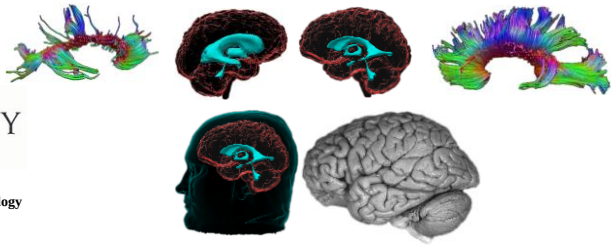
UPDATED 9.1.18

Erin D. Bigler, Ph.D., ABPP

BRIGHAM YOUNG UNIVERSITY

Professor Emeritus, Department of Psychology and Neuroscience Center
Founding Director, Magnetic Resonance Imaging Research Facility
and the Brain Imaging and Behavior Lab



THE UNIVERSITY OF UTAH

Departments of Psychiatry and Neurology

UCDAVIS SCHOOL OF MEDICINE

Department of Neurology

erin_bigler@byu.edu

38TH ANNUAL CONFERENCE
OCTOBER 17-20, 2018

BECOMING AGENTS OF CHANGE

SHERATON NEW ORLEANS HOTEL | NEW ORLEANS, LA

Throwback to NAN's 1996 Annual Conference in NOLA

Now is your chance to relive, or perhaps experience for the first time, the 1996 Presidential Address on NeuroWrestling from NAN's very own Dr. Jeffrey T. Barth.

"I hope folks will discover that NAN can be FUN too," added Dr. Barth recently. Please enjoy the presentation and make your plans today to attend this year's Annual Conference back in New Orleans!

Course Objectives

- Course participants will first learn various methods for traditional identification of different kinds of lesions and abnormalities with in a scan, based on standard clinical review of the images.
- Participants will be informed and come away with a basic knowledge of neuroimaging quantification techniques and how to conduct them.
- Participants will learn fundamentals of how to extract clinically relevant information from commercially available programs as well as those that are open source.

National Academy of Neuropsychology Objectives

- Advance knowledge in assessment and remediation of neurological impairment
- Foster the development of neuropsychology as a discipline, science, and profession
- Interact with other professional groups

1996

Funding/Acknowledgements

MRI in Autism

Erin D. Bigler, Ph.D., Andrew L. Alexander, Ph.D.,
Jee Eun Lee, M.S., Mariana Lazar, Ph.D., E.K. Jeong, Ph.D.,
Nicholas Lange, Ph.D., William McMahon, M.D.,
Janet E. Lainhart, M.D.
BYU's Brain Imaging & Behavior Lab:
Tracy J. Abildskov and Jo Ann Petrie

A Psychiatric and Imaging Study of Pediatric Mild Traumatic Brain Injury

Jeffrey E. Max, M.D.
Erin D. Bigler, Ph.D.
Elisabeth E Wilde, Ph.D.
John R. Hesselink, M.D.

1 R01 HD068432-01A1

Social Outcomes in Pediatric TBI

Keith O. Yeates, Ph.D., Principal Investigator
Co-Principal Investigators
H. Gerry Taylor, Ph.D. Rainbow Babies & Children's Hospital
Kenneth H. Rubin, Ph.D. University of Maryland
Maureen Dennis, Ph.D., University of Toronto
Erin D. Bigler, Ph.D., BYU and University of Utah

Forensic Consultation

Oxford University Press

Cambridge University Press

adapt
Approaches and Decisions in Acute Pediatric TBI Trial

WISCONSIN
UNIVERSITY OF WISCONSIN-MADISON

MRI Markers of Outcome After Severe Pediatric TBI

Children 8 to 17 years of age with acute and follow-up MRI at one year of greater post-injury

Comprehensive Neuropsychological Follow-Up

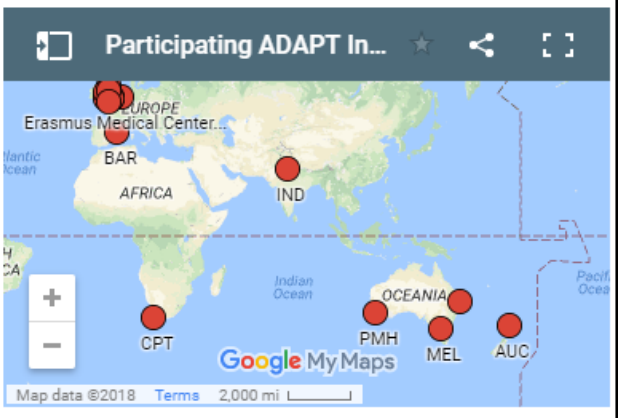
Approaches and Decisions in Acute Pediatric TBI Trial (ADAPT) is an international research study designed to evaluate the impact of interventions on the outcomes of children with severe traumatic brain injury.

adapt

Approaches and Decisions in Acute Pediatric TBI Trial

United States

International



e·nig·ma
/iˈnigmə/

noun

a person or thing that is mysterious, puzzling, or difficult to understand.

ENIGMA

(Enhancing Neuro Imaging Genetics through Meta Analysis) Military Brain Injury Working Group.

