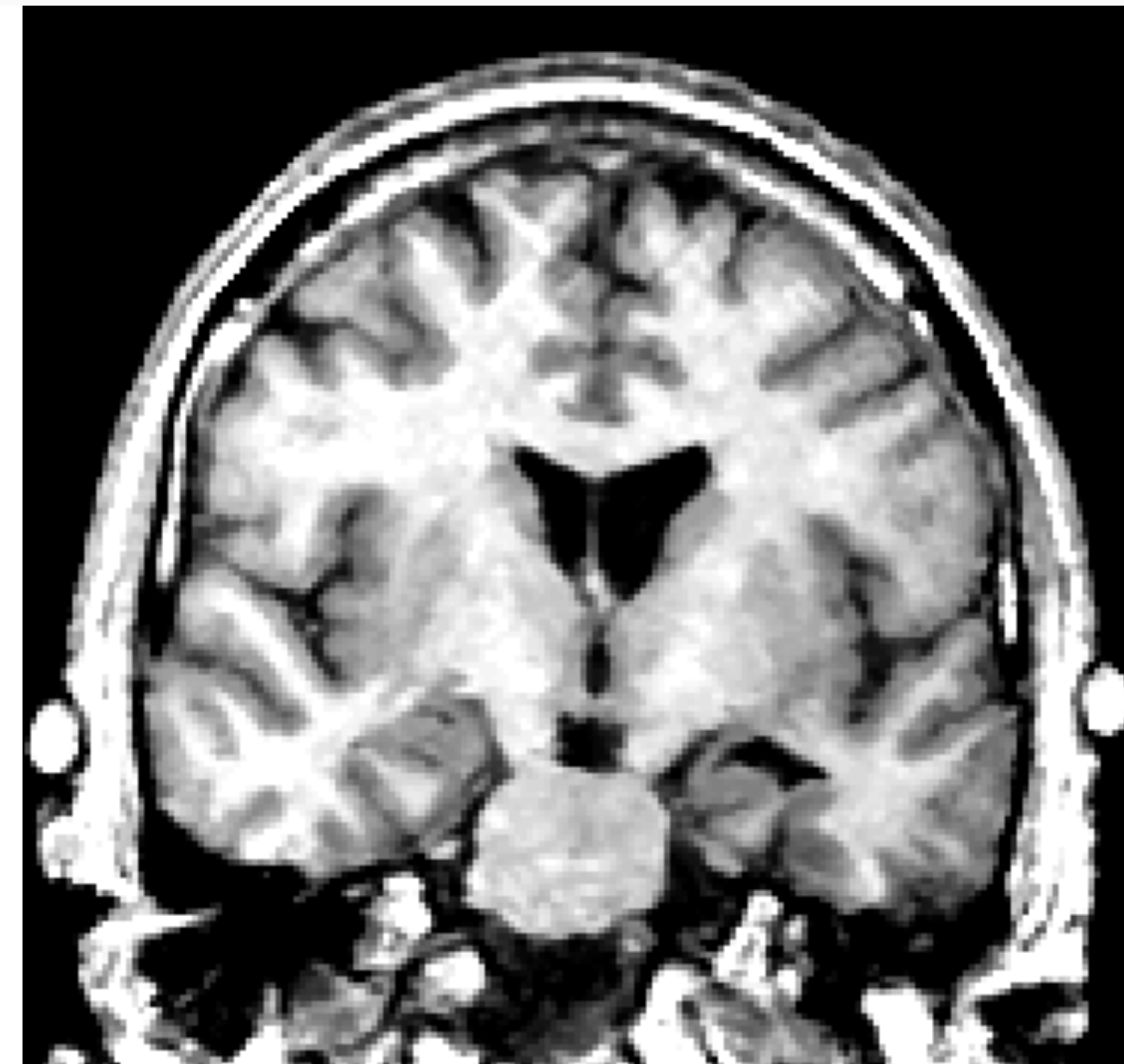
## ABNORMALITIES OF THE LEFT TEMPORAL LOBE AND THOUGHT DISORDER IN SCHIZOPHRENIA

### A Quantitative Magnetic Resonance Imaging Study

MARTHA E. SHENTON, PH.D., RON KIKINIS, M.D., FERENC A. JOLESZ, M.D., SETH D. POLLAK, M.A., MARJORIE LEMAY, M.D., CYNTHIA G. WIBLE, PH.D., HIROTO HOKAMA, M.D., JOHN MARTIN, B.S., DAVE METCALF, B.S., MICHAEL COLEMAN, M.A., AND ROBERT W. MCCARLEY, M.D.



Healthy Control



Patient with Schizophrenia

**NEJM 1992**



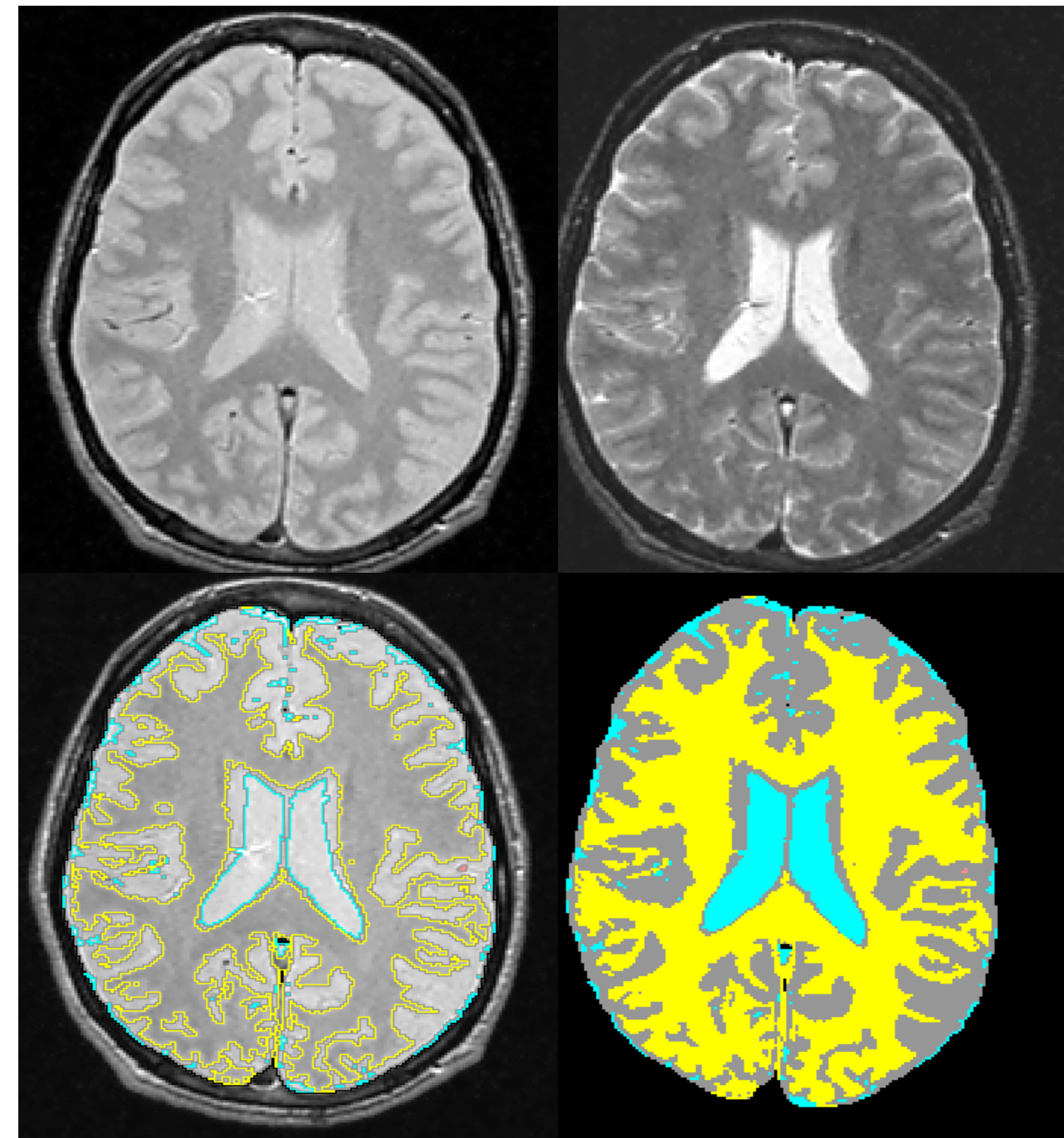
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## Automated Segmentation into Tissue Classes

**1992-1994** Stanley Foundation Grant

**1992-1995** Whitaker Foundation Grant

Assign a single label to a set of points in an image which belongs to the same structure.







