



The Montreal Neurological Institute in 1934



Towards a global brain imaging network

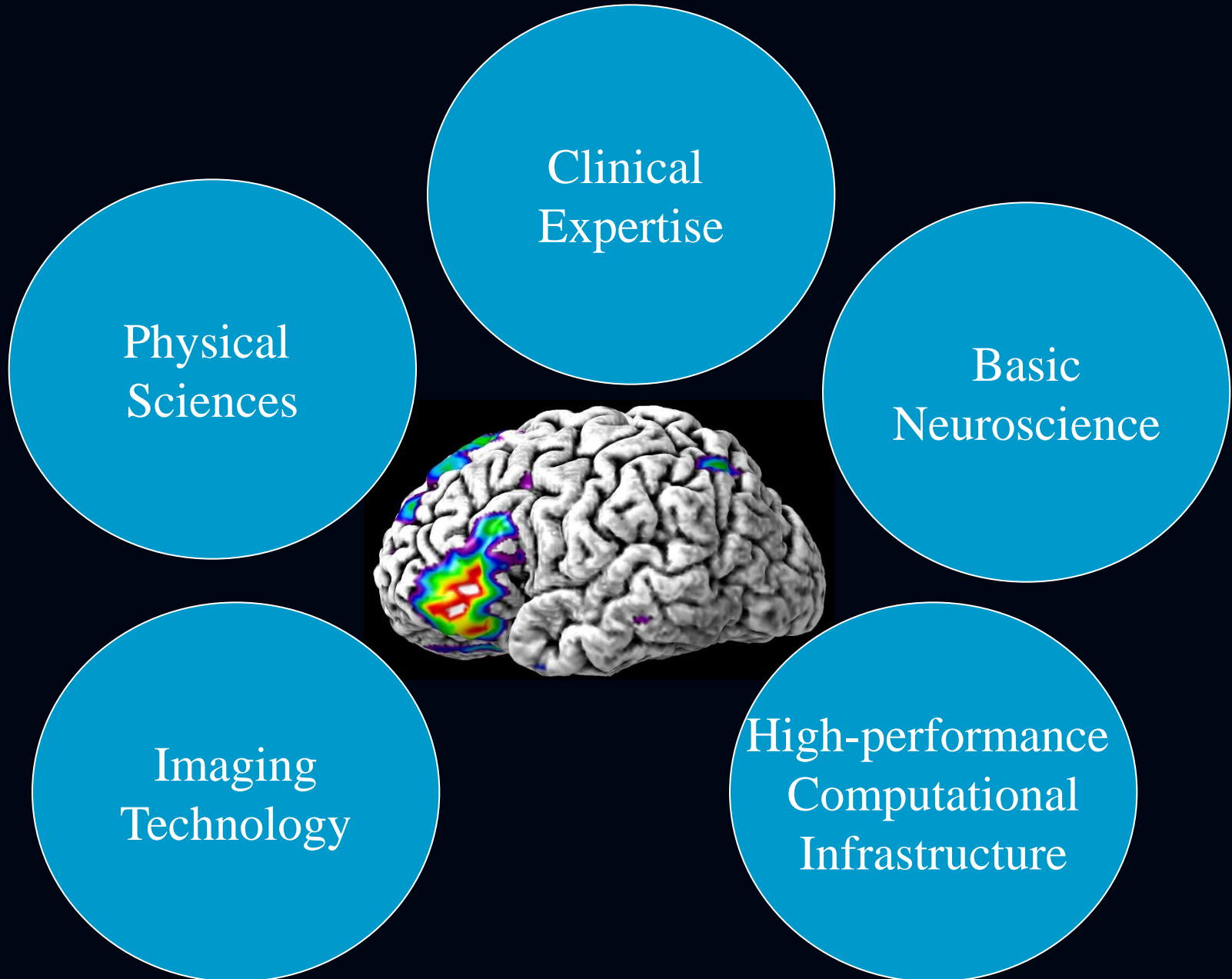
AC Evans, Ph.D.

Montreal Neurological Institute

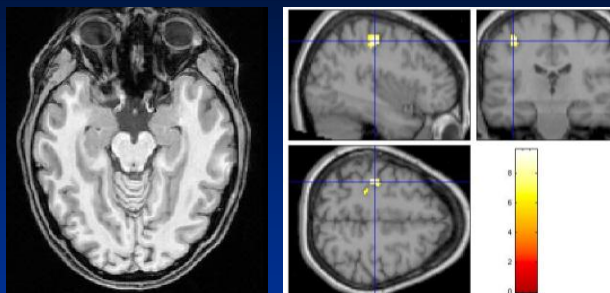
Global Health Conference

April 26th, 2010

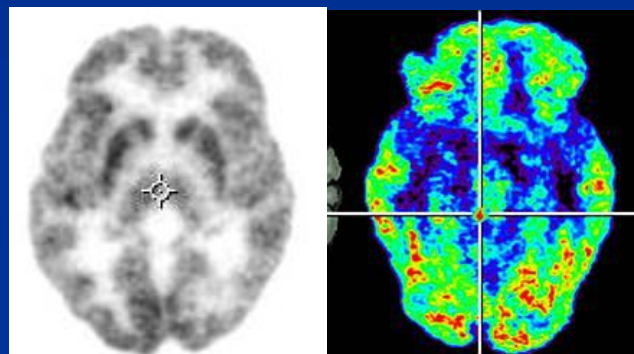
Mapping the Brain with Neuroimaging



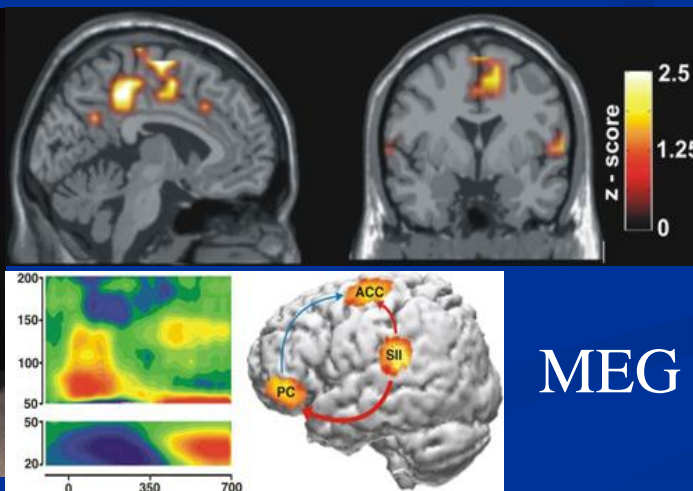
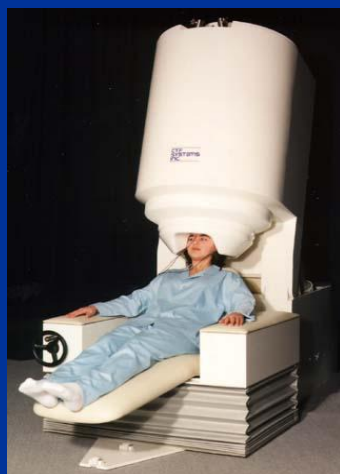
Scanner Infrastructure



MRI



PET

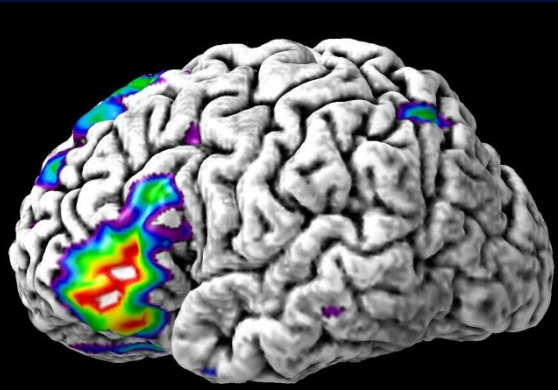


MEG

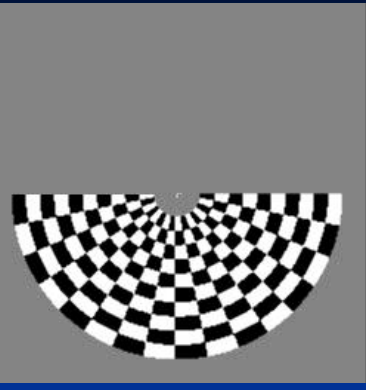
Computing



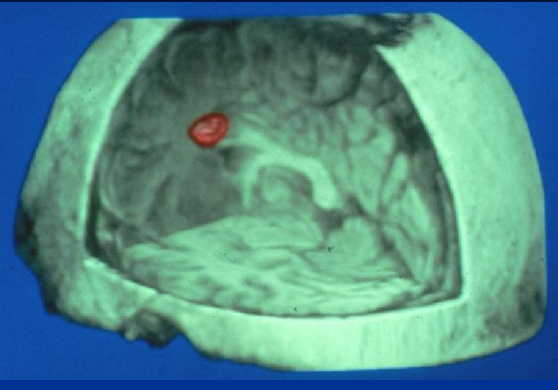
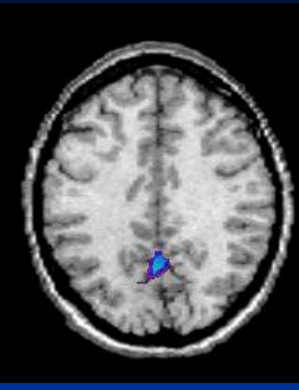
fMRI Activation Studies



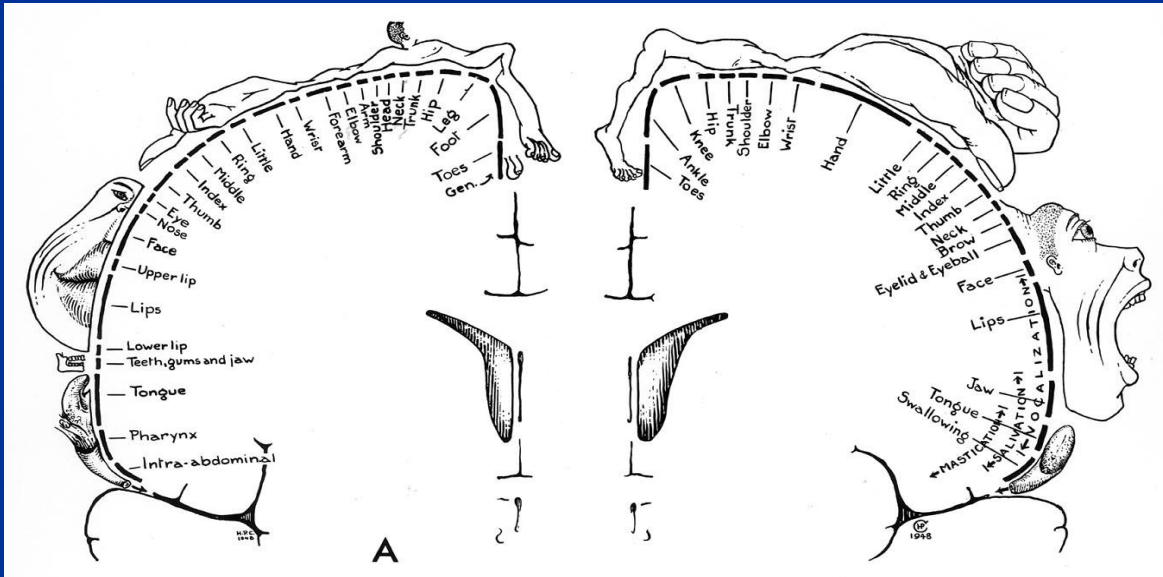
Language



Vision



Pain

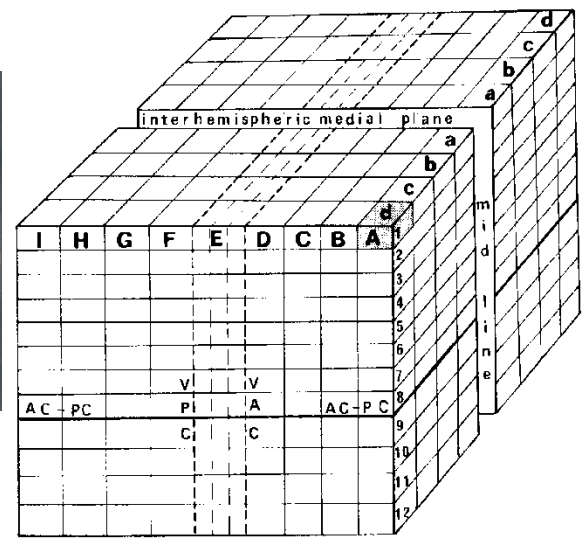
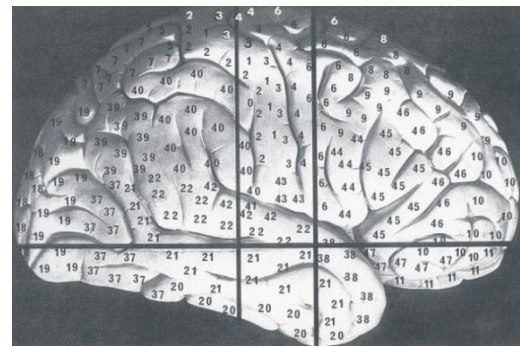
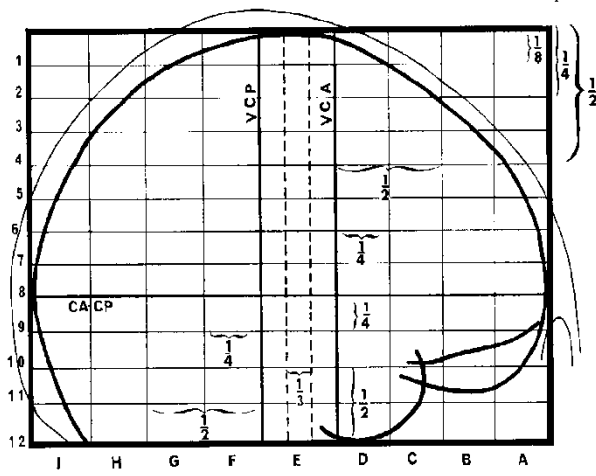