ENIGMA MILITARY BRAIN INJURY: A COORDINATED META-ANALYSIS OF DIFFUSION MRI FROM MULTIPLE COHORTS

Emily L. Dennis[1,2], Elisabeth A. Wilde[3-5,11], Mary R. Newsome[3,4], Randall S. Scheibel[3,4], Maya Troyanskaya[3,4], Carmen Velez[6], Benjamin S.C. Wade[6,7] Ann Marie Drennon[8], Gerald E. York[8], Erin D. Bigler[10], Tracy J. Abildskov[10], Brian A. Taylor[3,4,11], Carlos A. Jaramillo[12], Blessen Eapen[12], Heather Belanger[13,14], Vikash Gupta[1], Rajendra Morey[15], Courtney Haswell[15], Harvey S. Levin[3,4], Sidney R. Hinds II[16], William C. Walker[8,17,18], Paul M. Thompson[1,2,19], David F. Tate[6]

[1]Imaging Genetics Center, Keck School of Medicine of USC, Marina del Rey, CA, USA; [2]Department of Psychiatry and Biobehavioral Sciences, Semel Institute for Neuroscience and Human Behavior, UCLA, Los Angeles, CA, USA; [3]Michael E. DeBakey Veterans Affairs Medical Center, Houston, TX, USA; [4]Department of Physical Medicine and Rehabilitation, Baylor College of Medicine, Houston, TX, USA; [5]Department of Neurology, University of Utah, Salt Lake City, UT, USA; [6]University of Missouri-St. Louis, St. Louis, MO, USA; [7]Ahmanson-Lovelace Brain Mapping Center, Department of Neurology, UCLA, Los Angeles, CA, USA; [8]Defense and Veterans Brain Injury Center, San Antonio, TX, USA; [9]Alaska Radiology Associates, Anchorage, AK, USA [10]Department of Psychology and Neuroscience, Brigham Young University, Provo, UT, USA; [11]Department of Radiology, Baylor College of Medicine, Houston, TX, USA; [12]Polytrauma Rehabilitation Center, South Texas Veterans Health Care System, San Antonio, TX; [13]James A. Haley Veterans Hospital, Tampa, FL, USA; [14]University of South Florida, Tampa, FL, USA; [15]Psychiatry, Duke University, Durham, NC; [16]Department of Defense/United States Army Medical Research and Materiel Command; [17]Department of Physical Medicine & Rehabilitation, Virginia Commonwealth University, Richmond VA; [18]Hunter Holmes McGuire VAMC, Richmond VA; [19]Departments of Neurology, Pediatrics, Psychiatry, Radiology, Engineering, and Ophthalmology, USC, Los Angeles, CA

Proc IEEE Int Symp Biomed Imaging. 2018 Apr;2018:1386-1389.
doi: 10.1109/ISBI.2018.8363830.

TBI N = 437 **Control N = 268**

Soon to Have Sample Sizes >5,000

ARTICLE IN PRESS

Archival Report

Biological Psychiatry

Cortical Brain Abnormalities in 4474 Individuals With Schizophrenia and 5098 Control Subjects via the Enhancing Neuro Imaging Genetics Through Meta Analysis (ENIGMA) Consortium

Theo G.M. van Erp, Esther Walton, Derrek P. Hibar, Lianne Schmaal, Wenhao Jiang, David C. Glahn, Godfrey D. Pearlson, Nailin Yao, Masaki Fukunaga, Ryota Hashimoto, Naohiro Okada, Hidenaga Yamamori, Juan R. Bustillo, Vincent P. Clark, Ingrid Agartz, Bryon A. Mueller, Wiepke Cahn, Sonja M.C. de Zwarte, Hilleke E. Hulshoff Pol, René S. Kahn, Roel A. Ophoff, Neeltje E.M. van Haren, Ole A. Andreassen, Anders M. Dale, Nhat Trung Doan, Tiril P. Gurholt, Cecilie B. Hartberg, Unn K. Haukvik, Kjetil N. Jørgensen, Trine V. Lagerberg, Ingrid Melle, Lars T. Westlye, Oliver Gruber, Bernd Kraemer, Anja Richter, David Zilles,

ENIGMA (Enhancing Neuro Imaging Genetics through Meta Analysis) Schizophrenia Working Group.

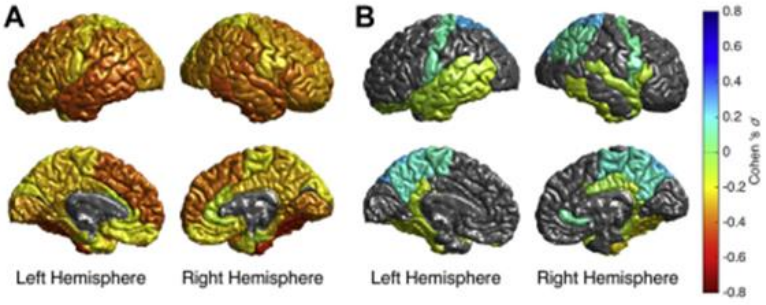


Figure 1. Cortical map of regional Cohen's *d* effect sizes for schizophrenia subjects' vs. healthy volunteers' cortical thickness contrast statistically controlling for age and gender **(A)** and age, gender, and global cortical thickness **(B)**. Only regions with $p_{false\ discovery\ rate} < .05$ are depicted in color. In panel **(B)**, warm colors (yellow-red) reflect regions in which the effect of schizophrenia is more than the mean global cortical thinning, and cool colors (green-blue) reflect regions where the effect of schizophrenia is less than the mean global thinning compared with healthy volunteers.

***Biol Psychiatry*. 2018 May 14. pii: S0006-3223(18)31517-8. doi: 10.1016/j.biopsych.2018.04.023**

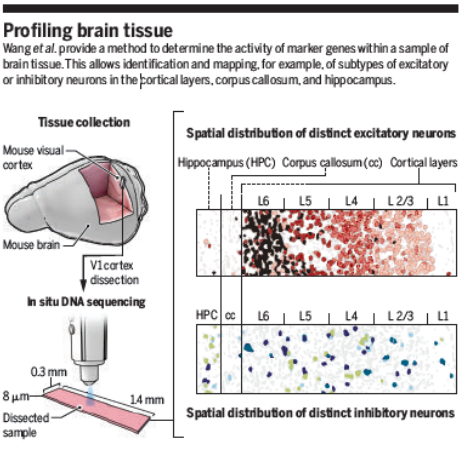
INSIGHTS | *PERSPECTIVES*

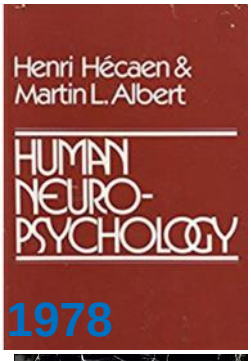
NEUROSCIENCE

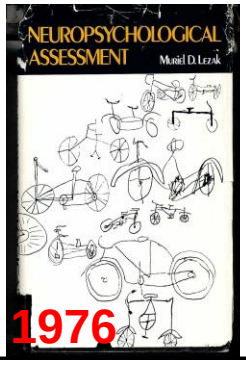
Neurotechnology to address big questions