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## Visualization for Pre-Surgical Planning

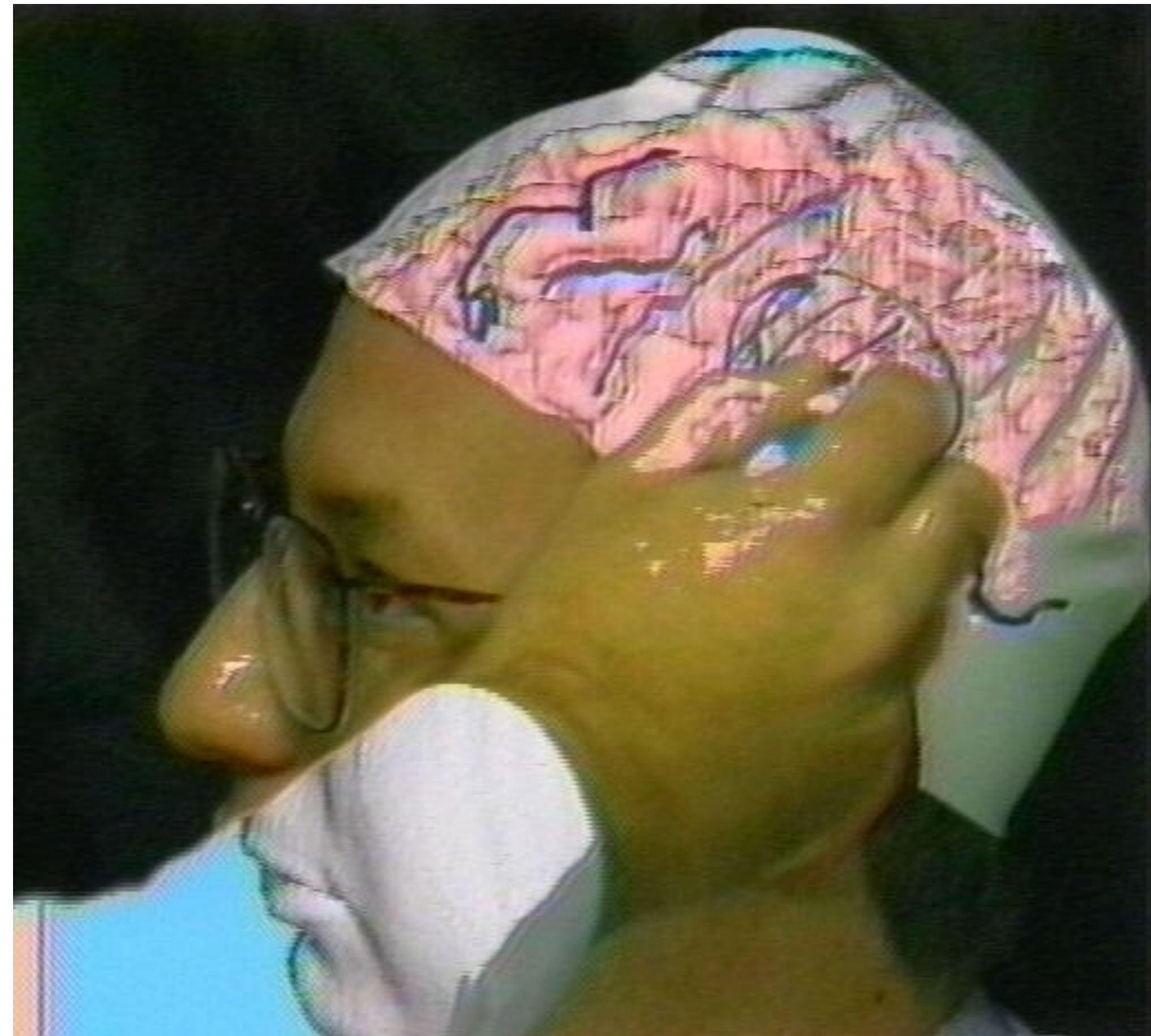
Image Guided Surgery (IGT)

Multiple Sclerosis