Sensory
homunculus

Motor
homunculus



Stereotaxic Space



J Talairach & P Tournoux
 "Co-planar stereotaxic atlas
 of the human brain"
 ed: Georg Thieme, 1988

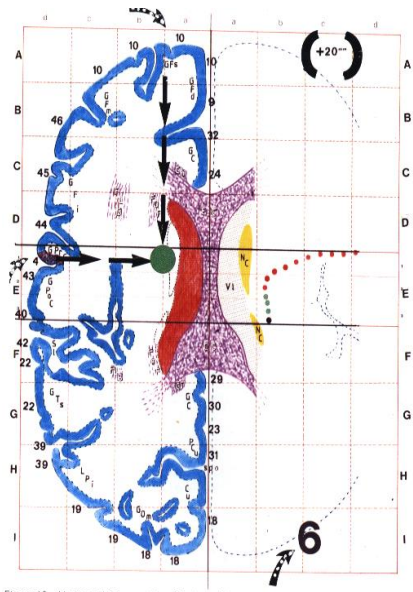


Figure 19 Horizontal Atlas section. Section of the Atlas 20mm from the CA-CP line.

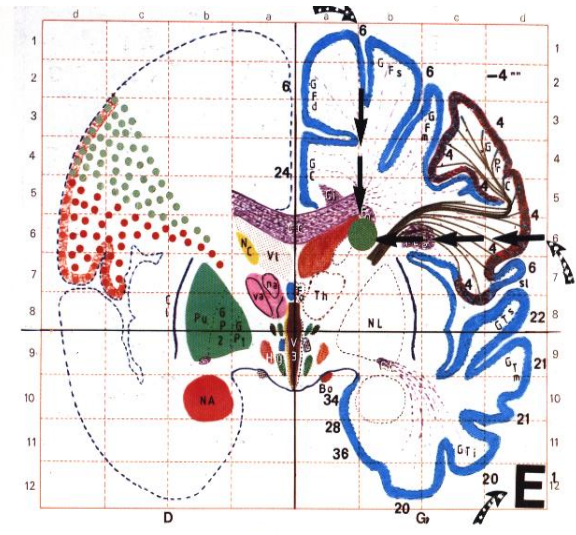
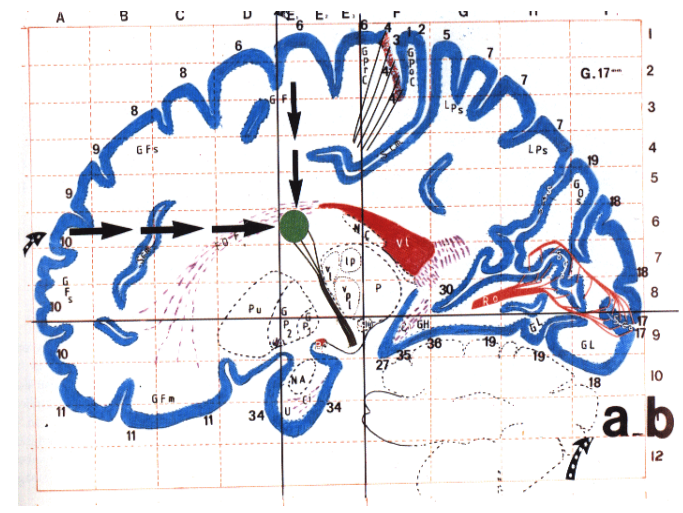
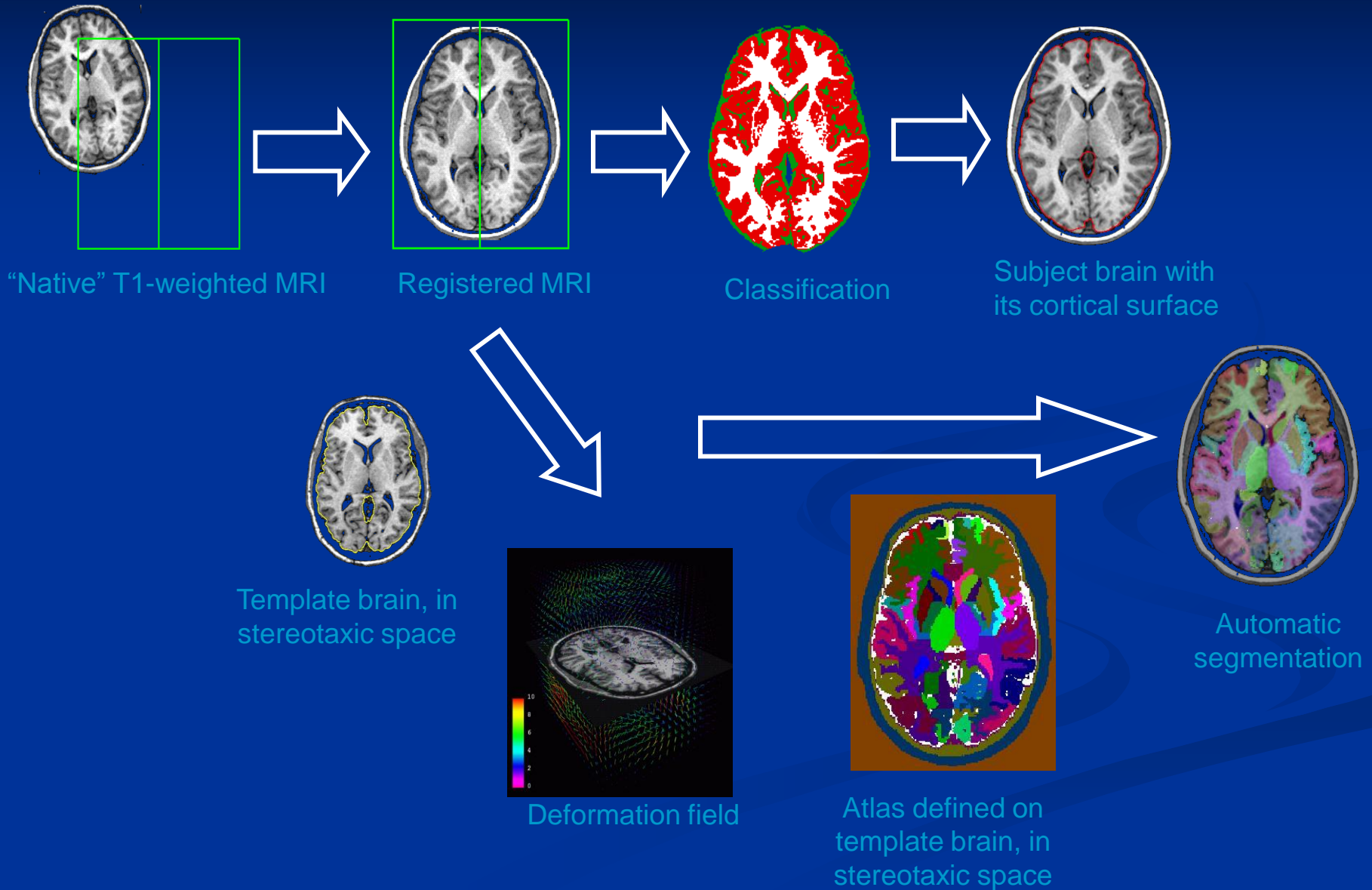


Figure 21 Verticalofrontal section of the Atlas corresponding to Figures 19 and 20.

Brain mapping uses a universal coordinate space “MNI Space”

- Labs around the world repeat experiments, compare results directly
- Raw image data and processed maps readily shared among labs
- Results are reproducible
- Networks of laboratories sharing data and/or algorithms become feasible
- Data repositories for global scientific community can be placed on the Web
- New questions can be asked of mapped data, long after primary research completed
- New or improved algorithms can easily be applied to old questions
- **Adaptable to any species, imaging modality or organ – N.B.**

Pipeline Processing



Phase III MS Trial – Myloral



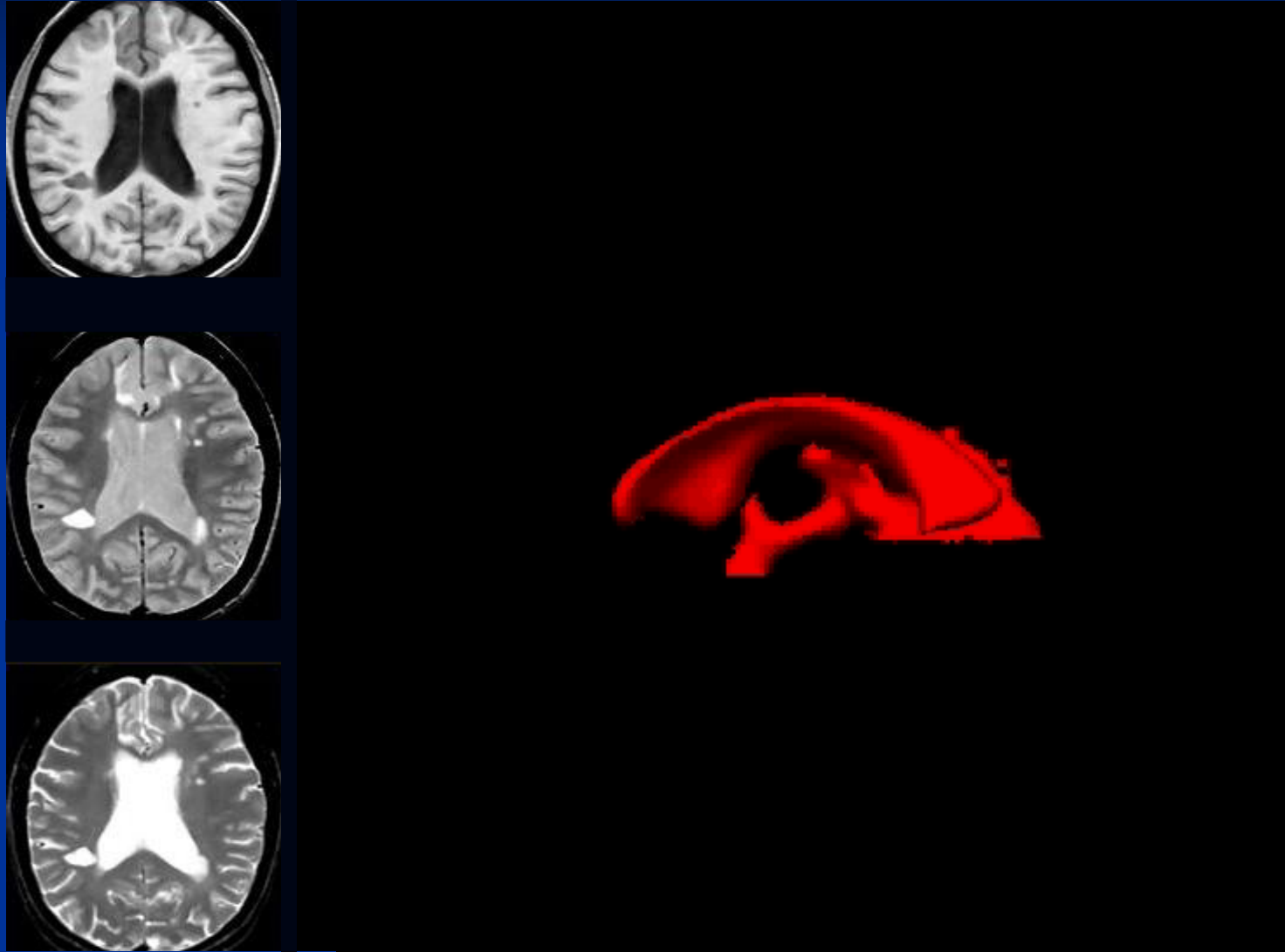
14 sites ; 508 patients (RR) ; 1800 studies