Profiling of single neurons in tissue allows structure and function linkage in brain circuits

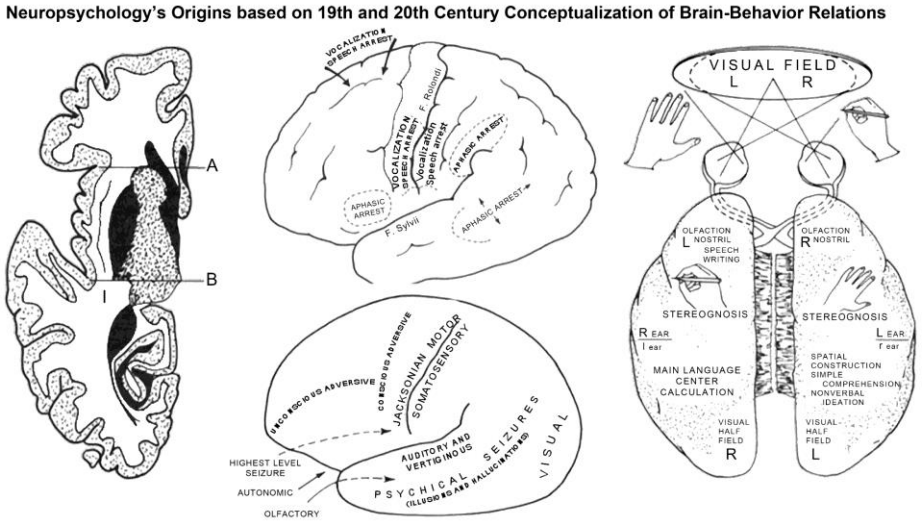
By Thomas Knöpfel







Neuropsychology's Historical Roots



Bigler E.D. Structural neuroimaging in neuropsychology: History and contemporary applications. *Neuropsychology*. 2017 Nov;31(8):934-953. doi: 10.1037/neu0000418.

Neuropsychol Rev
DOI 10.1007/s11065-015-9290-0

REVIEW

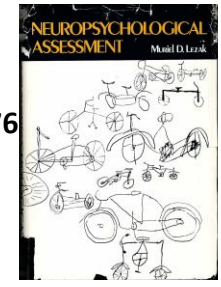
Neuropsychology, Neuroimaging and Brain-Behavior Relations

Structural Image Analysis of the Brain in Neuropsychology Using Magnetic Resonance Imaging (MRI) Techniques

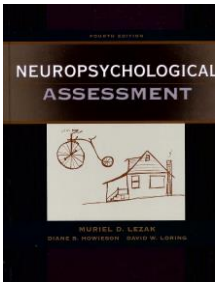
Erin D. Bigler[1,2,3,4]

43 Years of Teaching Neuropsychology, What has Changed?

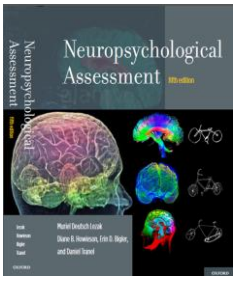
1976

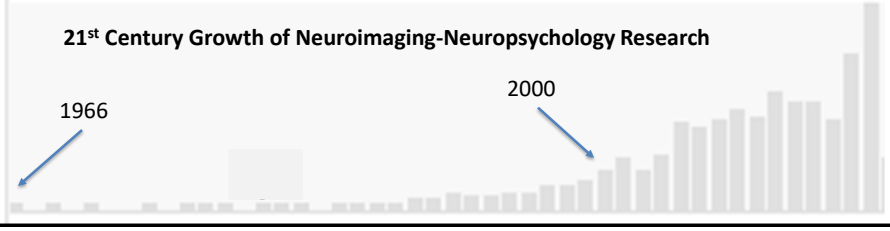


2004



2012





Neuropsychologia, Volume 8, 1970

1970 — Volume 8

Volume 8, Issue 4 Pages 395-506 (November 1970)

Volume 8, Issue 3 Pages 269-393 (July 1970)

Volume 8, Issue 2 Pages 137-267 (April 1970)

Volume 8, Issue 1 Pages 1-135 (January 1970)

Index 1 to Volume 8 Pages iii-iv (1970)

Two other journals

Cortex

Journal of Comparative and Physiological Psychology

Neuropsychologia. 1970. Vol. 8. pp. 13 to 19. Pergamon Press. Printed in England

THE STRUCTURE OF PSYCHOLOGICAL PROCESSES IN RELATION TO CEREBRAL ORGANIZATION

A. R. LURIA, E. G. SIMERNITSKAYA and B. TUBYLEVICH

Department of Neuropsychology, Moscow University and Department of Psychology, Warsaw University

(*Received* 25 *April* 1969)

Abstract—Every attempt to analyze the cerebral organization of a psychological process has to take in account not only its stable structure but the change of this structure during the ontogenetic and functional development as well.

This presumption is illustrated by an analysis of the disturbances of writing in two cases of left parieto-occipital lesions where copying and slow writing based on optico-spatial analysis of letters was impossible but quick writing based on automatised writing skill remained intact.

IN MODERN psychology, it is now widely accepted that each kind of mental activity has a distinct psychological structure and is effected through the joint activity of discrete cortical zones.

But how was neurological impairment identified?