Schizophrenia

Diagnostic Imaging

Other

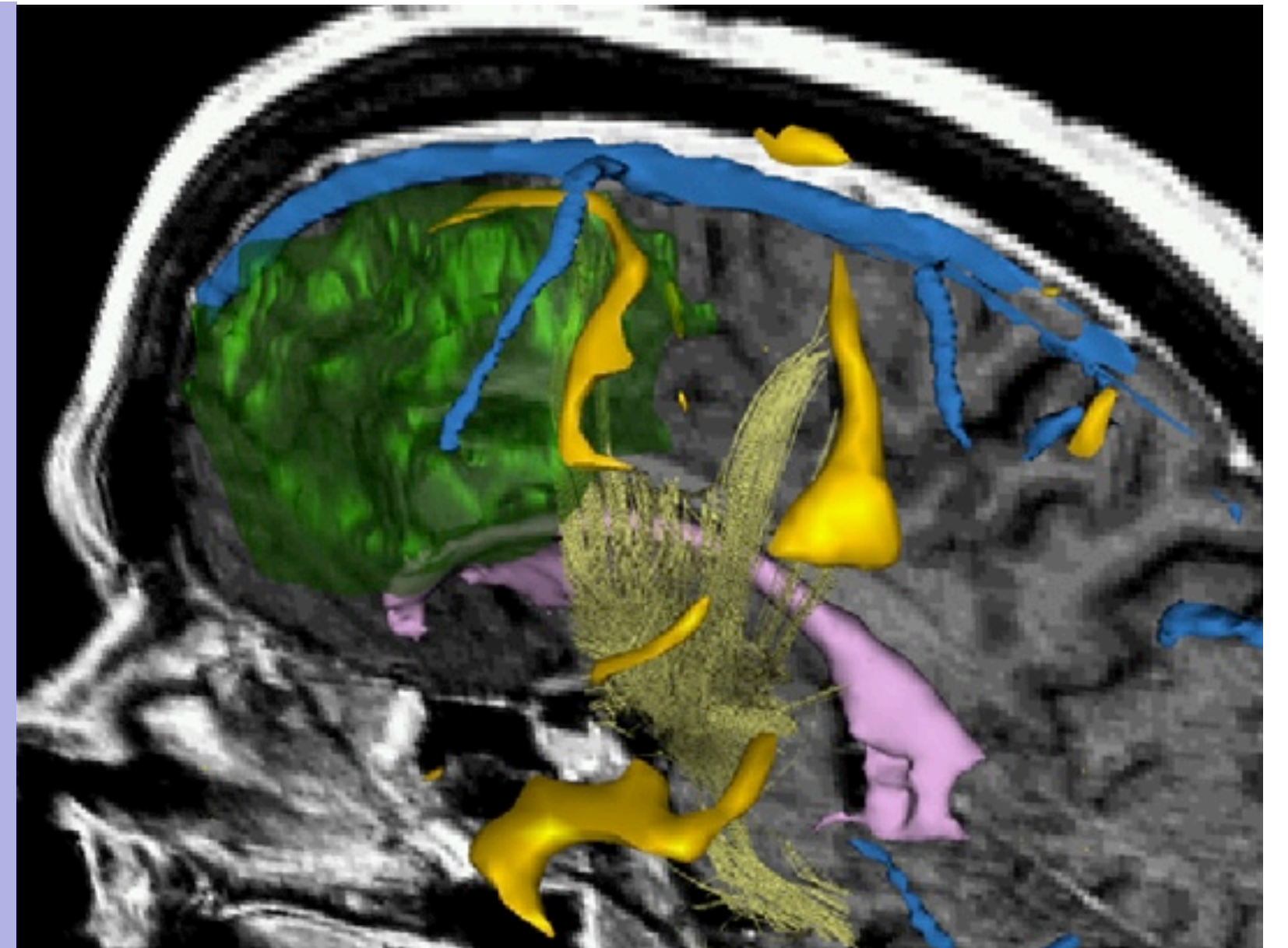
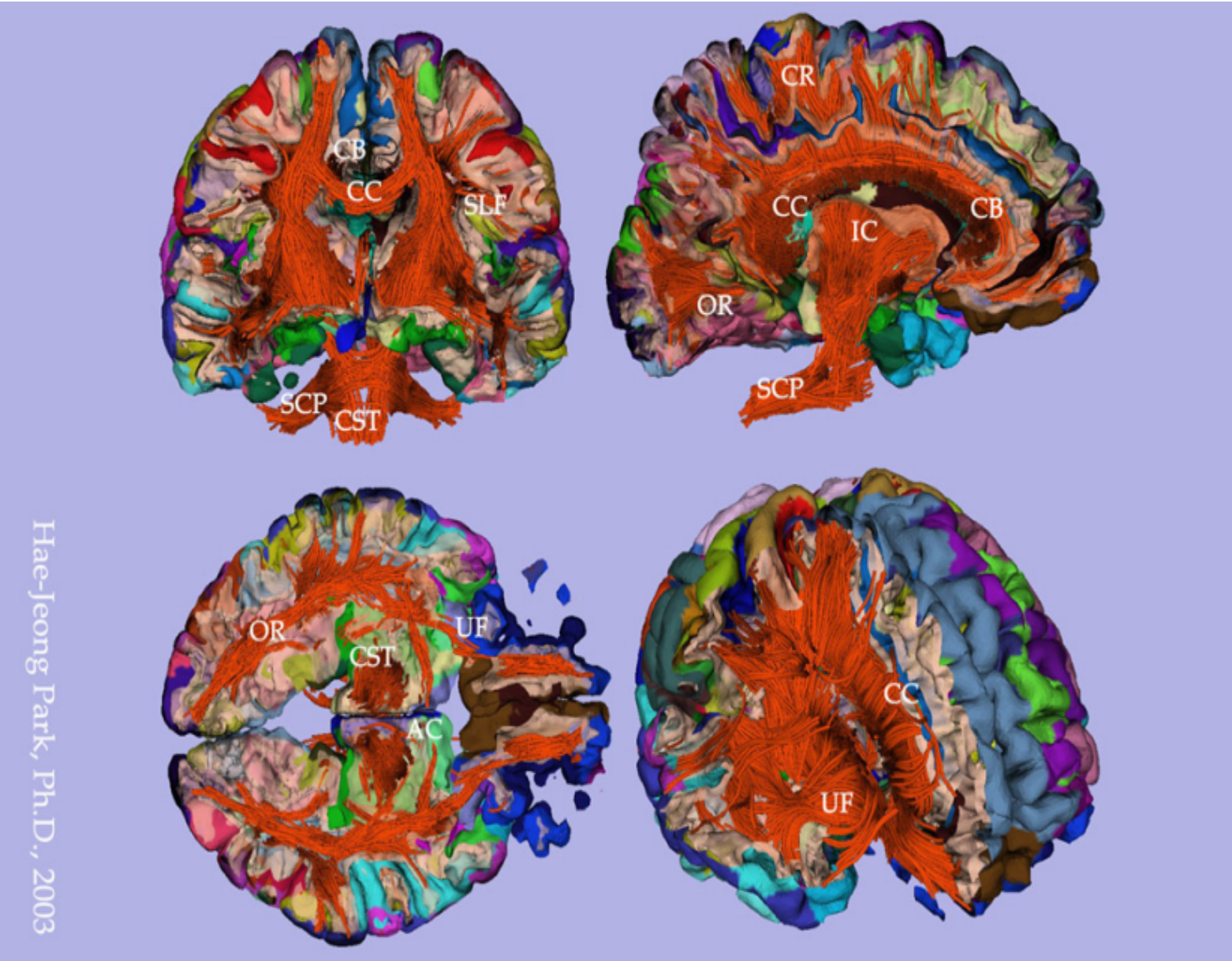
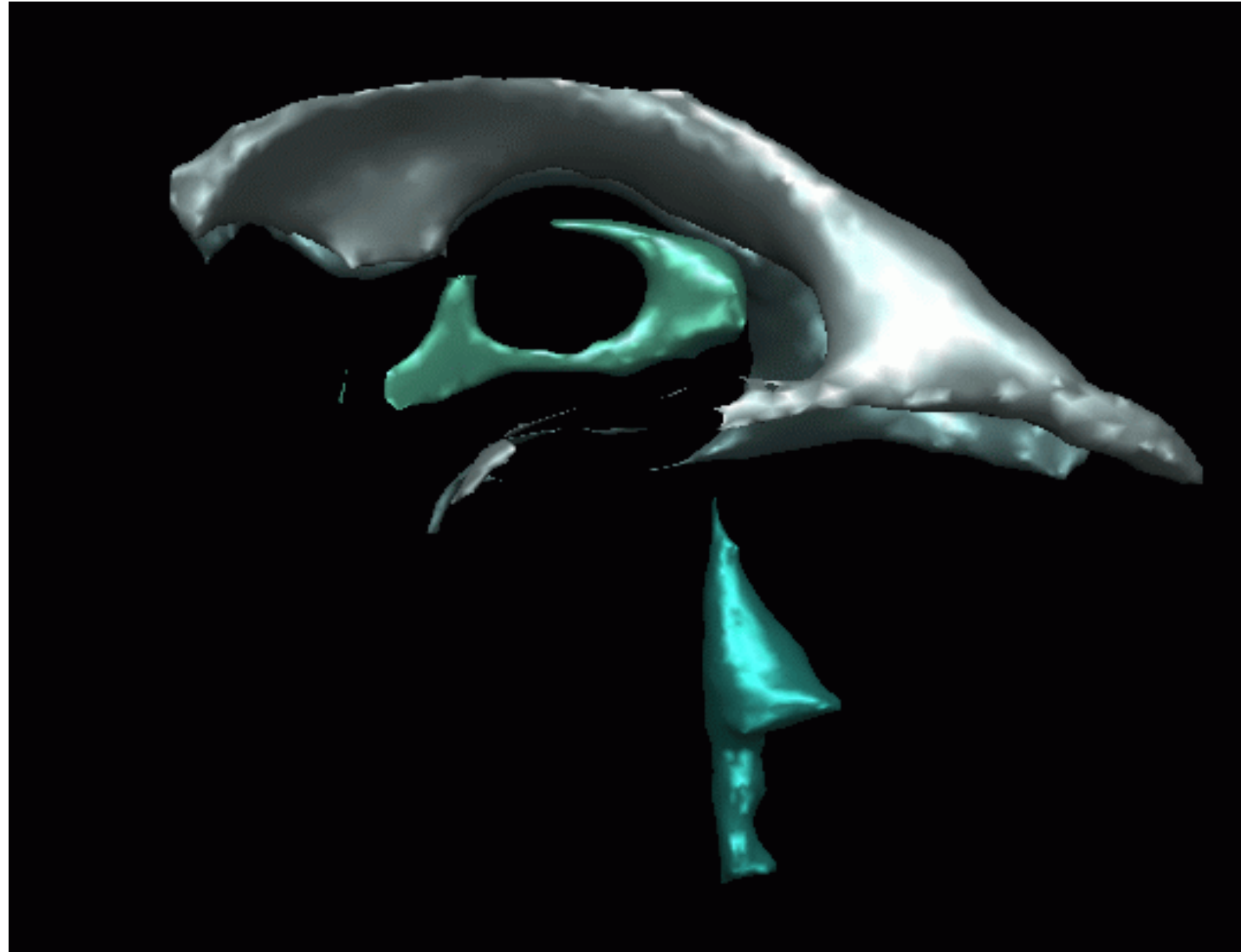