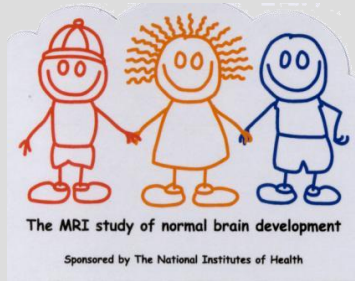
T1, T2, PD volumes at each study

T1: 3D GE, 60 x 3mm, TR=35, TE=min, flip = 45

T2/PD: 2D multi-slice, double SE, TR=3000, TE=30,80

MS lesion map (425 patients)





NIH MRI Study of Normal Brain Development (N=500)




Behavior/MRI for ages 0-18 yrs

Structure-behavior relationships


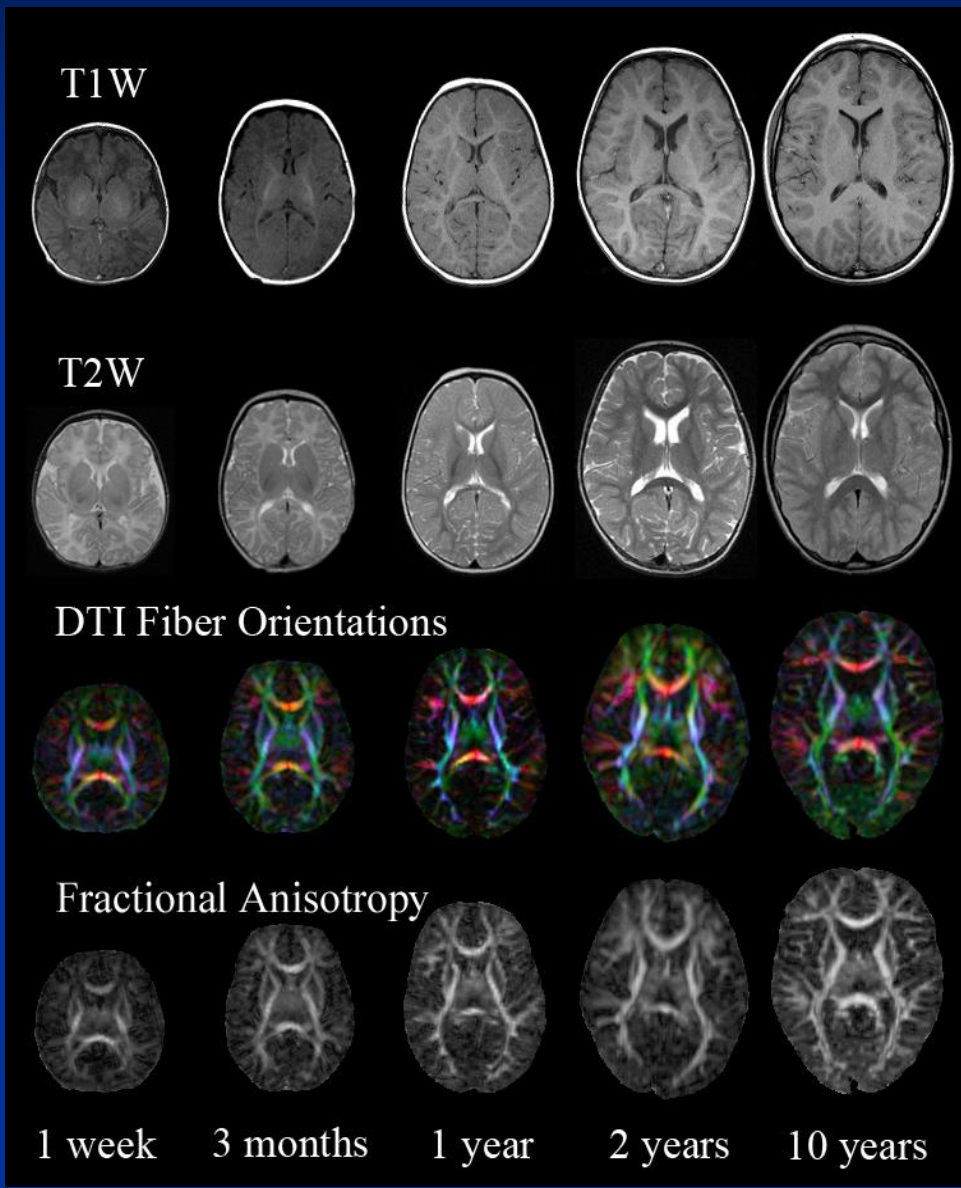
Disseminate results

What does it feel like inside the scanner?

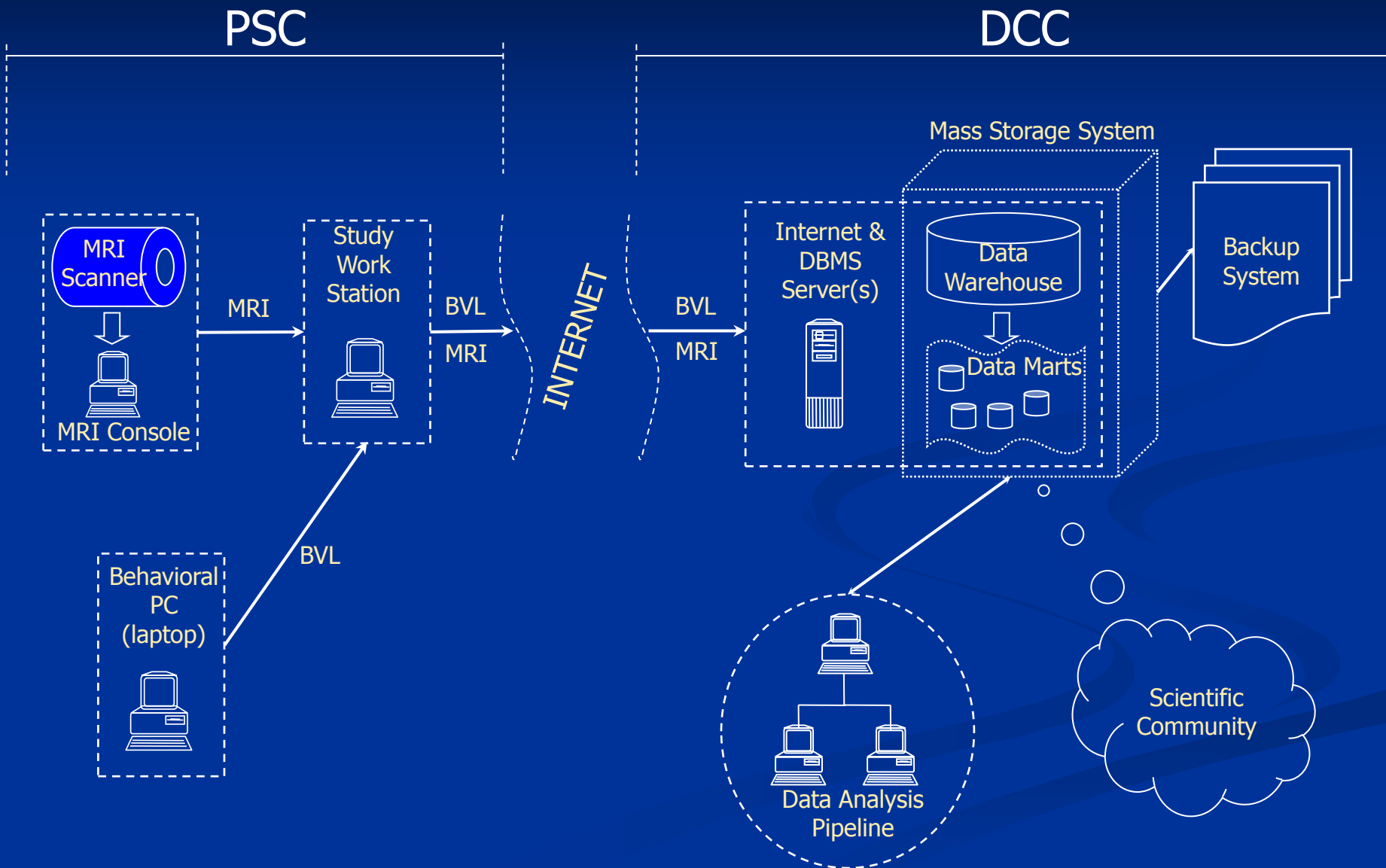
Children will be positioned comfortably on a scanning bed that slides into the tunnel-shaped magnet. When the scanner is turned on, it makes humming and knocking sounds. Earmuffs or earplugs will be provided. An intercom system allows the child and technologist to speak to each other at all times.

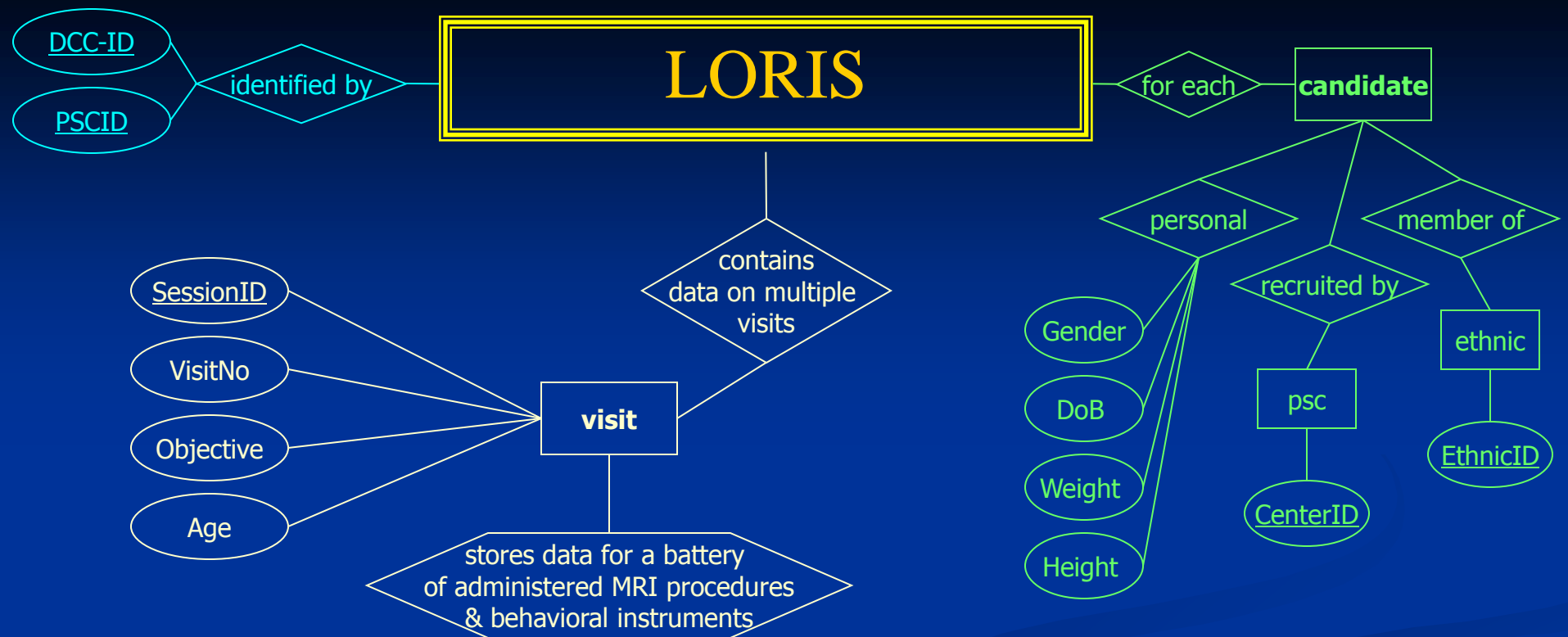


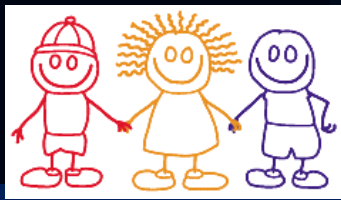
Parents may accompany their child into the scanning area.