In Memory
1927 - 2018

Neuropsychological investigation with Luria's methods

1984

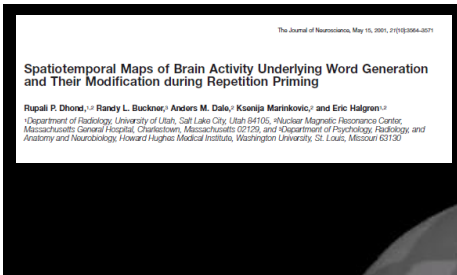
by Anne-Lise Christensen, PhD[1]

Original article
Scand J Work Environ Health 1984;10(1):33-34

www.ncbi.nlm.nih.gov/pubmed/6494854

"One of the main trends in Luria's concept of psychological function is that complex behavioral processes are not "localized" but are distributed throughout the brain in "functional systems."

Neurophysiological evidence of these considerations has been found, e.g., in cerebral blood flow studies, and the newest histological findings concerning the diversity of human brains give further support.



Spatiotemporal Maps of Brain Activity Underlying Word Generation and Their Modification during Repetition Priming

Rupali P. Dhond,[1,2] Randy L. Buckner,[3] Anders M. Dale,[2] Ksenija Marinkovic,[2] and Eric Halgren[1,2]

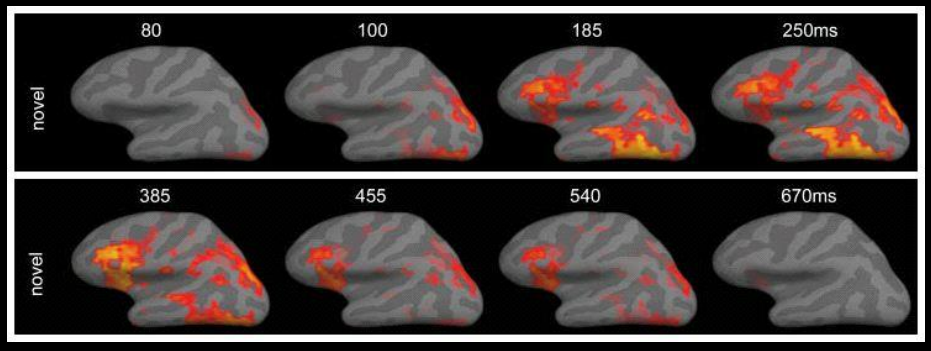
[1]Department of Radiology, University of Utah, Salt Lake City, Utah 84105, [2]Nuclear Magnetic Resonance Center, Massachusetts General Hospital, Charlestown, Massachusetts 02129, and [3]Department of Psychology, Radiology, and Anatomy and Neurobiology, Howard Hughes Medical Institute, Washington University, St. Louis, Missouri 63130

Why we need to study networks

Oral Reading of a nonsense word

Eric Halgren, University of Utah and Mass General Hospital

Bigler 2005



Behavior

Tissue to Organ level

1 m	Brain
10 cm	Systems
1 cm	Maps
1 mm	Circuits
100 µm	Neurons
1 µ	Synapses
1 Å	Molecules

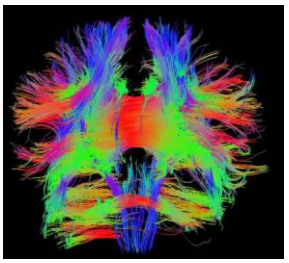
Å - Ångström : one ten-billionth of a meter

Whole-Brain Networks

Neuronal Networks

Synaptic Networks

Gene and Protein Networks

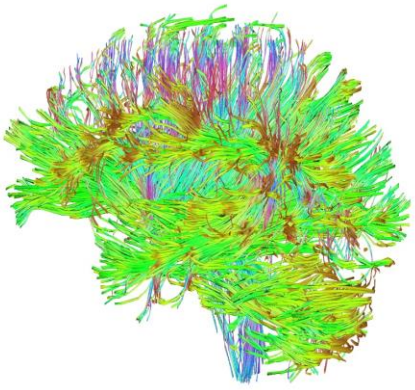


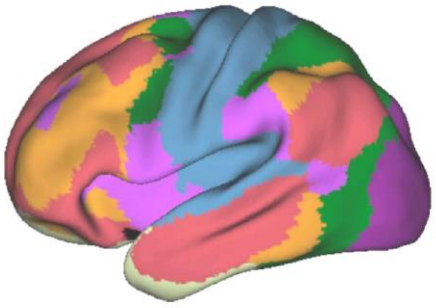
The Challenge of Scale and Complexity

One Cubic Millimeter =

80,000 Neurons
200,000 Glial Cells

4.5 million synapses





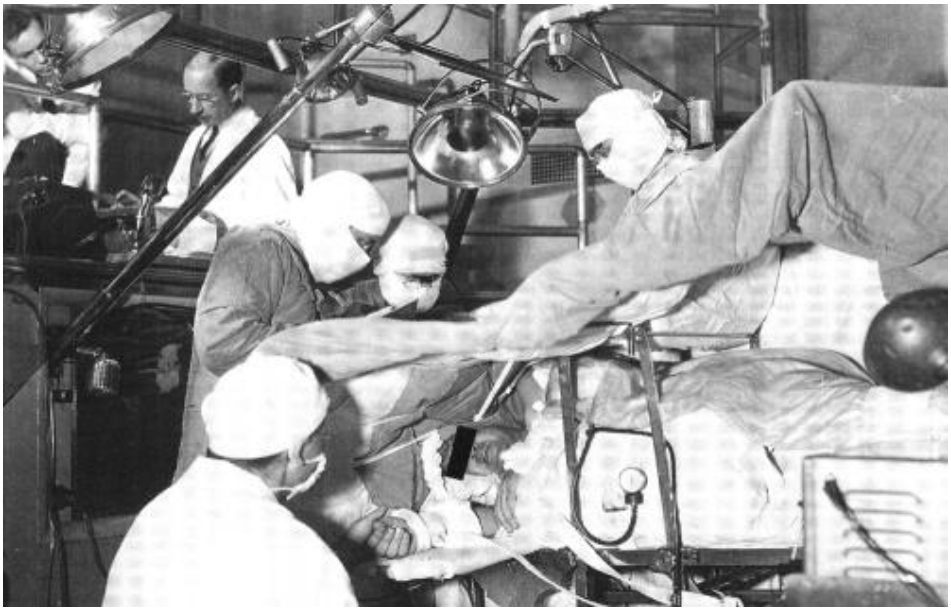
Purple (Visual)
Blue (Somatomotor)
Green (Dorsal Attention)
Violet (Ventral Attention)
Cream (Limbic)
Orange (Frontoparietal)
Red (Default)