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## Extracting Visual Information from Medical Images







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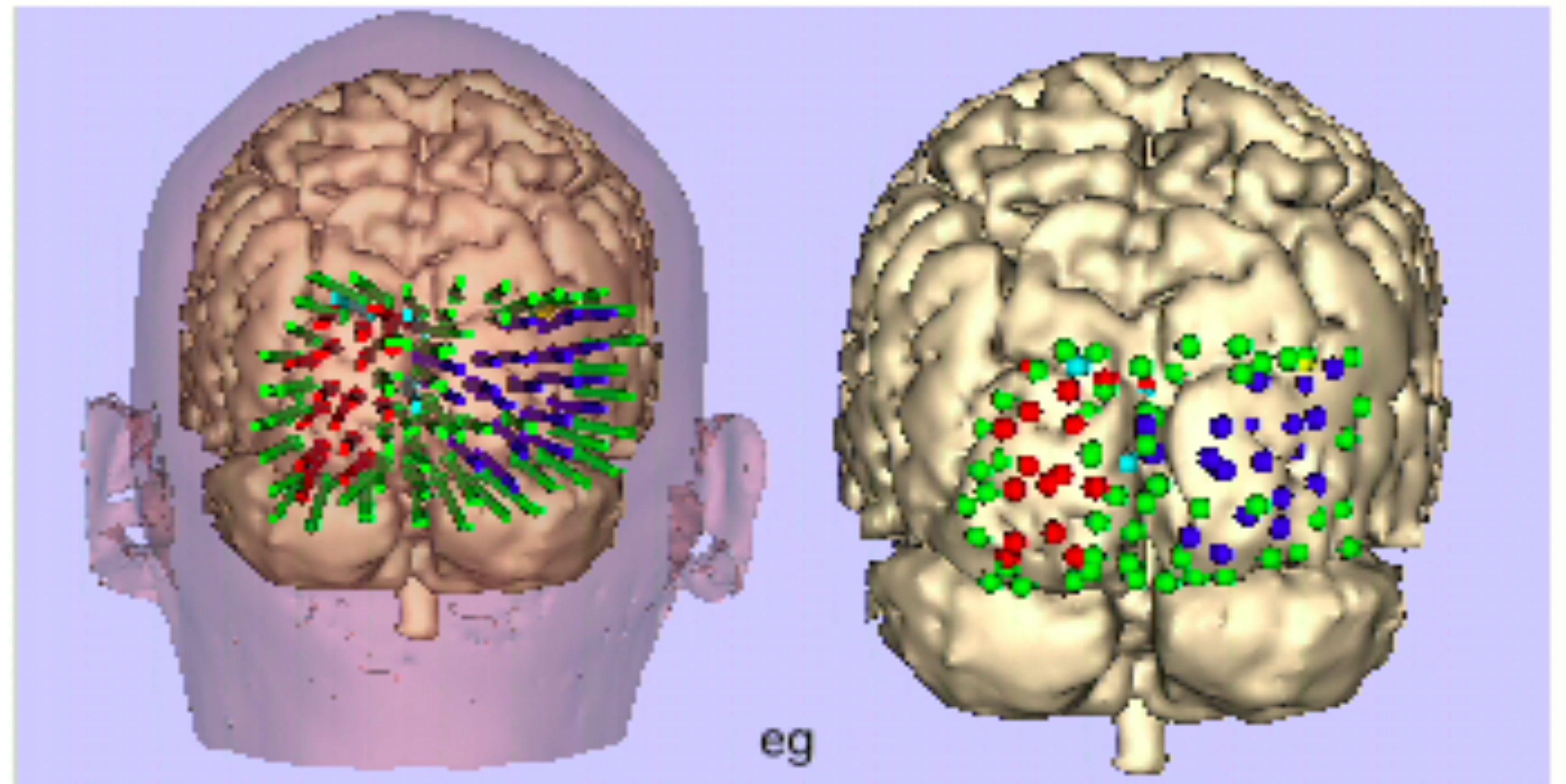
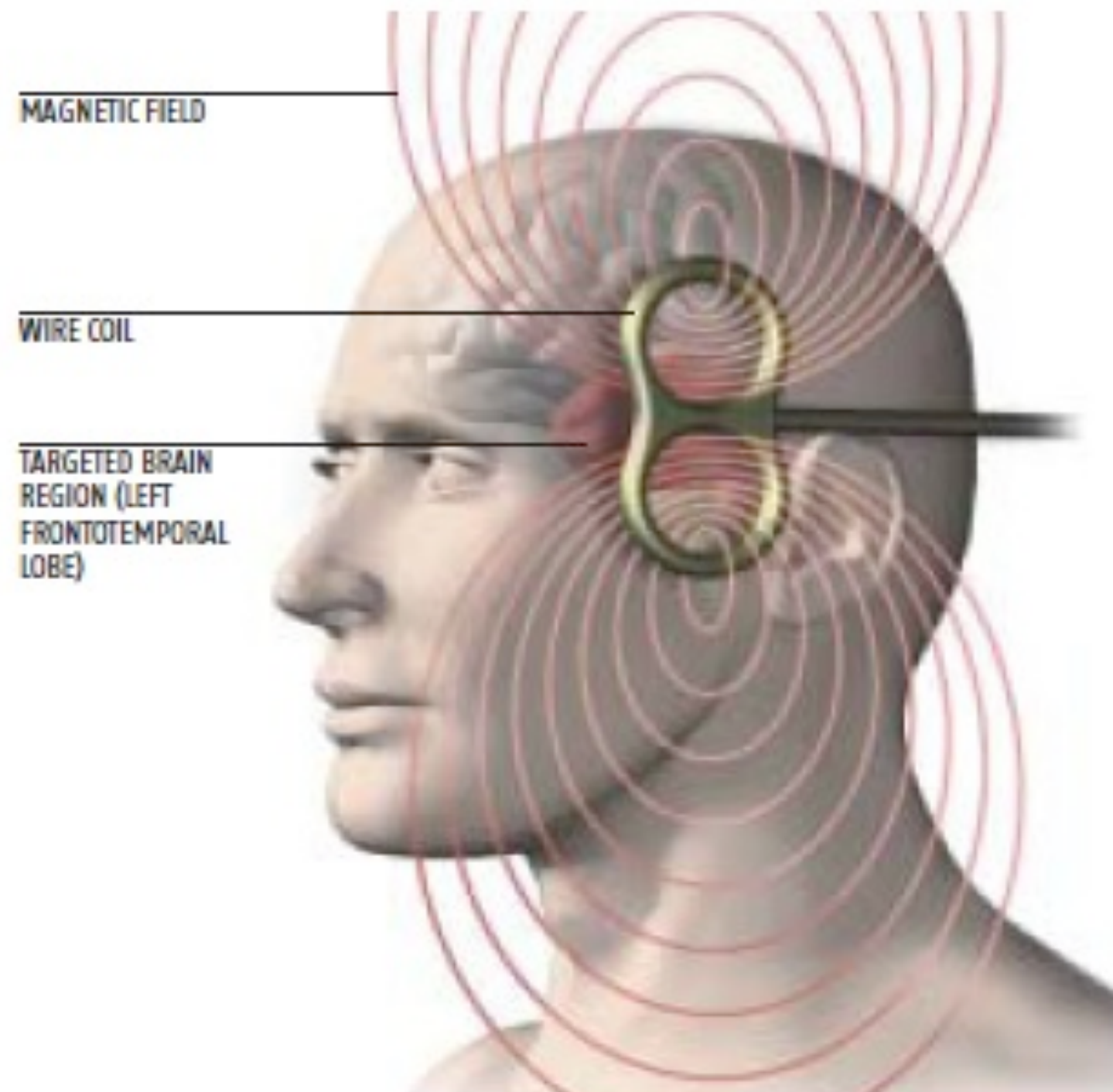
**1995-1997 – Scottish Rite Grant: Transcranial Magnetic Stimulation**

## **GENIUS MACHINE or Too Much Time on Our Hands?**

Ron Kikinis, Martha Shenton, Eric Grimson, Eben Alexander III, Laverne Gugino  
(Gill Ettinger, Mike Leventon, Linda Aglio, Geoff Potts)

– **Saturday Mornings** –

**TMS Figure 8 Coil**

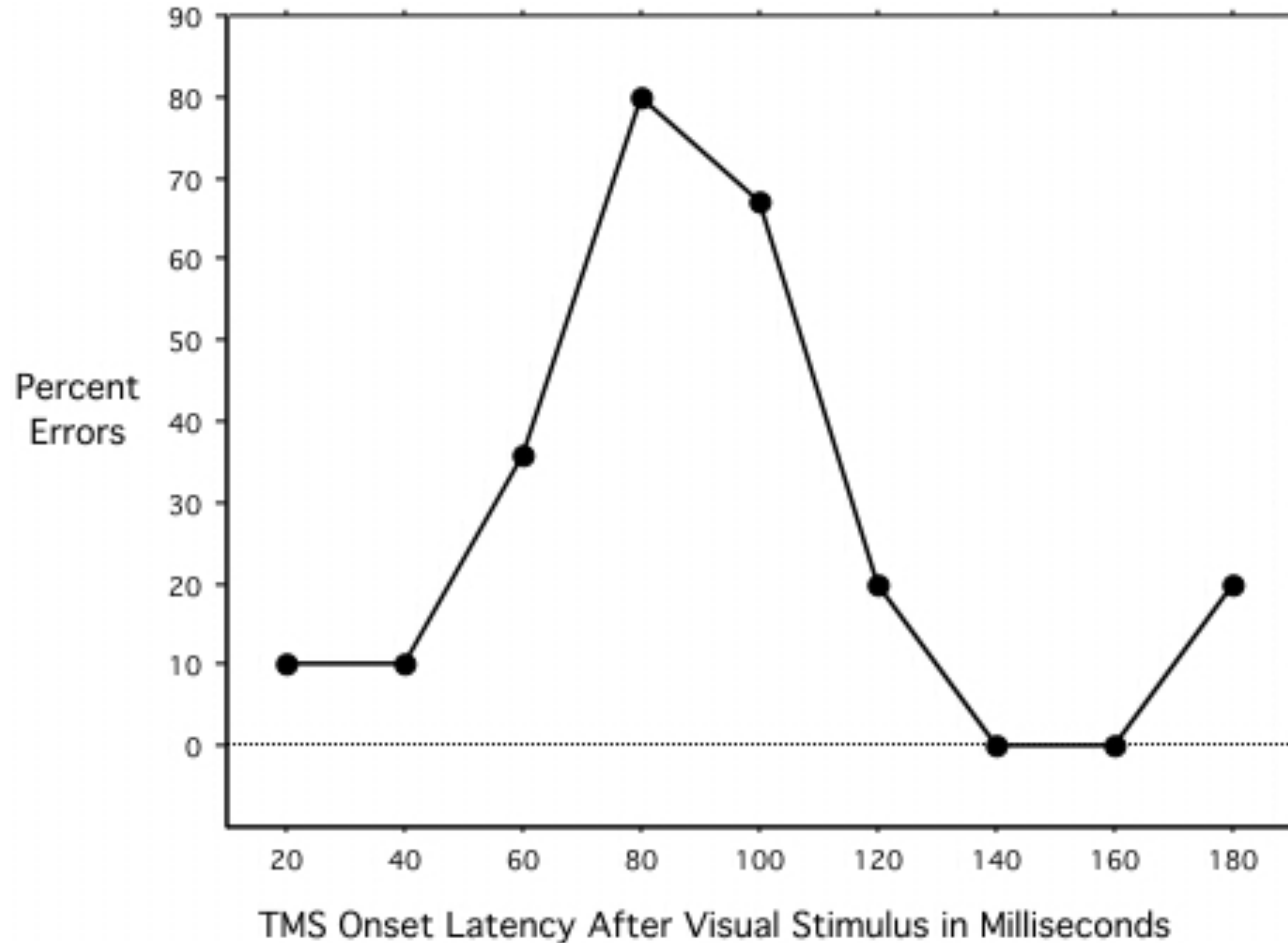






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## Suppressing Vision (Visual Blindness) Using TMS





# How the Brain Works – 1999

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## 1999 Diffusion Tensor Imaging