NIHPD Network Architecture







Clinical Neurobehavioral Battery

Objective 1 (4.5-18.0 yrs)



1. Handedness: Performance Task
2. IQ - Age dependent
 - Differential Ability Scales (DAS)
 - Wechsler Abbreviated Scale of Intelligence (WASI)
3. Achievement: Woodcock –Johnson III (WJ-III)
4. Physical/Neurological Examination
5. Tanner Staging Questionnaire
6. Saliva & Urine sample Collection
7. Verbal Fluency (NEPSY) -Semantic & Phonemic
8. California Verbal Learning Test-Children's Version (CVLT-C) or CVLT-II
9. CANTAB: Motor Screening, Spatial Span, Spatial Working Memory
10. Purdue Pegboard
11. Junior Temperament and Character Inventory (JTCI)
12. Behavior Rating Inventory of Executive Function (BRIEF)
13. MRI Questionnaire – music, sports, leisure activities, medication exposure

MRI Study of normal brain development

Behavioral characterization (Objective 1)

Journal of the International Neuropsychological Society (2007), 13, 1–18.
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DOI: 10.1017/S1355617707070841

The NIH MRI study of normal brain development: Performance of a population based sample of healthy children aged 6 to 18 years on a neuropsychological battery

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KELLY N. BOTTERON,⁴ GABRIEL LEONARD,⁵ DENISE MILOVAN,⁵ TOMAS PAUS,^{5,6}
JUDITH RUMSEY,⁷ AND THE BRAIN DEVELOPMENT COOPERATIVE GROUP

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(RECEIVED May 8, 2006; FINAL REVISION February 2, 2007; ACCEPTED March 2, 2007)

Abstract

The National Institutes of Health (NIH) Magnetic Resonance Imaging (MRI) Study of Normal Brain Development is a landmark study in which structural and metabolic brain development and behavior are followed longitudinally from birth to young adulthood in a population-based sample of healthy children. The neuropsychological assessment protocol for children aged 6 to 18 years is described and normative data are presented for participants in that age

NIH MRI Study of Normal Brain Development Behavioral characterization (Objective 1)

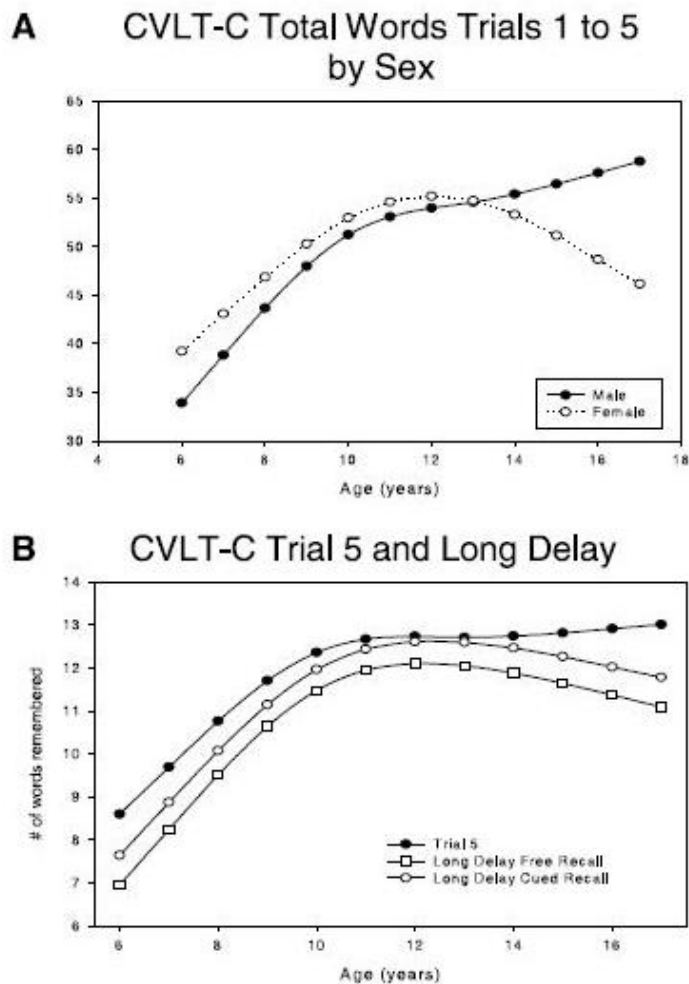


Fig. 3. Estimated relationship of age to raw scores for California Verbal Learning Test for Children (CVLT-C). In addition to linear effects of age, there were significant quadratic effects for all outcomes ($p < .01$). (A) Estimated relationship of age to raw scores for Total Words Trials 1–5 displayed separately for males and females (adjusted for income) and (B) Estimated relationship of age to raw scores for Trial 5, Long Delay Free and Long Delay Cued Recall. Although the Age \times Sex interaction is not displayed the CVLT variables in Fig. 3B in the interest of simplicity, this interaction was in fact significant for each of them and the shape of the functions for males and females is very similar to that displayed in 3A for Total Words Trials 1 to 5.

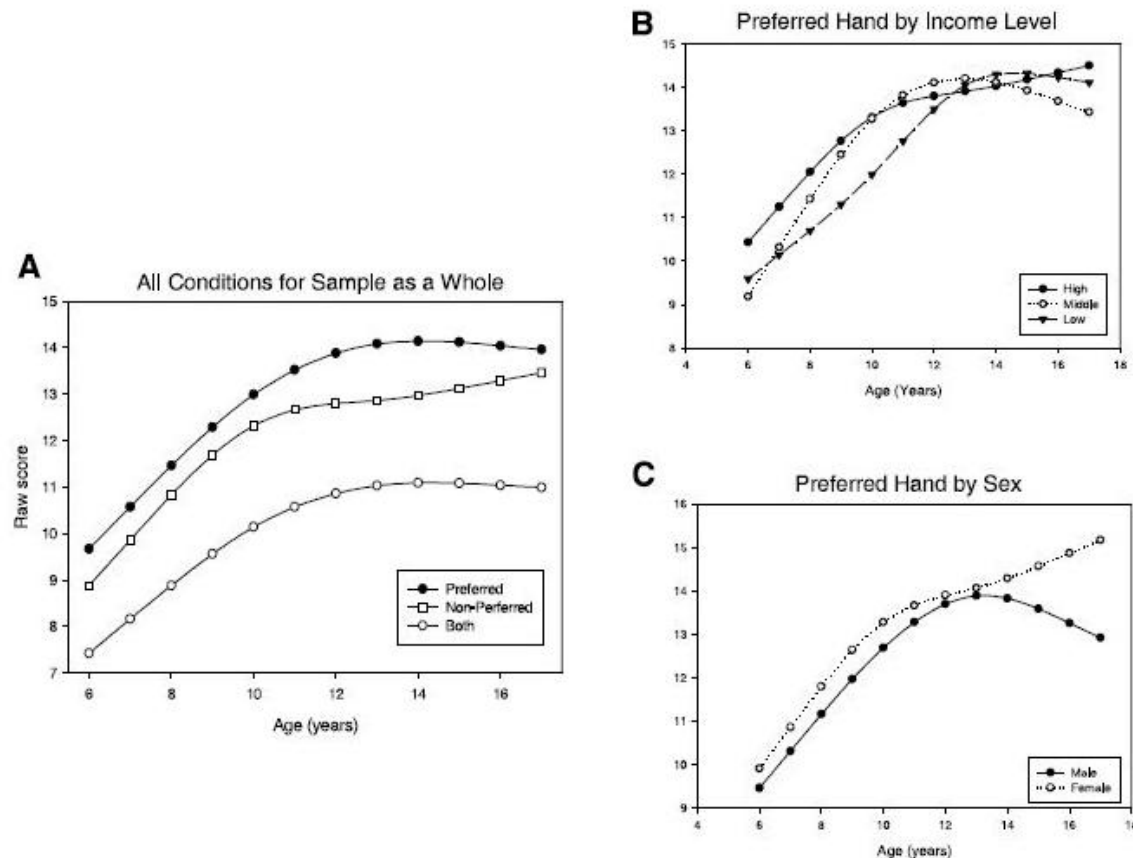


Fig. 4. Estimated relationship of age to number of pegs correctly placed on Purdue Pegboard. (A) Estimated relationship of age to number of pegs for preferred hand, non-preferred hand, and both hands adjusted for sex and income level. In addition to linear effects of age, there were significant quadratic effects for the preferred and both conditions ($p < .05$); a significant cubic effect was documented for the non-preferred condition ($p < .05$). Interactions of age with sex and income level were observed for the Preferred Hand condition only. (B) Estimated relationship of age to number of pegs correctly placed with preferred hand displayed separately for income level (adjusted for sex). (C) Estimated relationship of age to number of pegs correctly placed with preferred hand displayed separately for males and females (adjusted for income).

Objective 2 Battery (0.0-4.5 yrs)

Neurological Examination (NEURO)	0:0 to 4:5	neurological development
Bayley Scales of Infant Development-II (BSID-II)		
Mental Scale	0:3 to 2:6	mental development
Motor Scale	0:3 to 3:0	motor development
Behavior Rating Scale	0:3 to 2:6	behavioral development**
Preschool Language Scale-3 (PLS-3)		
Auditory Comprehension Subscale	0:3 to 4:5	receptive language
Expressive Communication Subscale	0:3 to 4:5	expressive language
Total Language	0:3 to 4:5	total language
Differential Abilities Scale (DAS)		
Block Building	3:0 to 3:5	fine motor, visual perceptual
Verbal Comprehension	3:0 to 4:5	receptive language
Picture Similarities	3:0 to 4:5	reasoning, recognition
Naming Vocabulary	3:0 to 4:5	expressive language
Pattern Construction	3:6 to 4:5	visual-spatial orientation
Early Number Concepts	3:6 to 4:5	math concepts/skills
Copying	3:6 to 4:5	fine motor, visual perceptual
General Conceptual Ability	3:0 to 4:5	intelligence
Handedness-1:0 (HAND-1)	1:0 to 2:11	hand preference
Handedness-3:0 (HAND-3)	3:0 to 4:5	hand preference
Verbal Fluency (NEPSY)	3:0 to 4:5	semantic fluency
Purdue Pegboard (PEG)***	3:0 to 4:5	fine motor coordination
Cambridge Neuropsychological Test Automated Battery (CANTAB)		
Motor Screening	4:0 to 4:5	reaction time/accuracy
Spatial Span	4:0 to 4:5	figure/sequence memory
Spatial Working Memory	4:0 to 4:5	memory/plan/monitor
Big Circle-Little Circle	4:0 to 4:5	category rule/reversal
Intra/Extra Dimensional Set-Shift	4:0 to 4:5	rule shifting/interference

*Administration Ages—years:months (e.g., 2:6 = 2-years, 6-months)

**Behavioral Development includes: attention, engagement, emotional regulation, motor quality, etc.

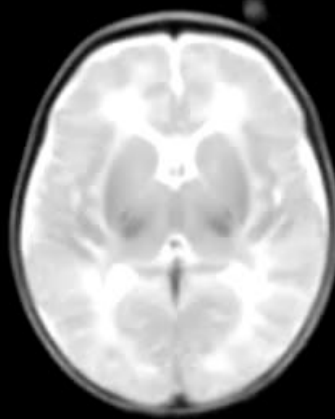
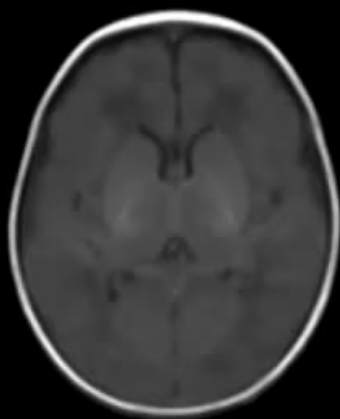
***Half-Board Version