Virtual Dissection of Erin Bigler's Brain

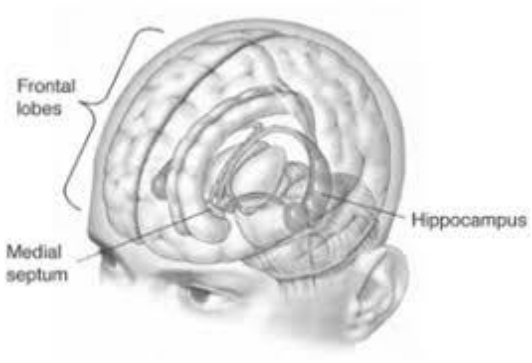
The passion brain | Erin Bigler | TEDxJacksonHole - YouTube

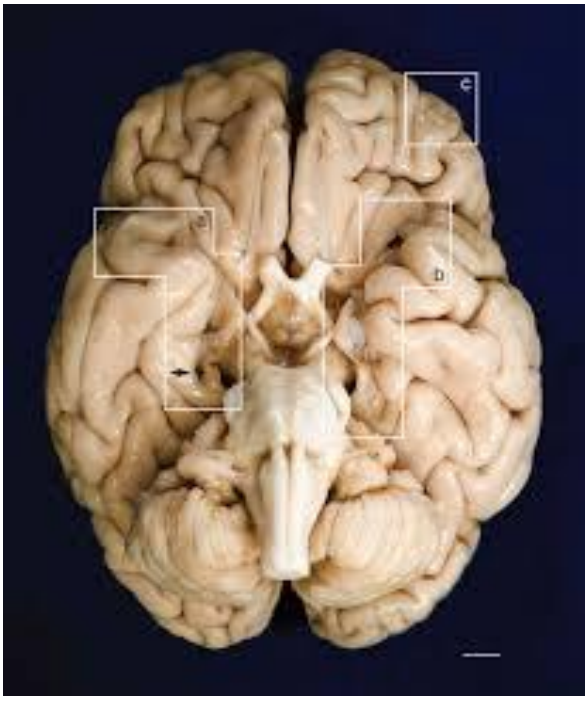
https://www.youtube.com/watch?v=uh8cCA2kxkg
Nov 11, 2016 - Uploaded by TEDx Talks
At its core, passion is a biological response of the brain that drives behavior. Cognitive neuroscience and ...

A Bit More History



Operating theatre at the Montreal Neurological Institute ca. 1958. Assisting Wilder Penfield with the procedure is Herber Jasper (monitoring EEG up upper left portion of picture) and Brenda Milner (back to camera and interacting with patient).





Neuropsychologia, 1970, Vol. 8, pp. 75 to 88. Pergamon Press. Printed in England

VERBAL AND MOTOR MEMORY IN THE AMNESTIC SYNDROME*

ARNOLD STARR†
Division of Neurology, Stanford University School of Medicine, Stanford, California 94305, U.S.A.
and
LAURA PHILLIPS
Departments of Psychology and Neurology, Veterans Administration Hospital, Palo Alto California 94304, U.S.A.

(*Received* 12 *March* 1969)

Abstract—The subject of this study was a 43-year old man who developed a disorder of memory following herpes simplex encephalitis six years earlier. Recent memory was severely affected in contrast to the preservation of both intellect and immediate and remote memory. The impairment of recent memory functions was evident on tasks using verbal material whereas memory for motor tasks such as maze learning and the rendering of new compositions for the piano was preserved. The deficit in remembering verbal items varied with (1) the type of retrieval (recall vs. recognition), (2) the modality of stimulus presentation (acoustic vs. visual), and (3) the way in which learning was attempted (serial presentation vs. self-ordering and classification). Evidence of proactive interference in memory formation was demonstrated by intrusion errors.

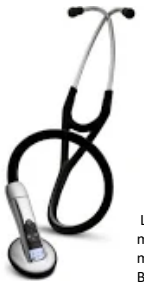
Table 1. Test results

1. WAIS

		Scaled Subtest Scores (Population Average=10; Range=0–19)	
Verbal IQ	135+	Verbal	
Performance IQ	110	Information (common knowledge)	14
Full Scale IQ	126	Comprehension (Why? How? What for?)	15
		Arithmetic (mental computation)	17
		Similarities (abstraction of common qualities)	17
		Digit Span (forward=9)	
		(backward=8)	19
		Vocabulary	14
		Performance	
		Digit-Symbol (copying; clerical-type skill)	8
		Picture Completion (supply missing parts)	11
		Block Design (speed and vis. mem. for designs)	15
		Picture Arrangement (comic strip sqs. arranged in logical order)	9
		Object Assembly (jigsaw puzzles)	11

2. Wechsler Memory Scale

Subtests	Form I*	Form II
Information	1/poss. 6	1/poss. 6
Orientation	4/poss. 5	2/poss. 5
Mental Control	no errors	no errors
(Saying alphabet, counting backwards, and counting by 4s)	time: 6″, 3″, 10″ av. score=9	time: 4″, 6″, 15″ av. score=9
Memory for connected passages	av. score=6/poss. 46	av. score=5/poss. 46
Digits: Forward	8 digits	8 digits
Backwards	7 digits	7 digits
Visual Reproduction	11/poss. 14 pts.	10/poss. 14 pts.
Associate Learning		
Easy (common free associates; e.g. "baby cries")	4.5/poss. 6	4/poss. 6
Hard (e.g. "cabbage-pen")	0/poss. 4	0/poss. 4
Total Score (age corrected)	90.5	84
MQ	89	80