Carl-Fredrik Westin



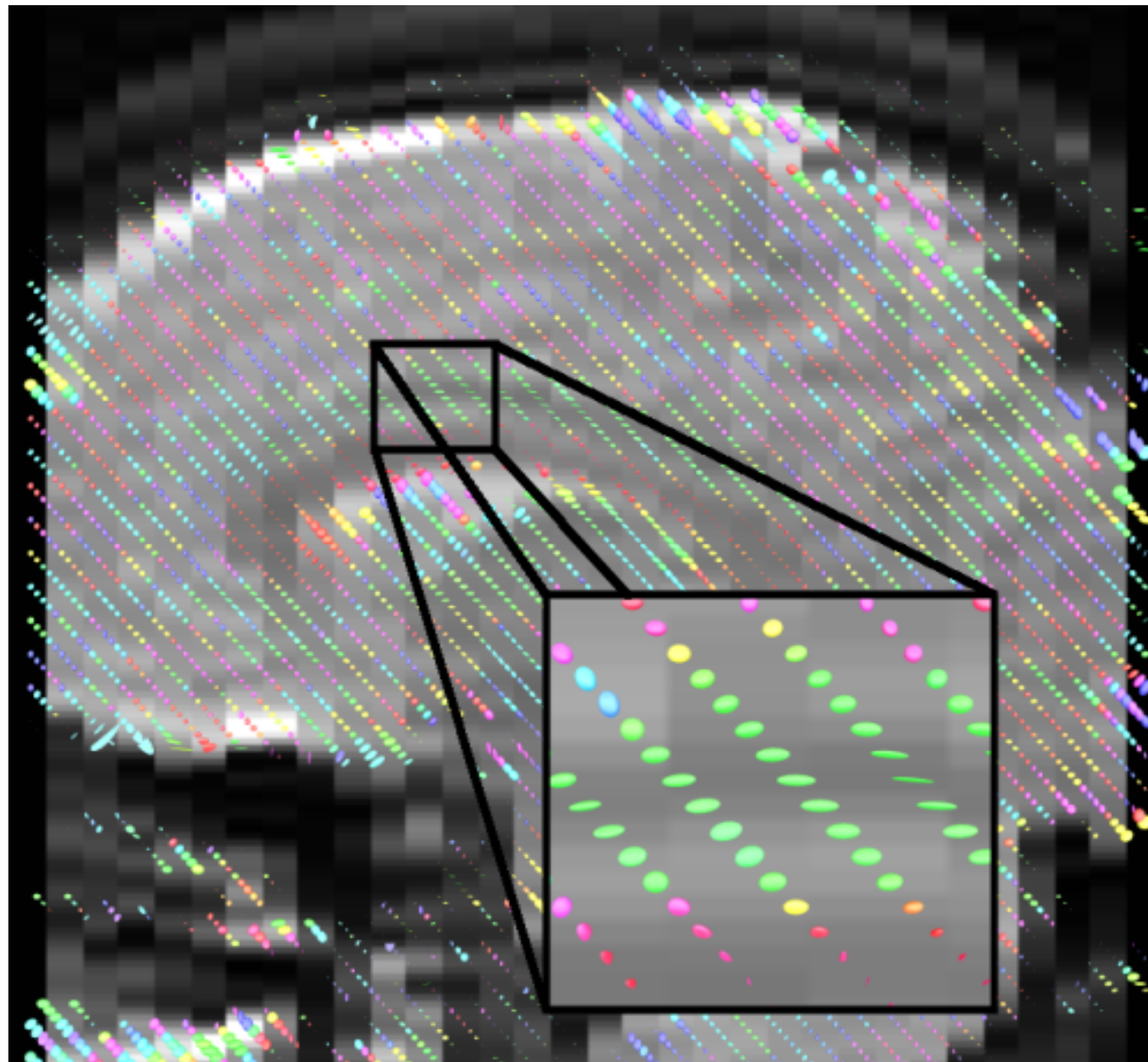
Marek Kubicki





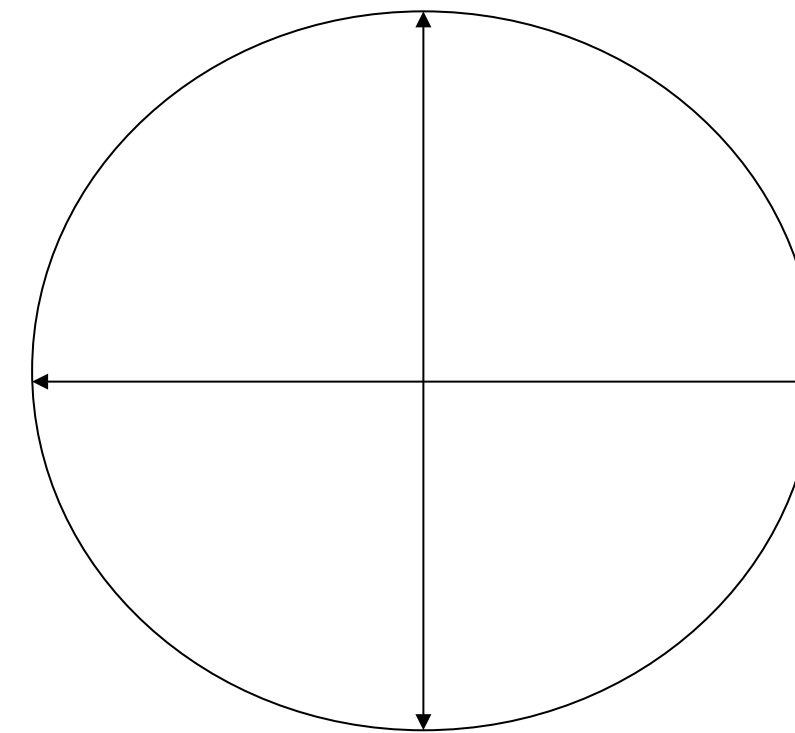
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## Principles of Diffusion Tensor Imaging

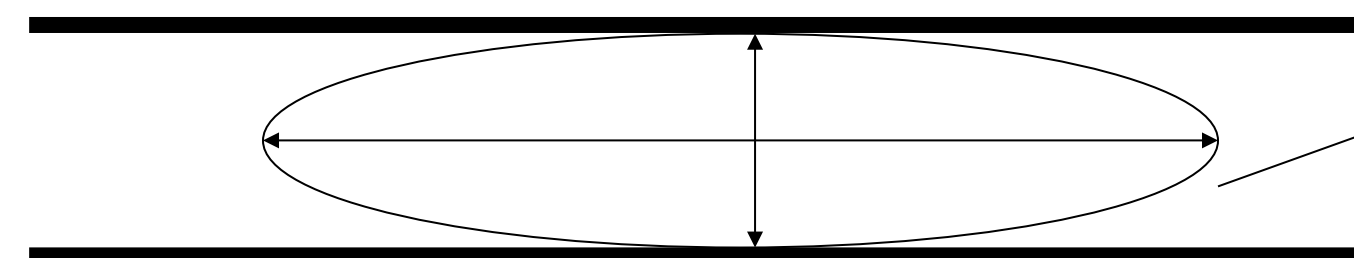


Courtesy of Gordon Kindlmann

Unrestricted Isotropic Diffusion



Restricted Anisotropic Diffusion



Myelin Sheath

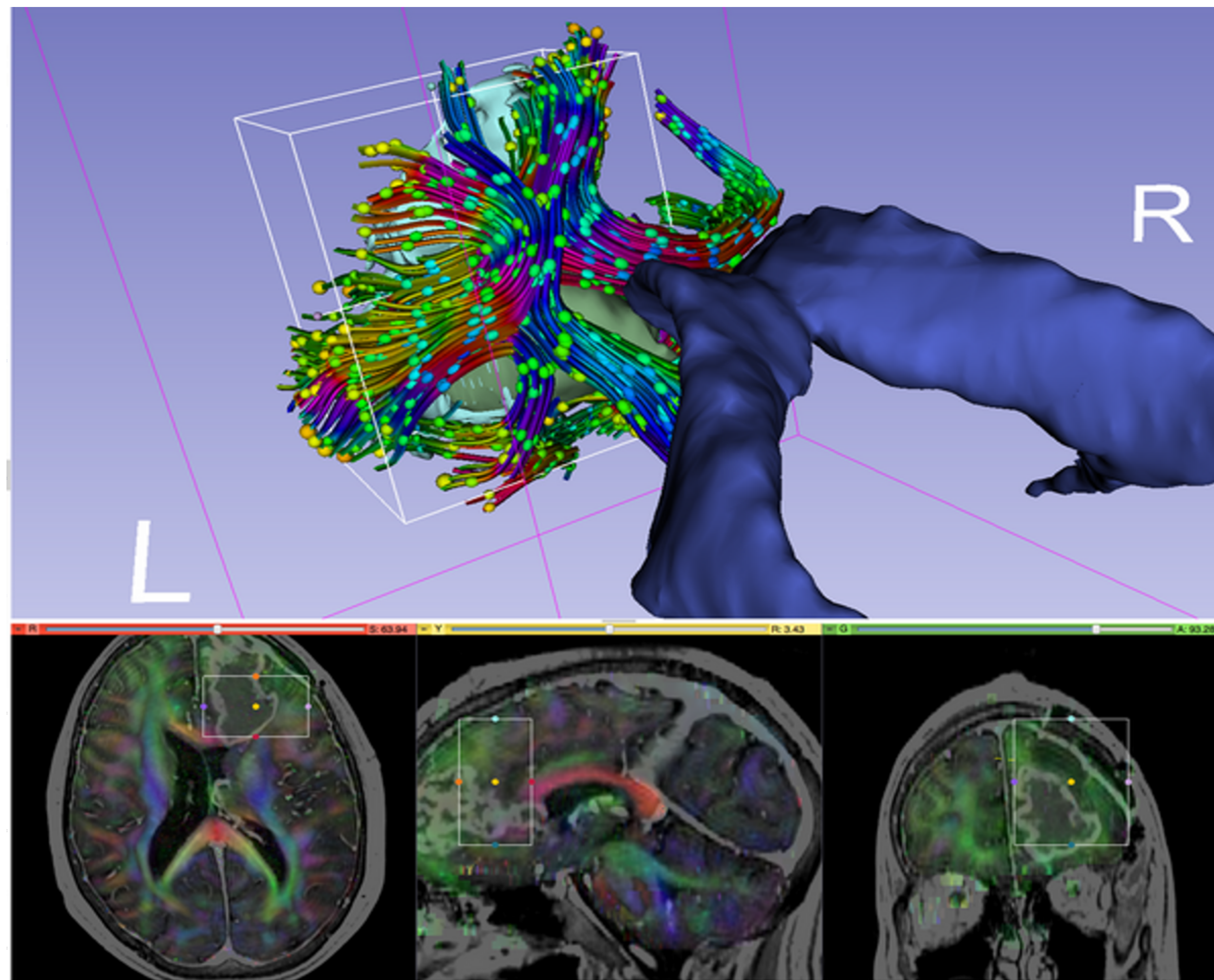
Diffusion Ellipsoid





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## Diffusion MRI Data for Neurosurgical Planning