Normal brain growth from 0-48 months (N=50)

T1

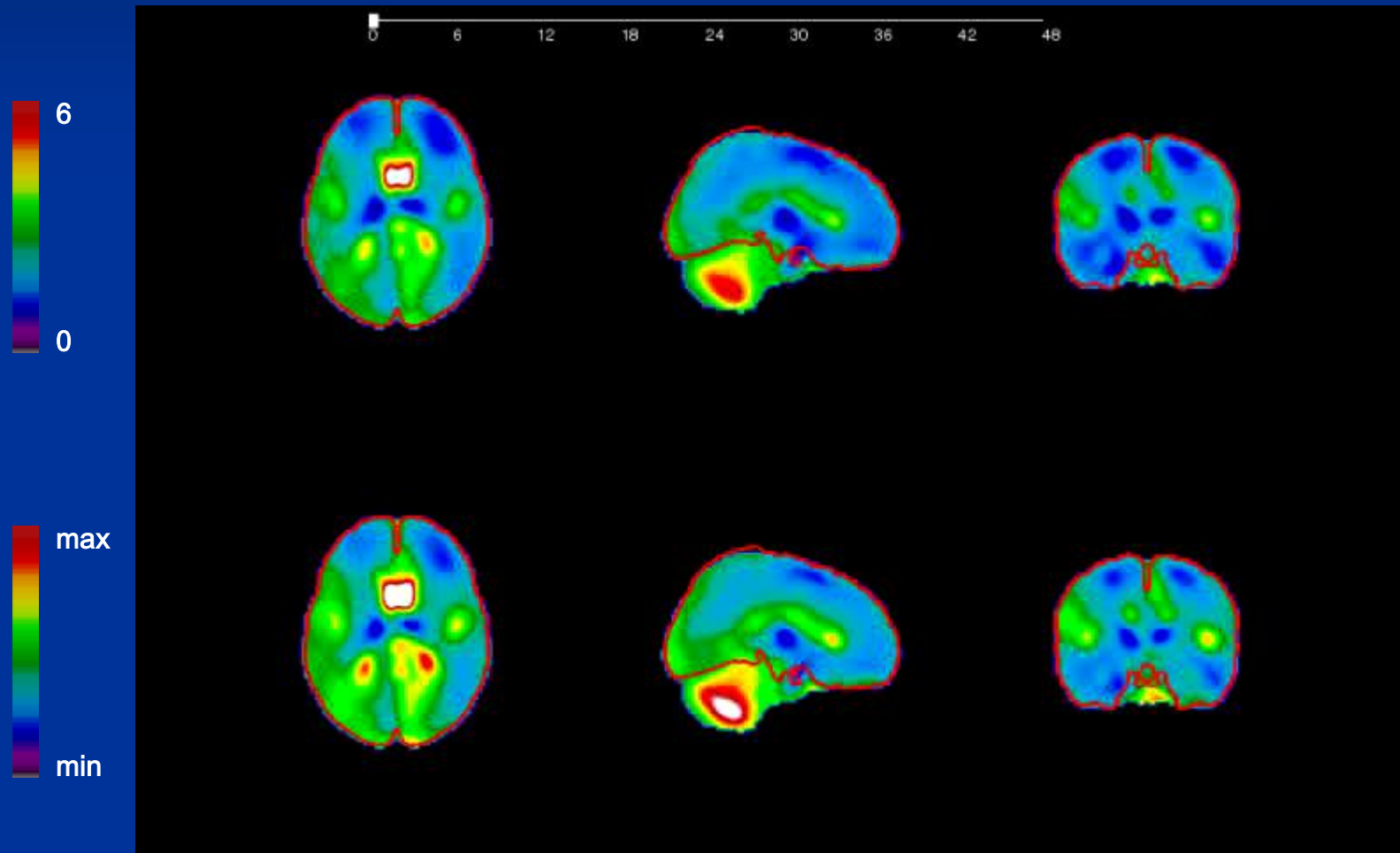
T2

PD



MRI Study of Normal Brain Development

Objective 2 - annual tissue growth rate



NIH MRI Study of Normal Brain Development

www.bic.mni.mcgill.ca/nihpd/info

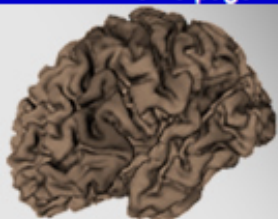
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The NIH MRI Study of Normal Brain Development

A project sponsored by the National Institutes of Health



Welcome to the Pediatric MRI Data Repository Website. This site provides information about the NIH MRI Study of Normal Brain Development (Pediatric MRI Study) and resulting Pediatric MRI Data Repository. This website serves as the portal through which data can be obtained by qualified researchers. The overarching goal of the Pediatric MRI Study is to foster a better understanding of normal brain maturation as a basis for understanding atypical brain development associated with a variety of disorders and diseases.

Project overview:

This multi-site longitudinal study uses technologies (anatomical MRI, diffusion tensor imaging (DTI), and MR spectroscopy (MRS)) to map pediatric brain development and is organized around two Objectives. Data collection began in November 2001 and will continue through August 2007. Data will be released in stages... [read more](#) →

Protocols:

A collaborative effort among the participating centers and NIH resulted in age-appropriate MRI protocols and clinical/behavioral batteries of instruments... [read more](#) →

Publications:

Published papers from the project are available... [read more](#) →

Data access:

Qualified researchers may apply by completing the Data Use Certification, available through this website. Full and partial data sets of clinical/behavioral and image data are available for download... [read more](#) →

[Study design overview](#)

[Data user documentation](#)

[FAQs](#)

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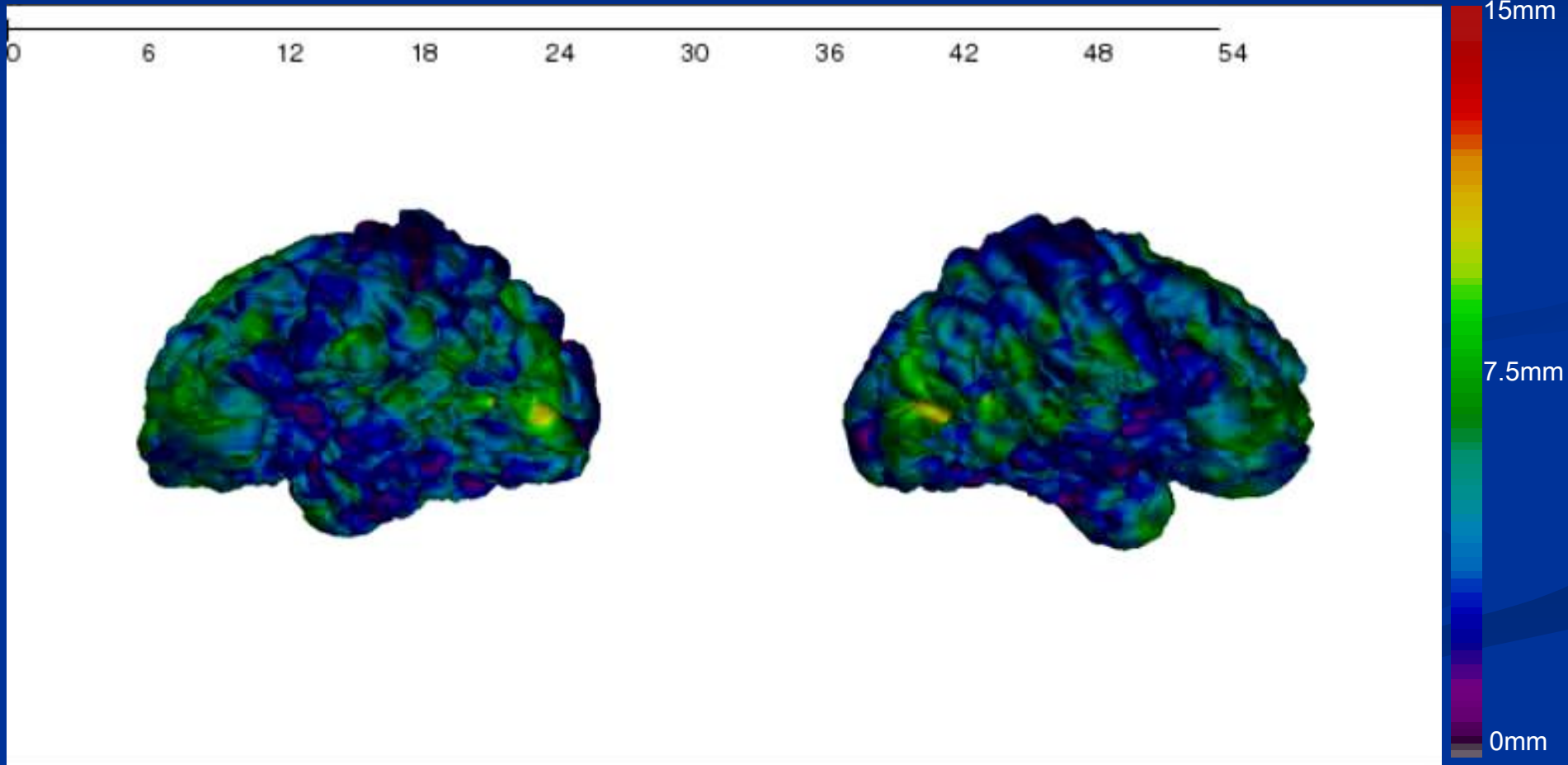
[Privacy policy](#)

MRI Study of normal brain development

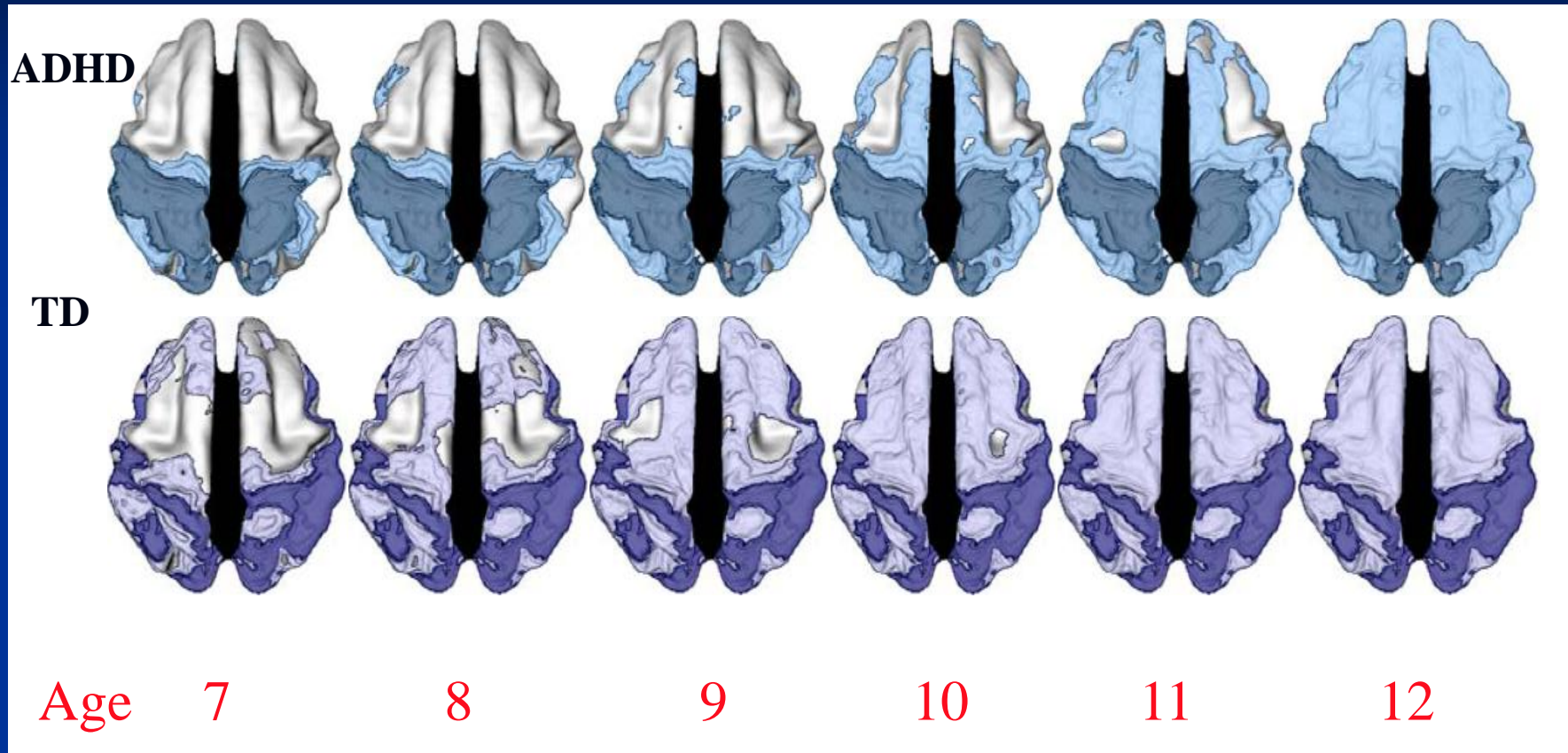
Evolution of hemispheric asymmetry from 0-54 months