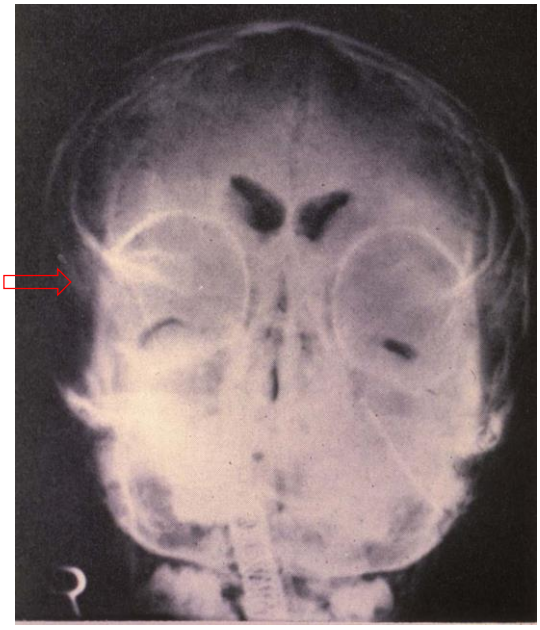


Laennec, René (1819). De l'auscultation médiate ou traité du diagnostic des maladies des poumon et du coeur. Paris: Brosson & Chaudé.

Circa ~1888
Lanska DJ. The history of reflex hammers. Neurology. 1989 Nov; 39(11):1542-9.

MATERIALS AND METHODS

The subject was a 43-year old right handed man (MK, Veterans Administration Hospital #562-26-7538) whose memory became impaired following herpes simplex encephalitis. The patient had been a mathematics and science instructor in high school prior to illness. In December of 1960 he developed headaches, fever, a "fine vesicular rash" on the forehead and lips and progressed to coma and convulsions. Cerebrospinal fluid studies showed 18 wbc/cc³ and a protein of 78 mg%. There was a rise in serum antibody titers to herpes simplex virus from 1:8 to 1:128 over a two week period whereas titers to mumps, St. Louis or Western Equine encephalitis varuses were unchanged. On regaining consciousness in early January of 1961 he was disoriented for time and place, confabulatory, and unable to remember new material. In April of 1961 he was transferred to the Veterans Administration hospital for domiciliary care where memory impairment persisted as the major neurological deficit. Psychological testing in March of 1965 (53 months after his acute illness) revealed an overall score of 125 on the Wechsler Adult Intelligence Scale (WAIS) 125 verbal scale and 121 performance scale. His memory for remote events was intact in contrast to his inability to recall recent events or to learn new material. He was described as emotionally immature and reacted to the examination in a childish manner. We tested the patient in January of 1967 (approximately six years after his acute illness). Neurological exam was normal except for an inability to taste the difference between salt, sugar, quinine, or acid (he described them all as "sweet") and to distinguish between the odors of camphor, tobacco, or lavender. Vision, hearing and touch were normal. Pneumoencephalogram showed enlargement of the third and lateral ventricles with a disproportionate dilatation of the temporal horns bilaterally (Fig. 1). The EEG was within normal limits. Clinical evaluation of memory showed superior immediate recall; the subject could repeat nine numbers forward or eight numbers backwards. His memory for events that had occurred many years earlier was intact. There was patchy recall of events in the years immediately preceding his illness. For instance, he remembered the details of his marriage and the birth of his first child but seemed unaware that he had two other children born within five years of his illness. Furthermore, he denied any particular familiarity with photography though it had been one of his best hobbies in the year immediately preceding his illness. The patient's recent memory was most impaired; he could not recall the names of three objects presented to him a few minutes earlier, nor could he recognize the examiner as familiar if he were briefly led out of the room during the course of the examination. His memory did not seem to improve even if the events evoked strong emotional responses. For instance, his wife noted that on one of the visits home the subject had been briefly angry at the son. When questioned immediately he could not recall what had affected him or his anger. It was apparent, however, that the patient had not totally lost his capacity for learning and retrieving new information. He was aware that he was in the hospital because of "memory trouble" and had developed the strategy of writing down reminders on slips of papers he carried in his breast pocket. He knew his way about the hospital grounds and was often used as a messenger by the ward clerks. He had learned the names of three of the hospital personnel in the course of the six years domicile: the ward doctor, the music teacher, and the swimming instructor. He was the pianist in the hospital band and knew that he had to be at rehearsals at 4 p.m. during the week. However, he would also be at the music building at 4 p.m. on weekends as well as he could not recall the day of the week even when reminded a few minutes before. He was aware of some major international events that had occurred in the interim since his illness such as the war in Vietnam and President Kennedy's assassination, though he could not recall their details.



H E Booker, C G Matthews, and W R Whitehurst. Pneumoencephalographic planimetry in neurological disease. J Neurol Neurosurg Psychiatry. 1969 June; 32(3): 241–248.