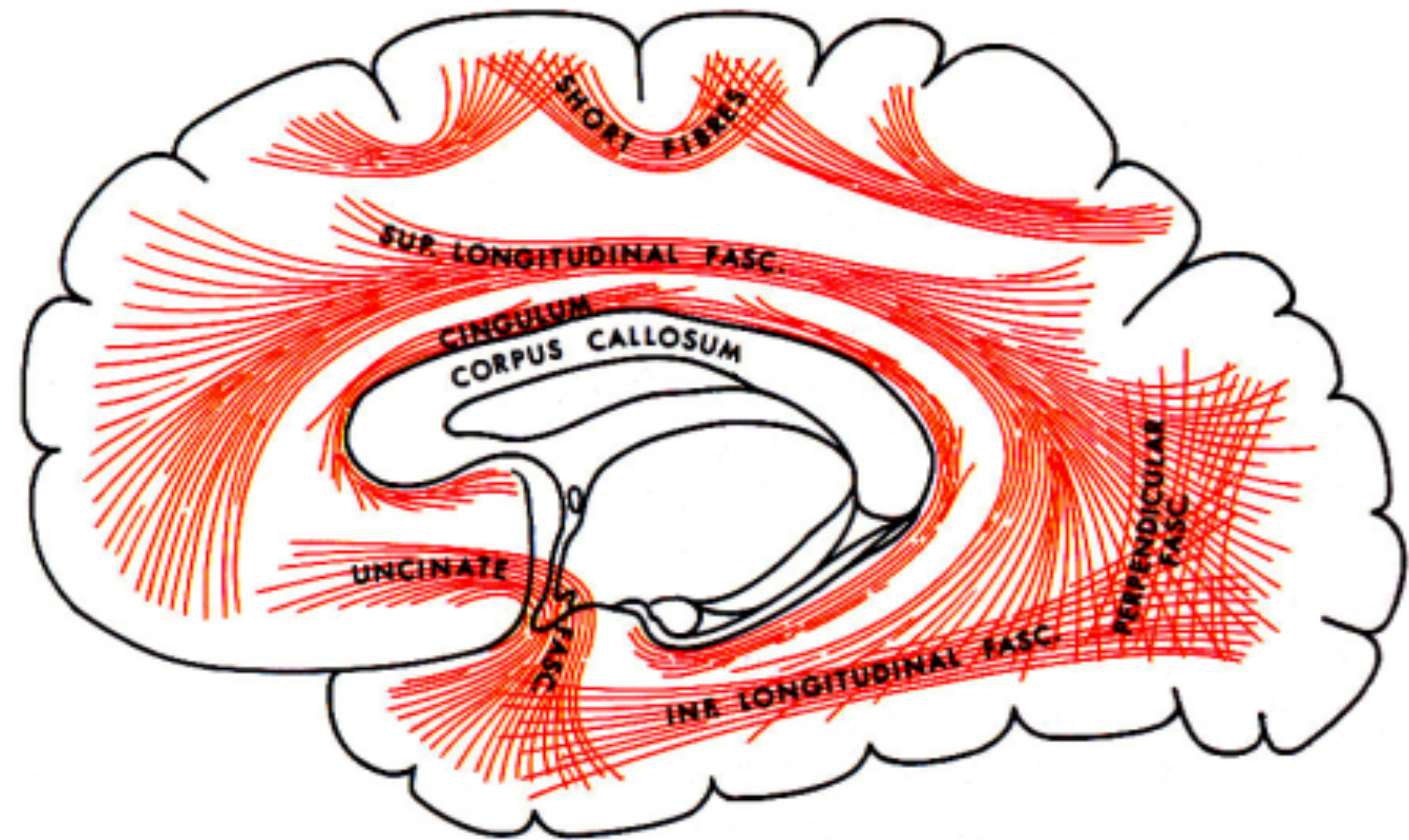
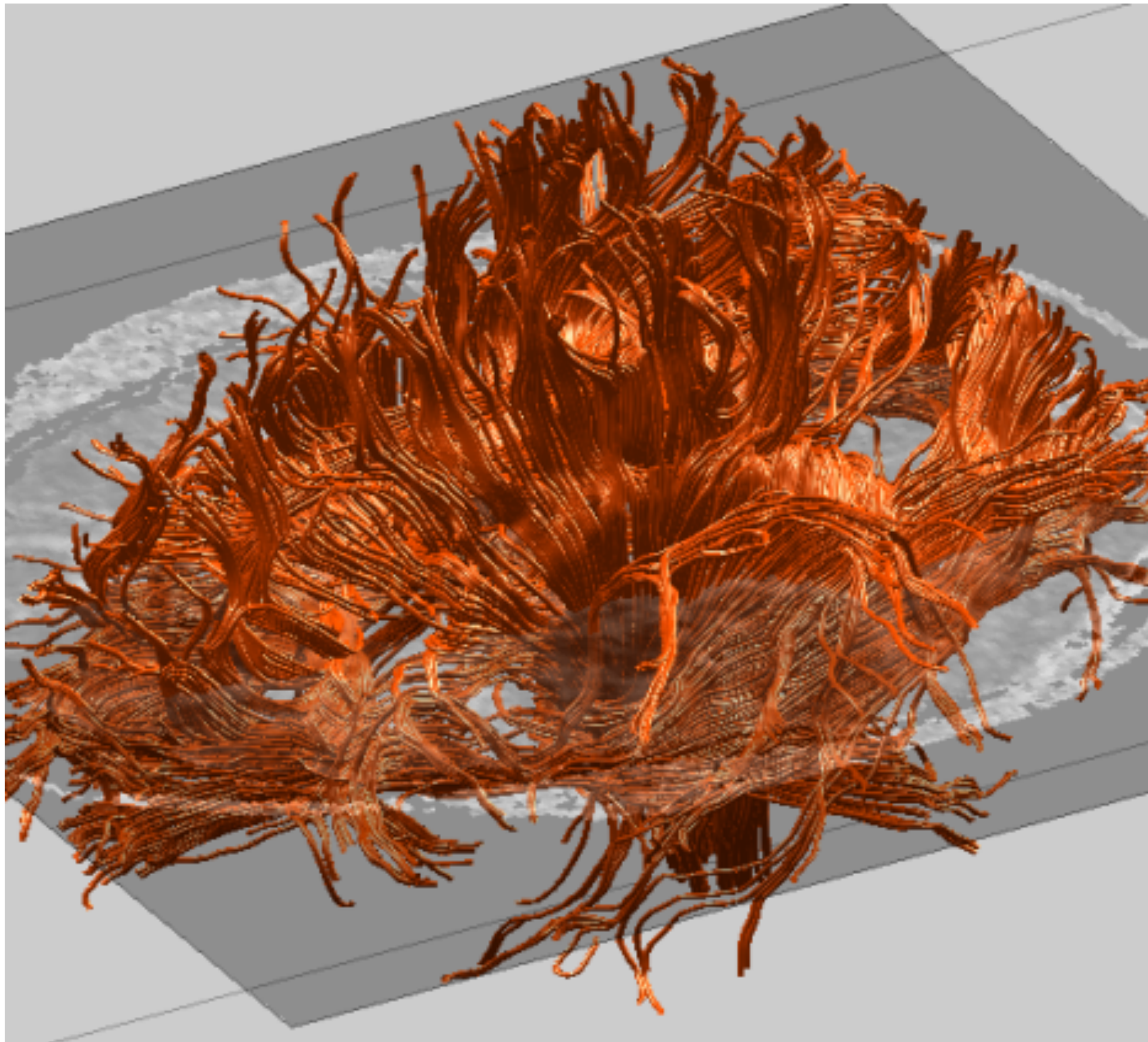






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... from **DT-MRI Tractography**



... to **white matter anatomy**





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## 2000 – NIH Reporter



***Drs. Ron Kikinis (left) and Ferenc Jolesz work on developing clinical applications for image processing and computer graphics. To accomplish this, they collaborate with physicists, computer scientists, medical researchers, and neurosurgeons. (Photo courtesy of the Surgical Planning Laboratory, Brigham and Women's Hospital, Boston)***





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**2003** First Computer Scientist in PNL



Sylvain Bouix, Ph.D.