(N=90)

Colours show hemispheric difference in surface position (L > R)



Delay in attaining peak cortical thickness in ADHD

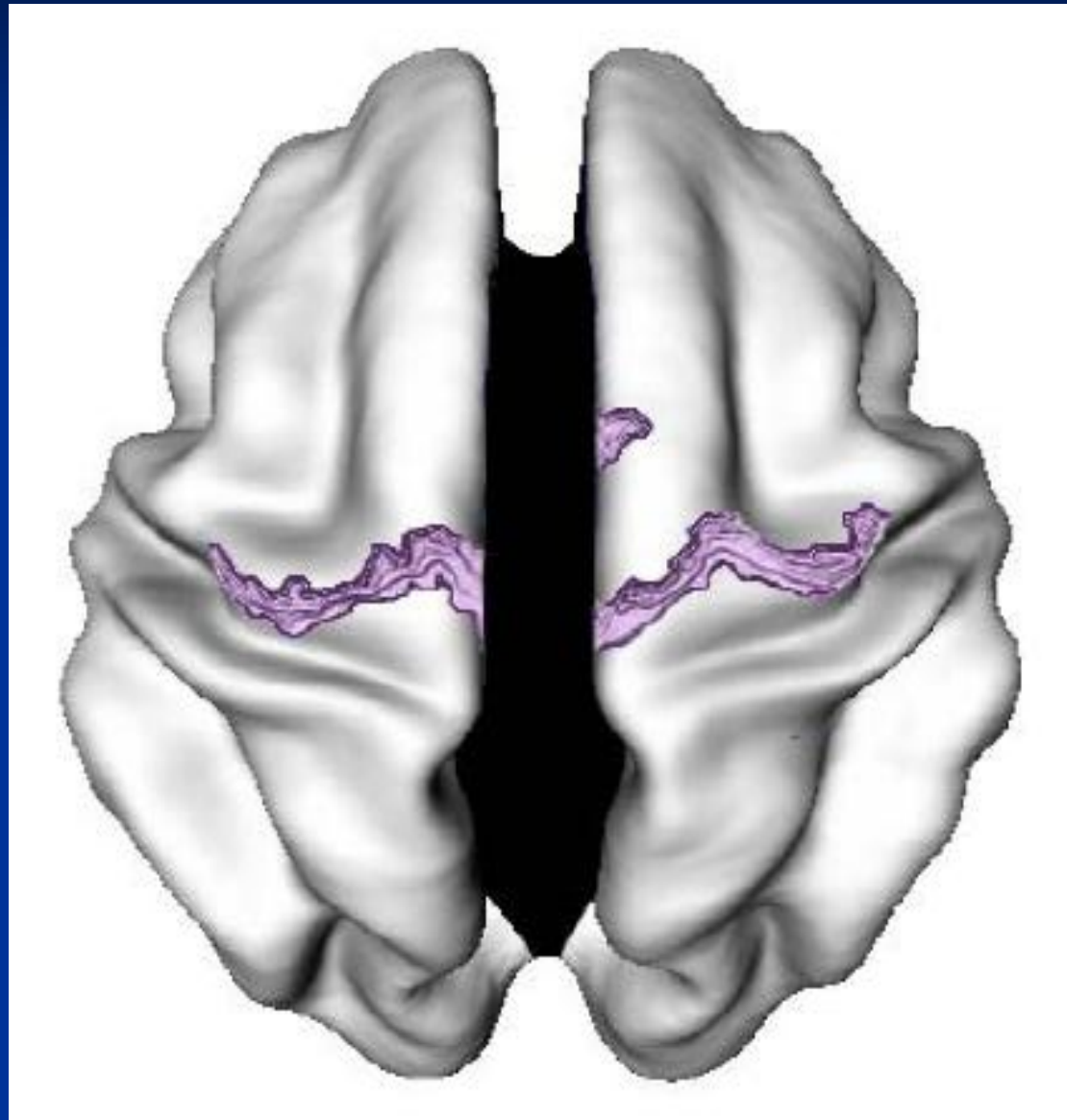


Dark colors → inappropriate quadratic model (peak age not calculable or outside age range).

Groups show similar sequence of regions attaining peak thickness, but ADHD is delayed.

Early cortical maturation in ADHD

indicated by younger age of attaining peak cortical thickness



Brain Networks



Brain Development in Autism: Infant Siblings

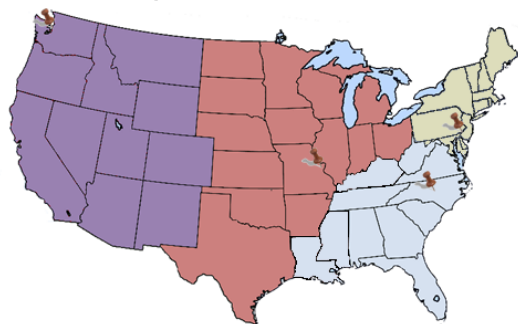
IBIS Network
Infant Brain Imaging Study

Home Study Goal What is MRI? Why Study Siblings? Study Sites

This study of very early brain development in autism has the potential to provide important clues relevant to early detection of autism and discovering the early changes in the brain for young children with autism.

Who Are We Looking For?

Younger (under 12 months of age) siblings (brothers and sisters) of children with a diagnosis of autism.



Click on your location to visit your area's study site.

What Does Participation Involve?

Participants will travel to their closest study location to receive developmental and behavioral assessments, an MRI scan of the brain and screening for Fragile X syndrome. Participants will be reimbursed for travel and related expenses. Assessment and MRI scans associated with the project are provided at no cost to the family, and participants will be given any new information gained upon completion of the study. Families of children at high risk for developing symptoms of autism will receive assistance with referrals for local services.

ICBM International Consortium for Brain Mapping

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About ICBM



International Consortium for Brain Mapping

The International Consortium for Brain Mapping (ICBM) was formed in 1993 with a grant from the NIMH. The primary goal of the ICBM project is the continuing development of a probabilistic reference system for the human brain. [More](#)

Databases



The ICBM Subject Database is a web-based database infrastructure that simplifies image dataset collection, organization and dissemination. A web interface provides the means to query the data base using a combination of subject demographics and scan-related attributes. [More](#)

Research



The goal of ICBM is the development of a probabilistic reference system for the human brain. To this end we have been incrementing existing data sets, expanding the range of studies with the inclusion of additional *in vivo* and post mortem data sets, and integrating the existing structural, functional and structure-function atlases that we have produced. [More](#)





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The MRI Study of Normal Brain Development

Sponsored by The National Institute of Mental Health

The National Institute of Child Health and Human Development
The National Institute of Neurological Disorders and Stroke

United States Department of Health & Human Services




The MRI study of normal brain development


Sponsored by The National Institutes of Health

What does it feel like inside the scanner?

Children will be positioned comfortably on a scanning bed that slides into the tunnel-shaped magnet. When the scanner is turned on, it makes humming and knocking sounds. Earmuffs or earplugs will be provided. An intercom system allows the child and technologist to speak to each other at all times.



Parents may accompany their child into the scanning area.




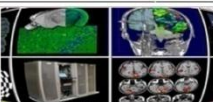
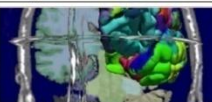
BIRN - Biomedical Informatics Research Network

http://www.nbirn.net/

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BIRN is supported by NIH Grants to the BIRN Coordinating Center (U24-RR019701), Function BIRN (U24-RR021992), Morphometry BIRN (U24-RR021382), and Mouse BIRN (U24-RR021760).

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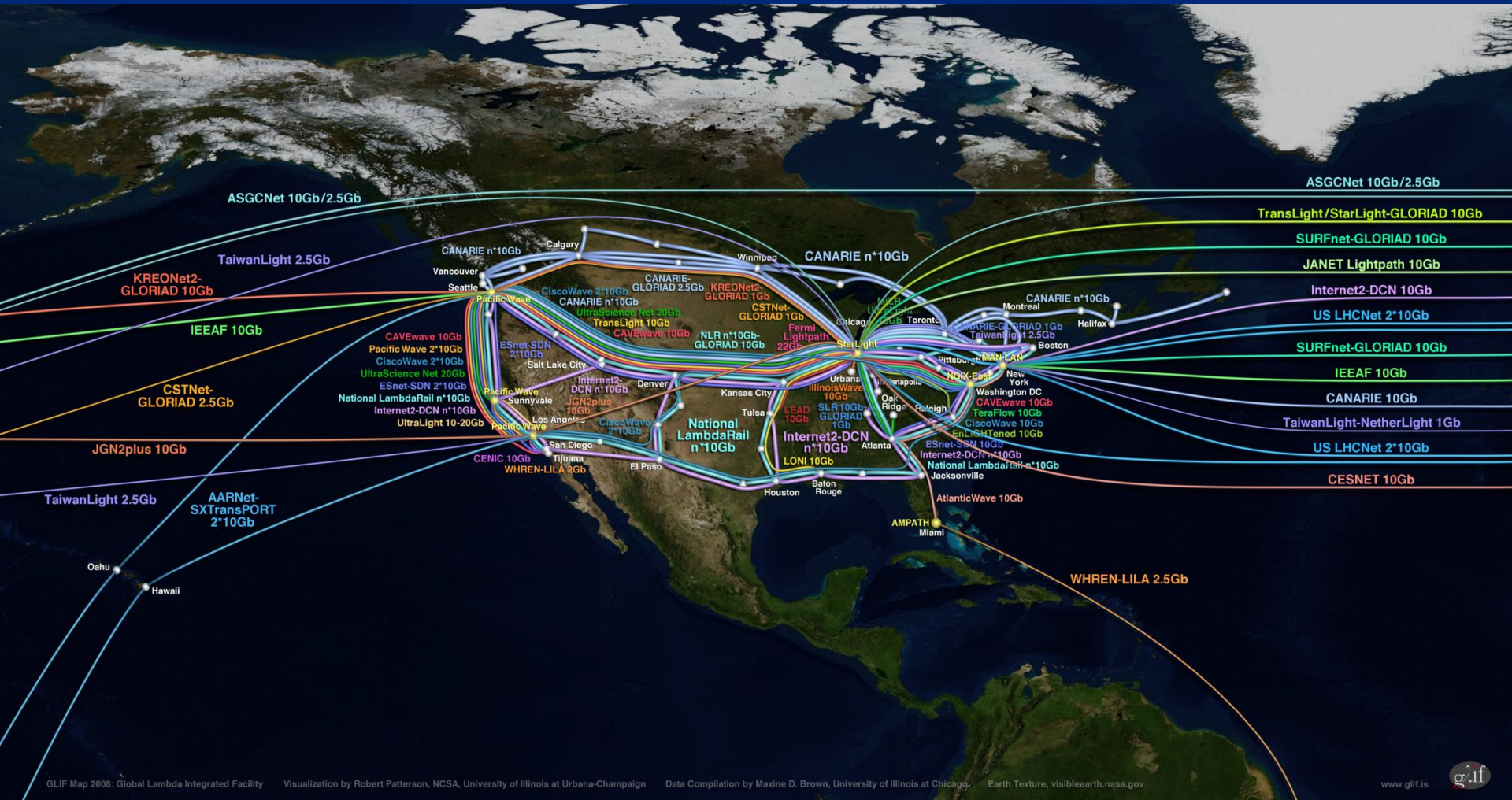
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- ▶ [Bill St. Arnaud Steps Down as Chief Research Officer of CANARIE](#)