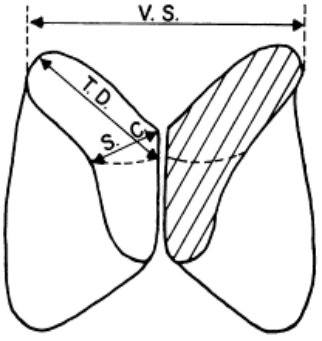
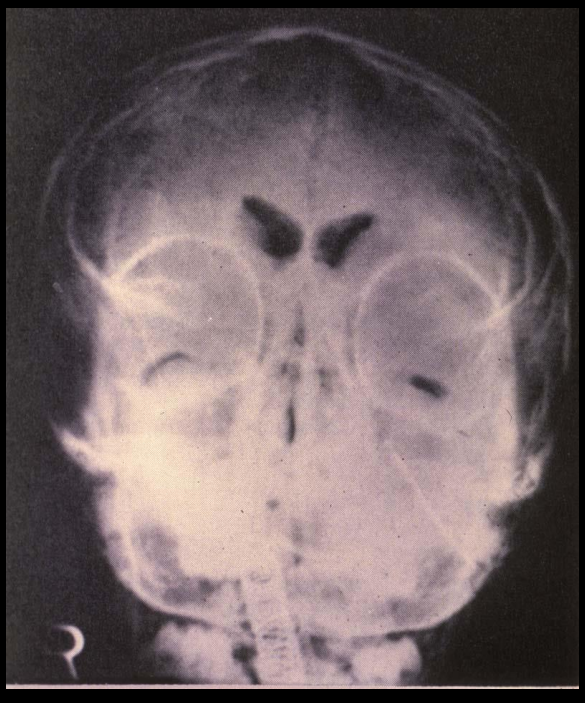


FIG. 2. *Diagram of measures used. V.S. = ventricular span. T.D. = transverse diameter. S.C. = septal-caudate line. Area measured by planimeter is lined.*



Neuropsychologia, 1964, Vol. 2, pp. 257 to 280. Pergamon Press Ltd. Printed in England

AN EXPERIMENTAL ANALYSIS OF THE BEHAVIORAL DISTURBANCE PRODUCED BY A LEFT FRONTAL ARACHNOIDAL ENDOTHELIOMA (MENINGIOMA)

A. R. LURIA, K. H. PRIBRAM and E. D. HOMSKAYA

Department of Psychology, Moscow University, U.S.S.R. and Department of Psychiatry, Stanford University School of Medicine, Palo Alto, California, U.S.A.

(*Received* 10 *July* 1964)

Abstract—A patient with a left frontal arachnoidal endothelioma was examined at the bedside. A series of simple tasks was administered. These showed:

(1) An inability to carry out compounded instructions whether these were given verbally or presented as a visual model.

(2) An inability to carry out "symbolic" instructions.

(3) These incapacities did not depend on any difficulty in apprehending the instructions *per se*.

(4) Error utilization appeared related to case of disequilibration as tested by the orienting reaction.

These results are believed to be indicative of frontal lobe impairment despite the presence of more generalized brain damage which may serve to bring out in relief and carricature the essence of a disturbance produced by the local lesion.

1. INTRODUCTION

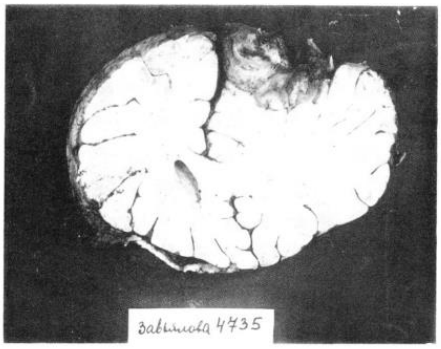


FIG. 1. Cross section through the frontal lobe of the brain of the patient examined in this study.

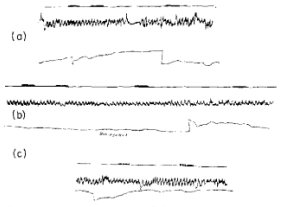


FIG. 2. Vegetative nervous system components of the orienting reaction showing the lack of activation by verbal instructions in the patient Zav:

(a) Vascular and galvanic skin components of the orienting reaction to sound alone. (Note variability and low amplitude of the response.)

(b) Same, after the introduction of the instruction: "towards the end of the sound there will be a prick". (Note absence of reaction.)

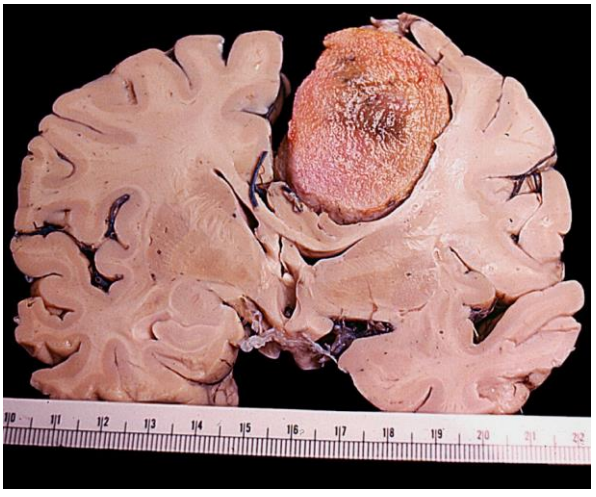
(c) Again, after the introduction of the instruction: "count the number of sounds". (Note that a reaction is again absent.)