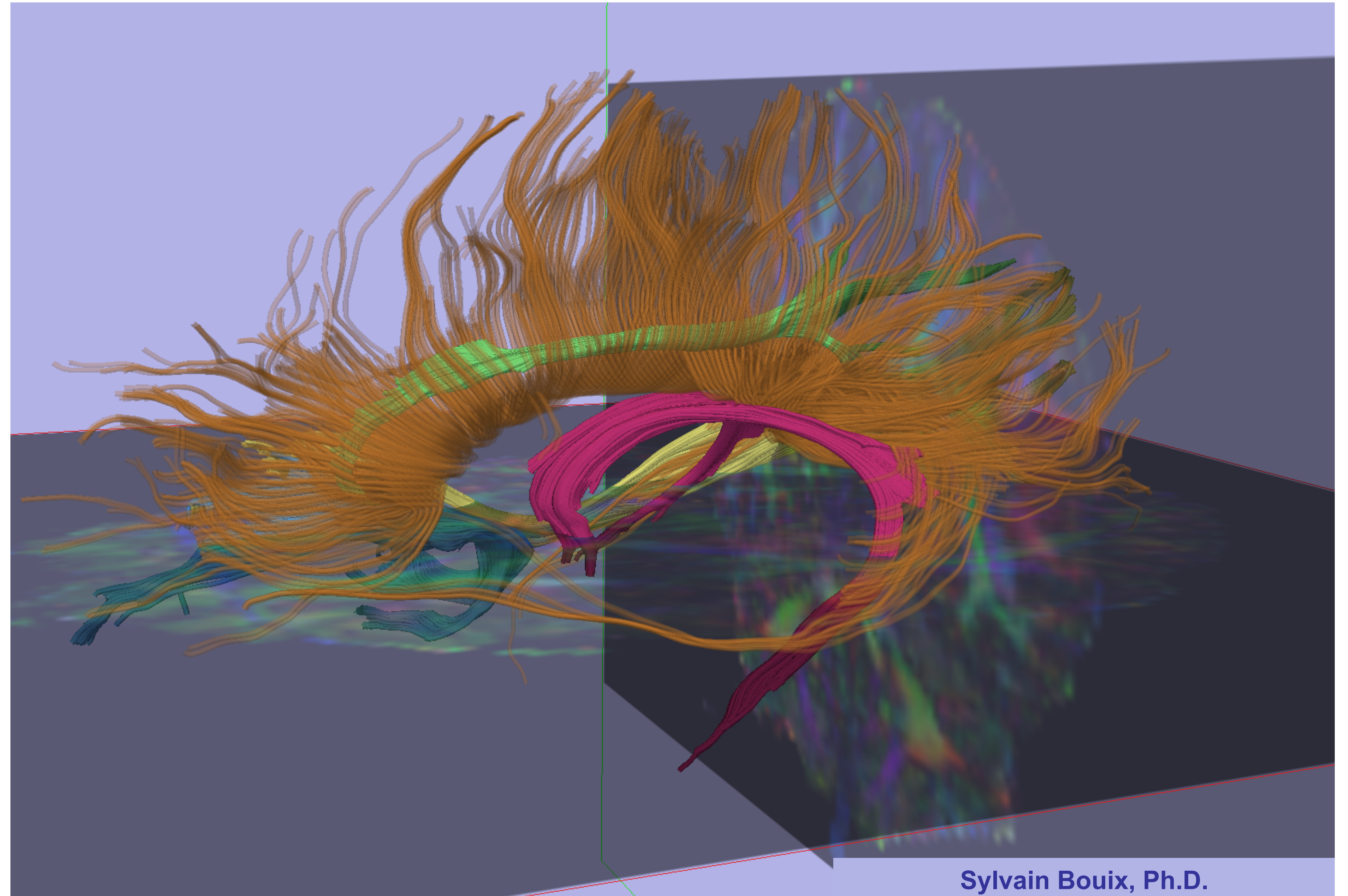


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Shape

Major Fiber Bundles in  
the Brain

Subject-Specific Profiles of  
Injury – Similar to  
Precision Medicine Approach



Sylvain Bouix, Ph.D.





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**2004-2015** *NA-MIC* is a national research center supported by grant U54 EB005149 from the NIBIB NIH HHS Roadmap for Medical Research Program.

Multi-institutional, interdisciplinary team of computer scientists, software engineers, and medical investigators who develop computational tools for the analysis and visualization of medical image data. The purpose of the Center is to provide the infrastructure and environment for the development of computational algorithms and open-source technologies, and then oversee the training and dissemination of these tools to the medical research community.

**2004-2007** Driving Biological Problem: Schizophrenia (Shenton)

**2007-2010** Velocardiofacial Syndrome (Kubicki)

**2010-2015** Atrial Fibrillation, Head & Neck, Lupus, Traumatic Brain Injury, Prostate Cancer, Autism





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**2005**

Move to 1249 Boylston Street



Gate B Fenway Park



# INTRuST Progress Flowchart 2008-2016

Total Cases on CNDA (n=438)

Scan Downloaded from CNDA	100% (438/438)
Case folder organized on network	100% (438/438)
Quality Control (n=384 passes)	88% (384/384)

T1W

SWI

DWI

Realign

100% (384/384)

Mask

100% (384/384)

- Semi-Automated Mask
- Manually edit

EMSeg  
(GM, WM, CSF)

100% (384/384)

FreeSurfer : Cortical  
Segmentation & Thickness

100% (384/384)

Semi-automated segmentation  
of amyg/hipp

100% (384/384)

Register Tensor masks to SWI space

100% (383/383)

Generate high-contrast image

100% (383/383)

Microbleed identification

100% (383/383)

ROI Tract Analysis

100%(384/384)

- Generate tracts: CC, AF, UF, IOFF, SLF
- Extract diffusion measures: FA, AD, RD, trace
- Tract volume measurement

Motion and eddy  
current correction

100%  
(384/384)

Mask

100%  
(384/384)

Whole Brain  
Tractography

100% (384/384)

Free Water  
Analysis

100% (384/384)