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CANARIE Presentations

CANARIE Photos

Research and Education Networks North America



CBRAIN

- Canadian Distributed Neuroimaging Platform (5 Canadian Centers)
- Prototype Collaborative 3D Visualization of a High Resolution Brain

Data



Computing



canarie



ABC-CNBC

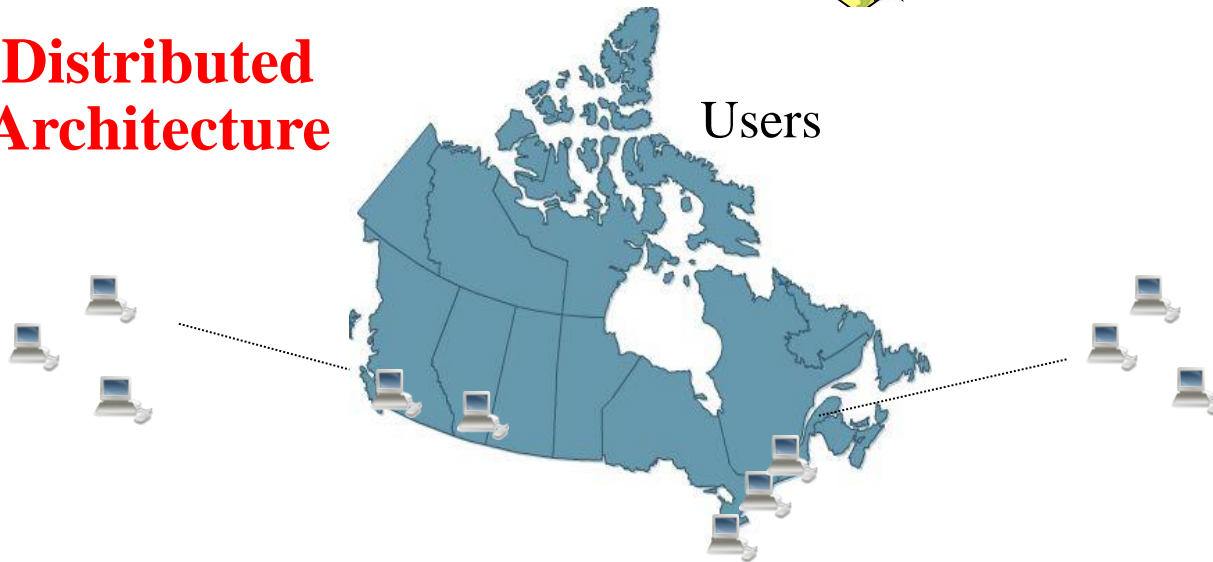
McGill

Université
de Montréal



Users

**Distributed
Architecture**



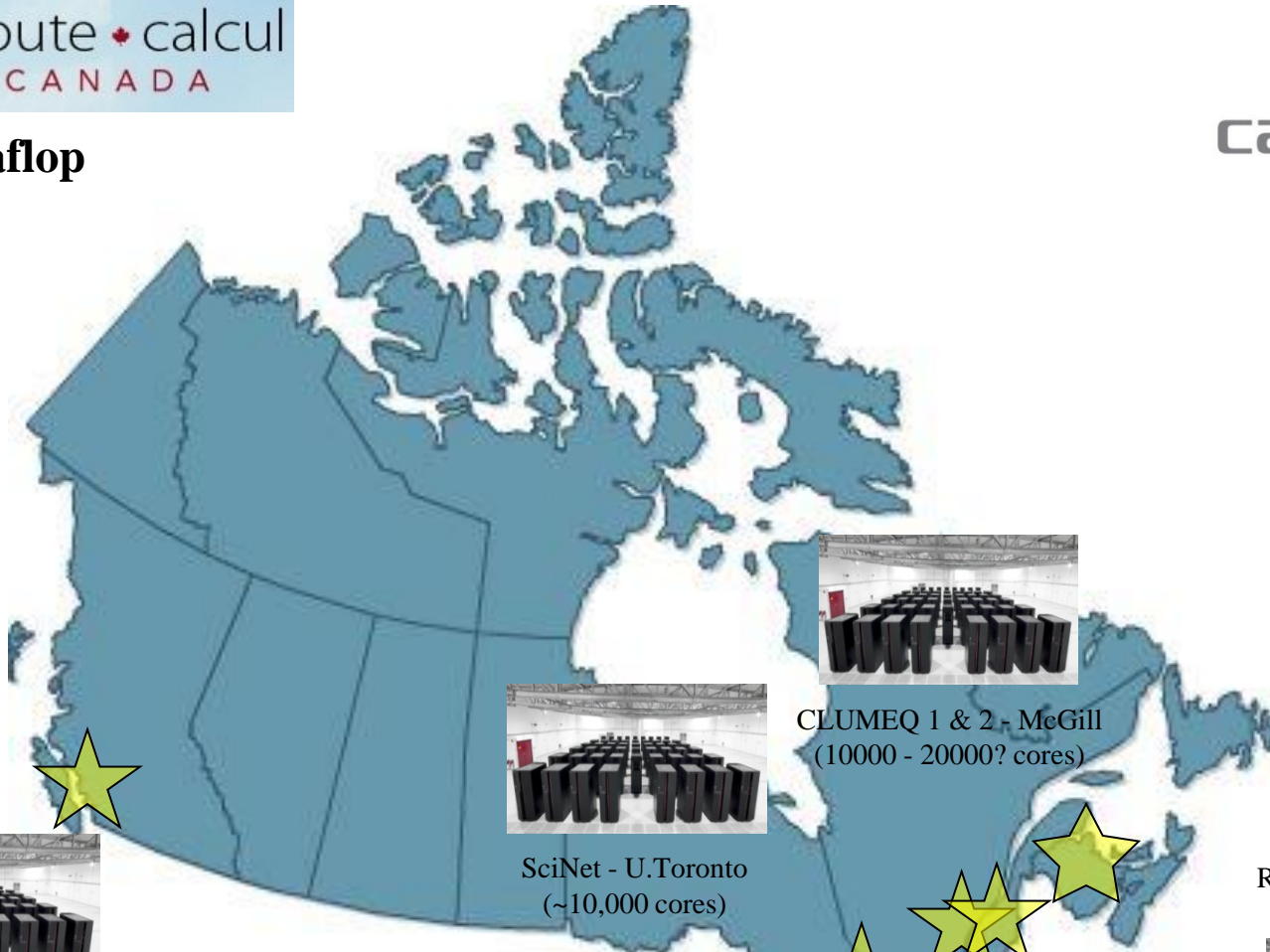
CBRAIN HPC Roadmap

(20,000 – 30,000 CPUs)



canarie

~ 1 Petaflop



Westgrid Orcinus – UBC
(3072 cores)



SciNet - U.Toronto
(~10,000 cores)



CLUMEQ 1 & 2 - McGill
(10000 - 20000? cores)



ACENet _ Dalhousie
(~3000 cores)



SHARCNET Saw - UWO
(2704 cores)



HPVLC- Queens
(~2000 cores)



RQCHP - U.Sherbrooke
(2112 cores)

International Links





Singapore Birth Cohort Study

H1: Epigenetic changes in conceptual tissues obtained at birth reflect fetal environment.

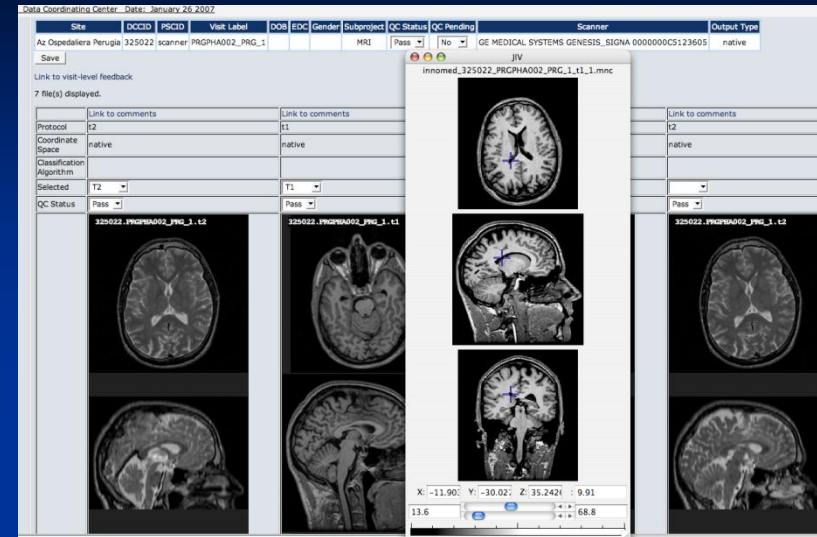
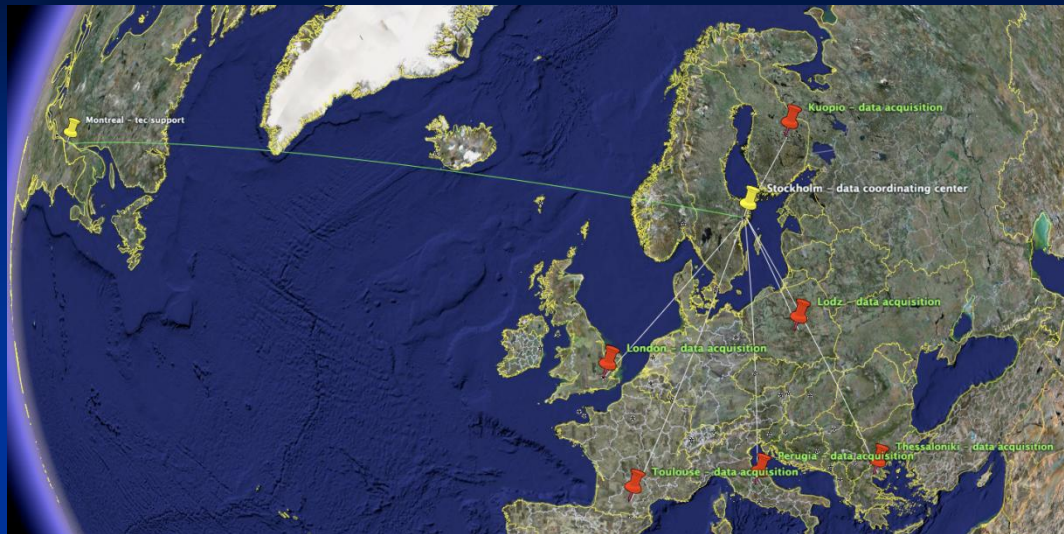
H2: Pattern of epigenetic marks in gene promoters in DNA of birth tissues, along with genotype, phenotype, and early environmental exposures predict risk of obesity and metabolic disease.

1200 mothers (200 Indian, 200 Malay, 800 Chinese) through pregnancy until the child 3yr of age.

Vanguard group of 100 mothers (60 Chinese, 20 Malay and 20 Indian) recruited from June 2009

Measure fetal/child growth and influences on *epigenetic* factors

Canada-Europe Brain Network Links



Innomed / AddNeuroMed
Alzheimer's Disease

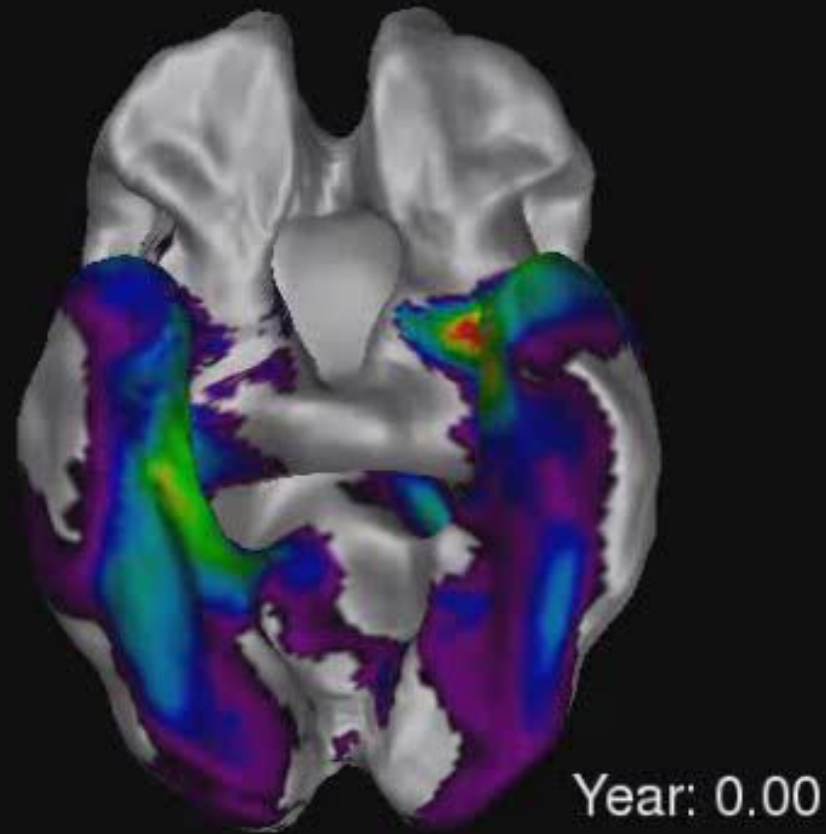


neuGRID
e-infrastructure

NeuGrid – Grid Computing
Distributed processing
Distributed databasing

Cortical atrophy in Alzheimer's Disease

(Lerch J et al., Cerebral Cortex 2005)



Latin American Brain Mapping Network (LABMAN)



NeuroImage 47 (2009) 312–313

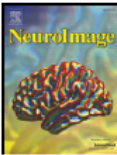


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NeuroImage

journal homepage: www.elsevier.com/locate/ynimg



Comments and Controversies

Latin American Brain Mapping Network (LABMAN)

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ABSTRACT

On March 8, 2008 in Havana, the Latin American Network for Brain Mapping (LABMAN) was created with participants from Argentina, Brazil, Colombia, Cuba and Mexico. The focus of LABMAN is to promote neuroimaging and systems neuroscience in the region through the implementation of training and exchange programs, and to increase public awareness of the Latin American potential to contribute both to basic and applied research in human brain mapping.

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Cuban Brain Mapping Project



Random sampling from
general population N=20,209

Age Range: 0-90

Both Genders

Screening for general pathologies

Age Range: 18-81

N = 1574

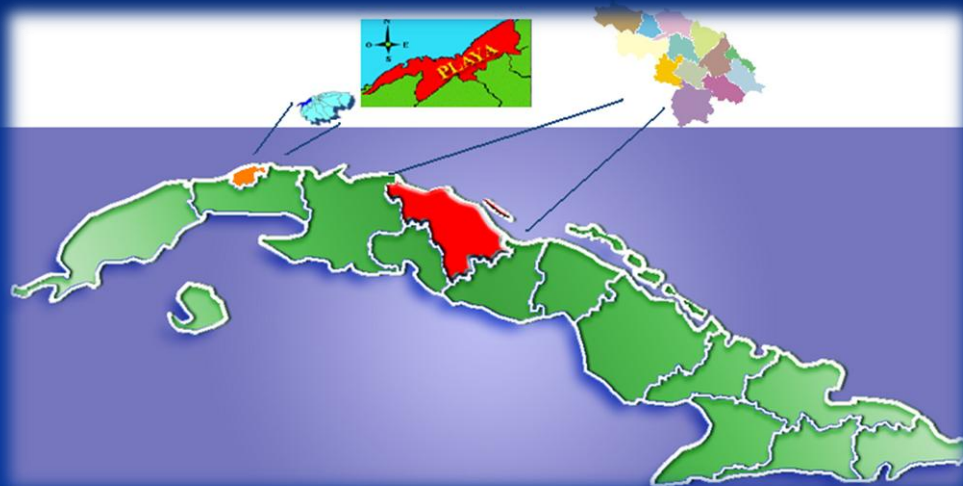
Causes of Exclusion	Quantity.	% respecting to the screened sample
Pathologies	705	44.79
Arterial Hypertension	224	14.23
Neurological Diseases	209	13.28
Athma	69	4.39
Psychiatric disorders	64	4.07
Other systemic diseases	59	3.75
Diabetes Mellitus	37	2.35
Cardiovascular diseases	29	1.84
Malignant neoplasia	8	0.5
AIDS	6	0.38
Others	277	17.6

Cuban Dementia and Alzheimer Study

Playa Municipality, Havana & Santa Clara, Villa

Clara

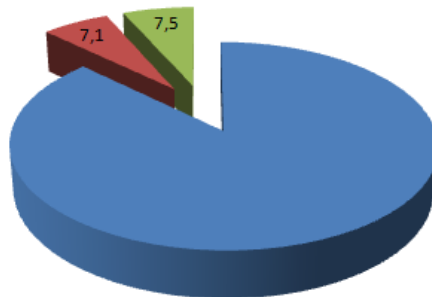
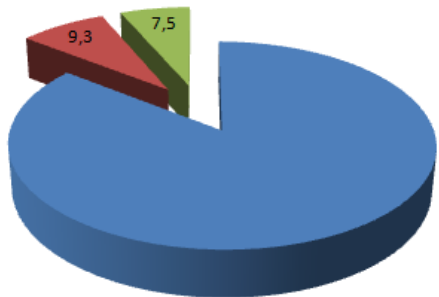
Total Municipalities Population Studied Over 65 years old approximately 40 000 inhabitants



Prevalence for each 100 inhabitants

Playa

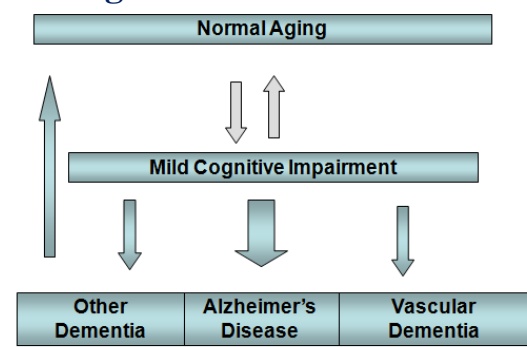
Santa Clara



- 2 Dementia Syndrome
- 3 Mild Cognitive Impairment (Risk population)

Diagnostic Problems of Alzheimer Disease (AD)

Depends on diagnosis
No biological markers



Indian National Brain Research Centre Manesar, Haryana



Drs. Vijayalakshmi Ravindranath, Prasun Roy, Shobini Rao
Dr. Sumitra Purkayastha (Indian Statistical Institute)

outGRID

Grand Vision

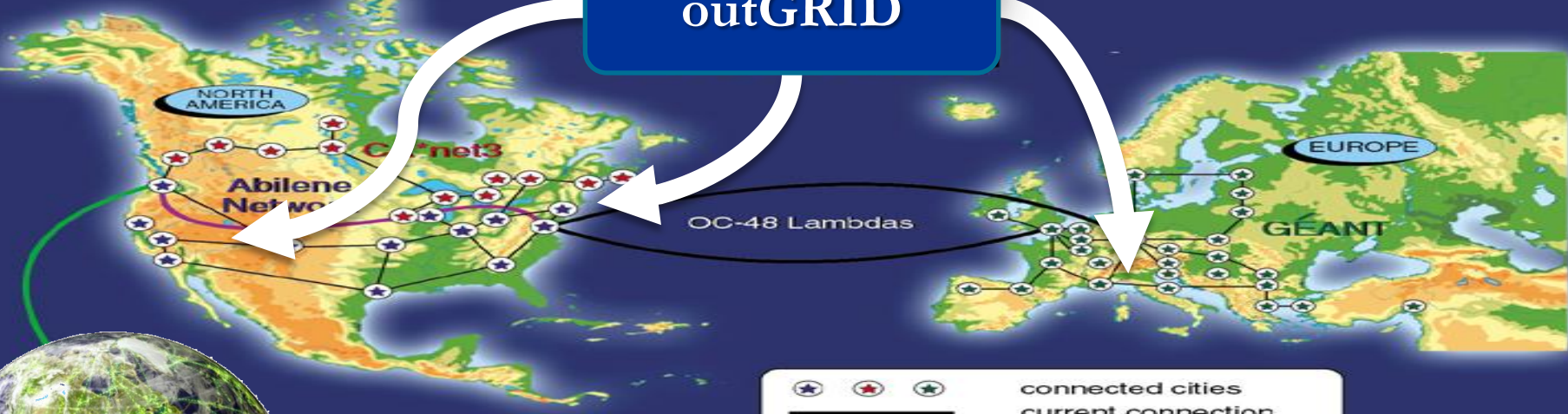


This block contains several screenshots of the outGRID system's applications:

- A medical data interface showing patient information and MRI scan results.
- A network diagram showing connections between various nodes labeled 'ISL Change Ring' and 'ISL Maths'.
- A 3D visualization of a brain structure.
- A 'Portal' interface with a grid of service icons.
- A 'wbar' (workspace bar) with icons for a file browser, printer, and power.



outGRID



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LONI seeks to improve understanding of the brain in health and disease. The laboratory is dedicated to the development of scientific approaches for the comprehensive mapping of the brain structure and function.

- CCB Center for Computational Biology
- ICBM International Consortium for Brain Mapping
- BIRN Biomedical Research Infrastructure Network
- ADNI Alzheimer's Disease Neuroimaging Initiative
- LONIR LONI Resource
- MAP Mouse Atlas Project

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Institute of Neuroscience and Medicine (INM)



The INM is devoted to brain research. The analysis of the normal and pathologically impaired structure and function of the nervous system with particular emphasis on mechanisms at the molecular, cellular, and systems level as well as the development of novel diagnostic and therapeutic techniques is the main goal of our institute. To reach this goal the INM cooperates with a number of universities, among them the universities of Köln, Bonn and Düsseldorf as well as the RWTH Aachen University in the framework of Jülich Aachen Research Alliance - Brain (JARA-BRAIN).

Important Research Fields:

- Brain Imaging Physics
- Cognitive Neurology
- Computational and Systems Neuroscience
- Human Brain Mapping
- Molecular Organization of the Human Cortex
- Neurostimulation

It's a great pleasure for us to inform you that from Friday 04th to Sunday 6th of December 2009 the Third Vogt Brodmann Symposium on "One hundred years anniversary of Brodmann's map: change of concepts" will take place in Juelich, Germany.

For further information please visit our website:
 http://www.fz-juelich.de/inm/Vogt-Symposium

LONI De-identification Debaltet

Download

A simple to use Java application for removing patient-identifying information (e.g., patient)

Automated Image Registration

Download

A tool for automated registration of 3D and 2D images within and across subjects and across



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JOURNAL COVERS

Human Brain Mapping Vol. 27 Dec 2006
 Neuroimage Vol. 31 May 2006
 Human Brain Mapping Vol. 25 Aug 2005
 Neuroimage Vol. 44 Jan 2009

PHOTO ALBUM



SCHEDULE

4 Sep 2009

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Zilles
Germany



Lee
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McGill Centre for Neuroinformatics and Genomics (MCNG)

Existing Strengths

- Well-defined global target community
- Spatial framework for combining results from brain mapping experiments
- Computational emphasis of the brain mapping field
- High profile neuroscience community
- Software infrastructure from for databasing and pipeline analysis
- High-bandwidth transfer capabilities from CANARIE
- CLUMEQ Supercomputing Facility
- Supercomputing resources across Canada (LRP)
- CBRAIN/GBRAIN
- High-bandwidth partners in US, Europe, Asia
- Commercial links already in place - Biospective

McGill Centre for Neuroinformatics and Genomics (MCNG)

Functions

- Database storage of brain mapping/genomic data (private or public)
- Creation/dissemination of gold-standard datasets for normal and disordered brain
- Processing of brain mapping data using BIC image-processing pipelines
- Statistical analysis of processed images, clinical/behavioural data
- Genomic analysis at every 3D voxel
- Training with brain image analysis methods for visiting scientists/students/HQP

Immense computation - Grid-computing, e.g. NeuGrid www.infoalzheimer.it/neugrid

Use CANARIE backbone and the HPC National Platforms www.c3.ca

Staff: 2 database managers, 2 IP specialists, 1 facilities manager, 1 financial manager

N.B. not restricted to human brain MRI

Species: human, primate, rodent

Organs: brain, heart, liver

Modalities: (PET, fMRI, histology, IHC, DNA/RNA)