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2008-Present

## NFL Study of Repetitive Head Trauma: Soccer Sub-Concussive Head Trauma



Ross Zafonte



Bob Stern



Inga Koerte



Alex Lin



Sylvain Bouix



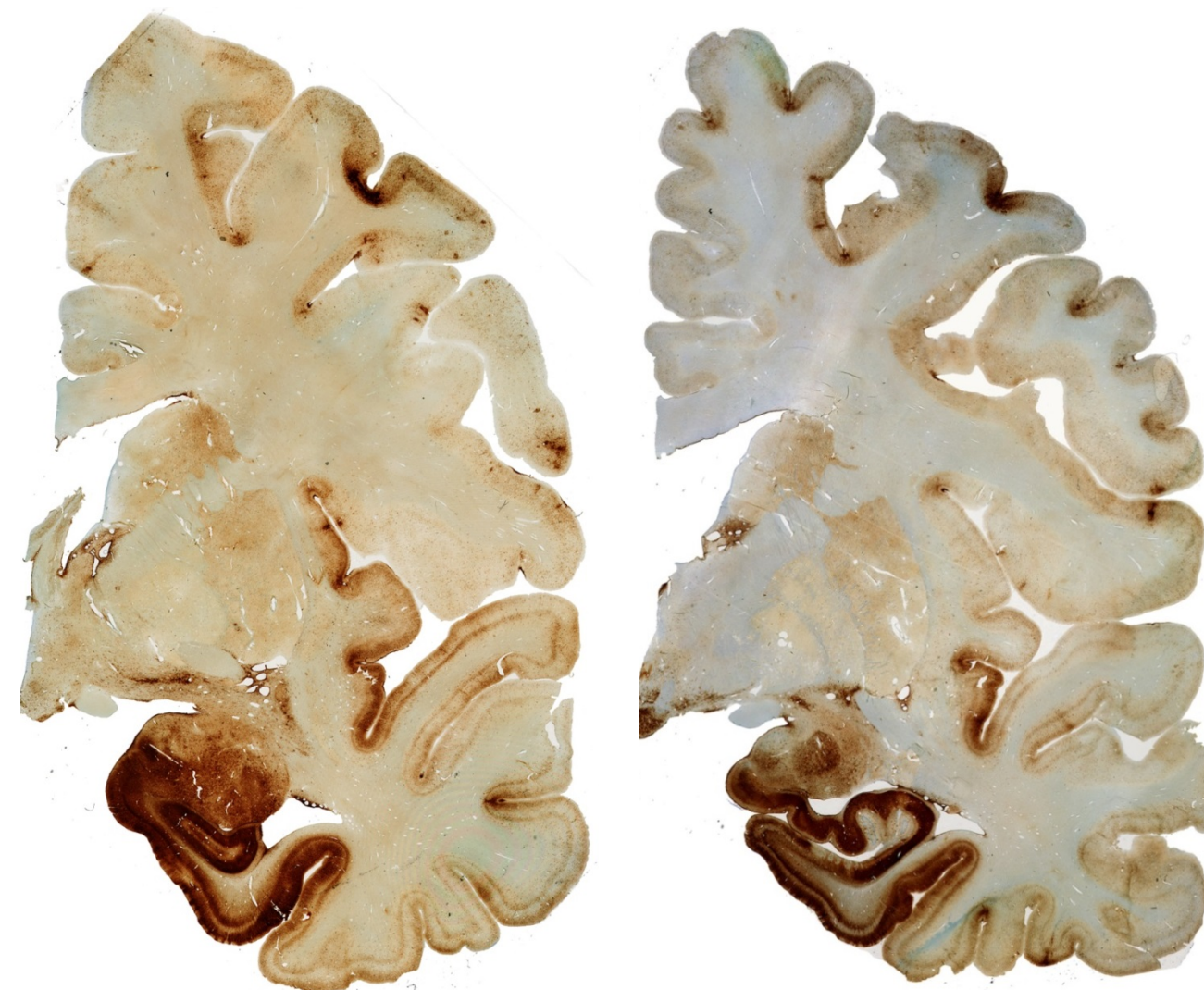
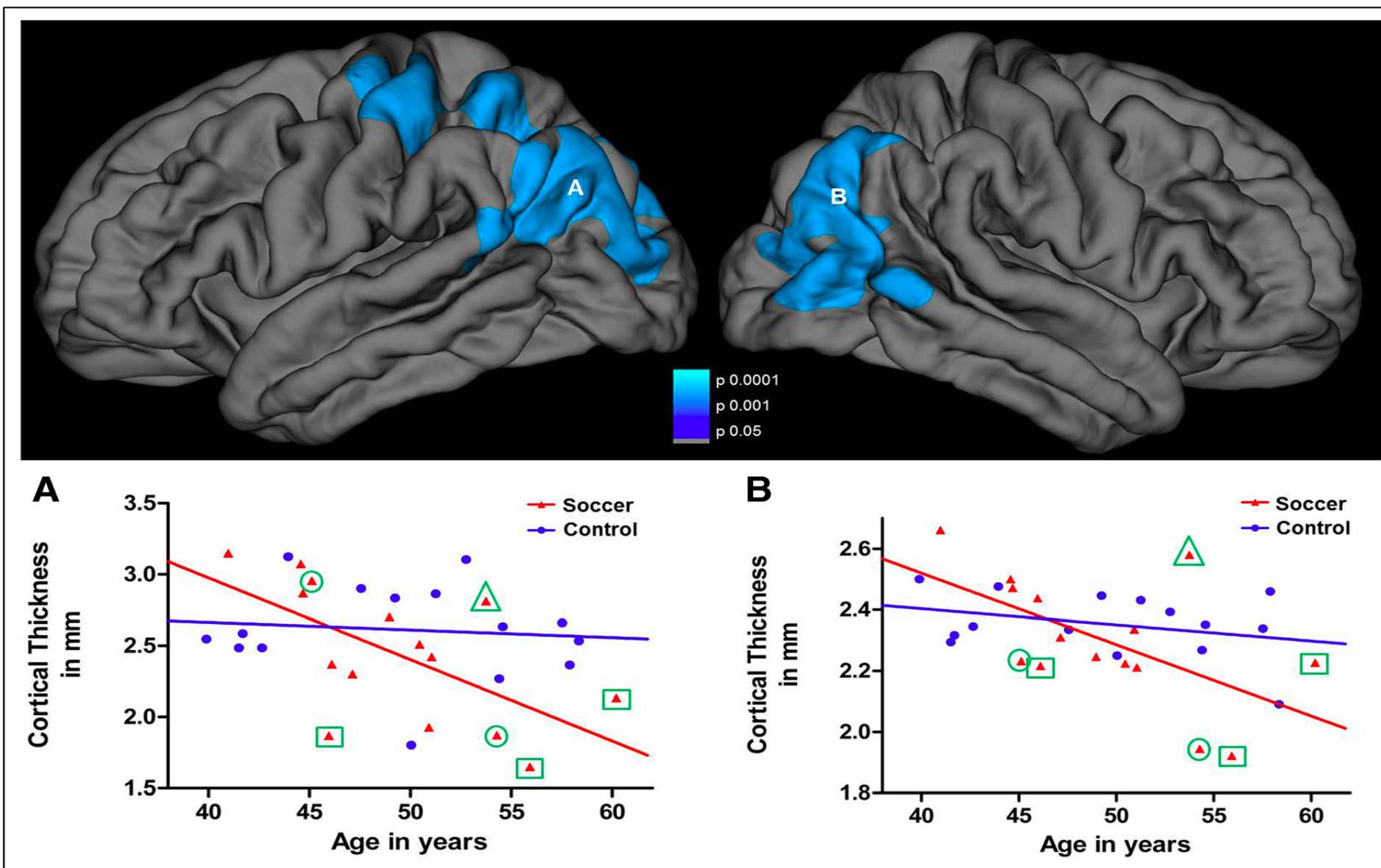
Yogesh Rathi



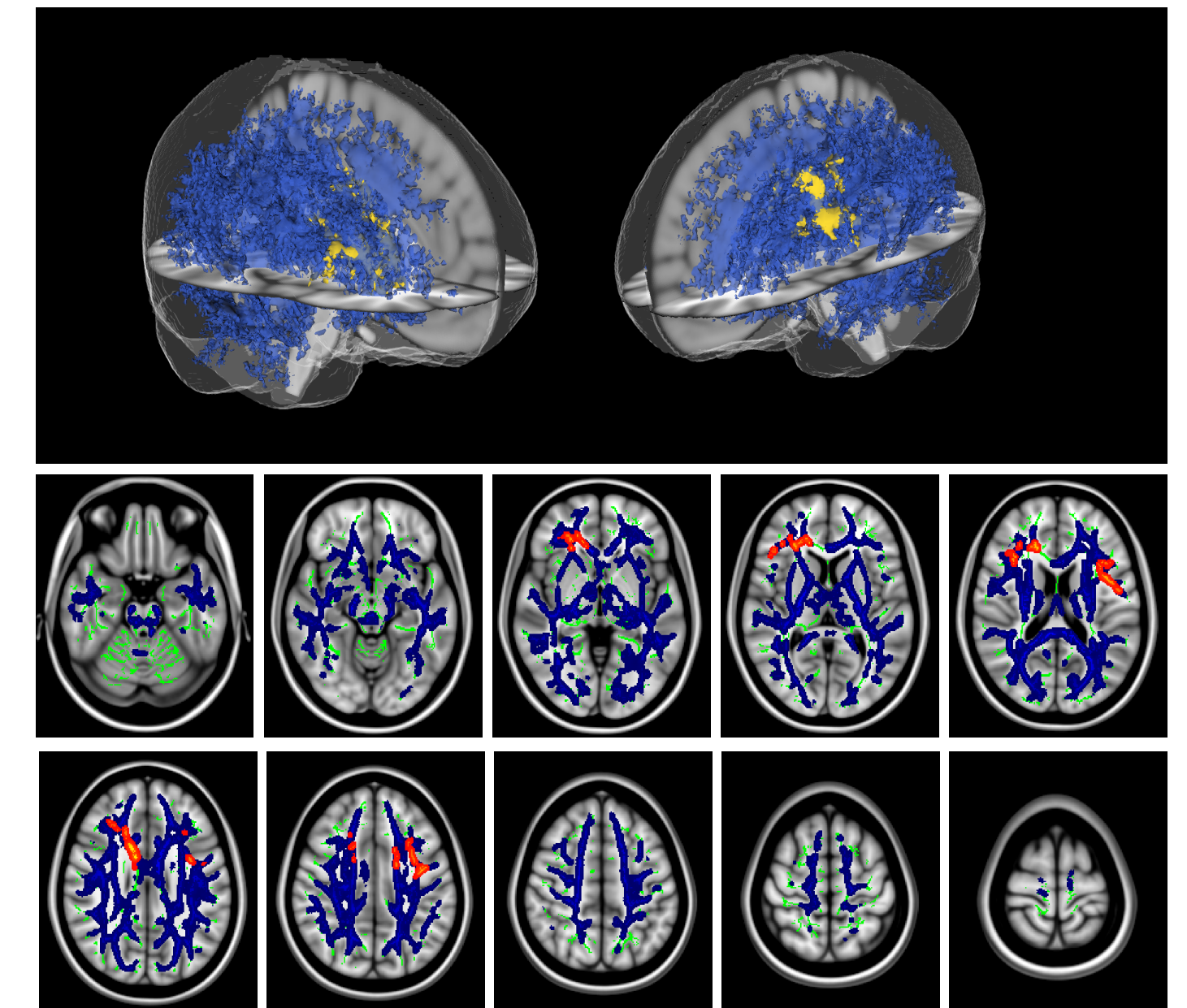
Ofer Pasternak



Mike Coleman



Ann McKee







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## "Forever Young"

May God bless and keep you always  
May your wishes all come true  
May you always do for others  
And let others do for you  
May you build a ladder to the stars  
And climb on every rung  
May you stay forever young  
Forever young, forever young  
May you stay forever young.

May you grow up to be righteous  
May you grow up to be true  
May you always know the truth  
And see the lights surrounding you  
May you always be courageous  
Stand upright and be strong  
May you stay forever young  
Forever young, forever young  
May you stay forever young.

May your hands always be busy  
May your feet always be swift  
May you have a strong foundation  
When the winds of changes shift  
May your heart always be joyful  
And may your song always be sung  
May you stay forever young  
Forever young, forever young  
May you stay forever young.





Thank you for your attention!



<http://pnl.bwh.harvard.edu>