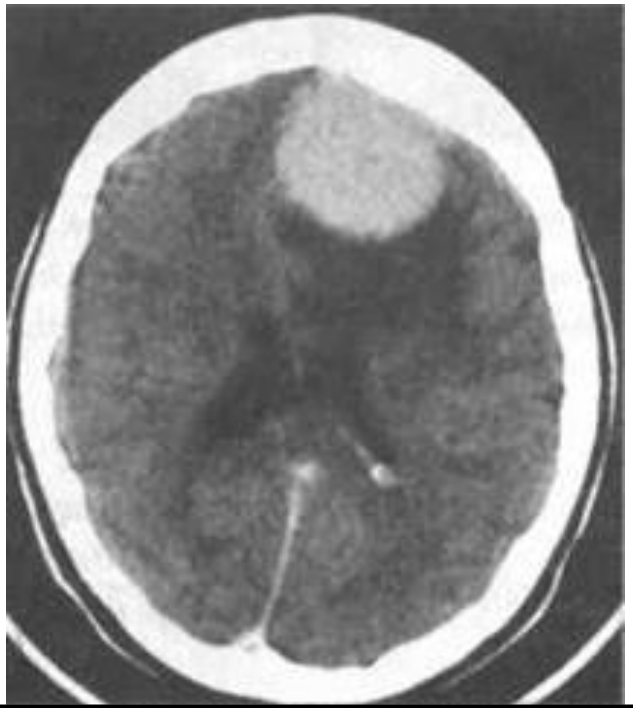
Game Changer

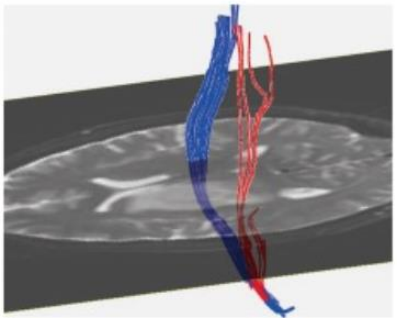
Sir Godfrey Hounsfield

The first EMI scanner designed by Hounsfield in 1971 was disassembled in the late 1970s and transferred from Atkinson Morley's Hospital to the Science Museum in London

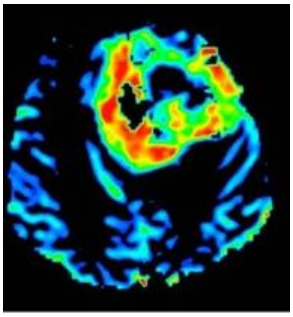
Introduced in the United States
In 1973 at the Mayo Clinic



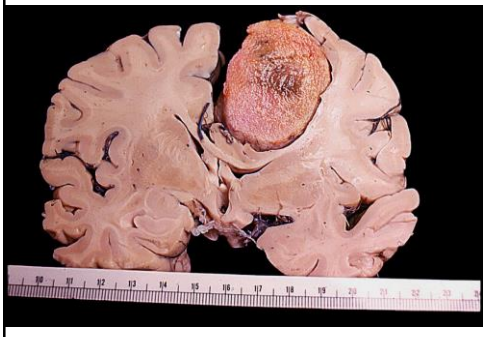


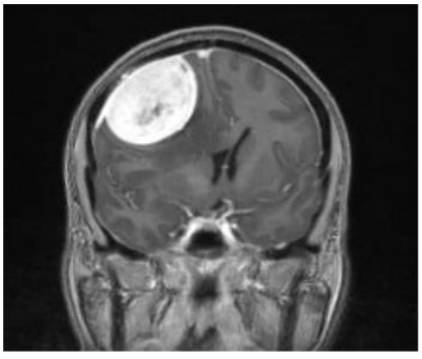


Tractography



Blood Flow



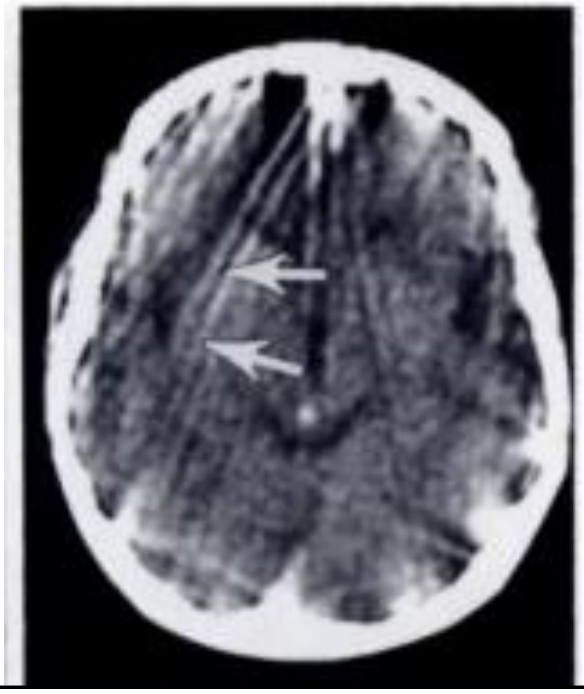


Morphometry

Back to Arnold Starr's HSE Case

Davis et al. Computed tomography of herpes simplex encephalitis, with clinicopathological correlation. *Radiology*. 1978 129(2):409-17

Zimmerman et al. CT in the early diagnosis of herpes simplex encephalitis. *American Journal of Radiology*, 1980, 134, 61 - 66

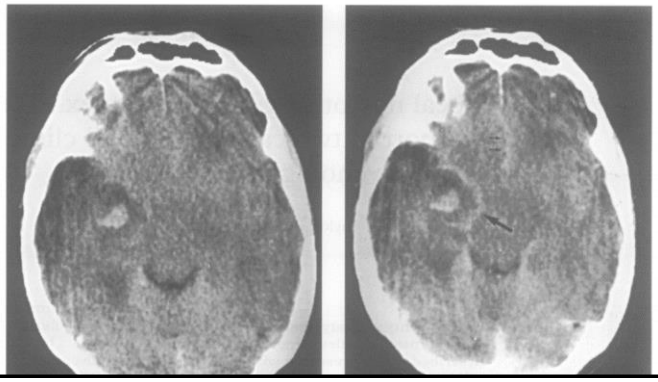


Journal of Neurology, Neurosurgery, and Psychiatry 1994;57:1115–1117

SHORT REPORT

Focal necrotising herpes simplex encephalitis: a report of two cases with good clinical and neuropsychological outcomes

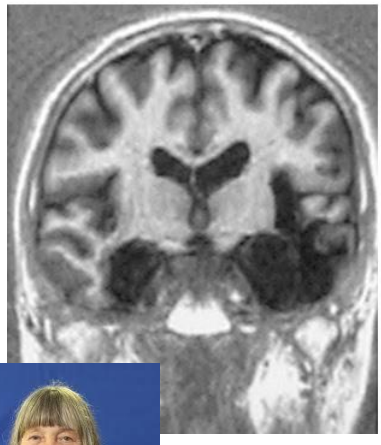
C E Counsell, R Taylor, I R Whittle



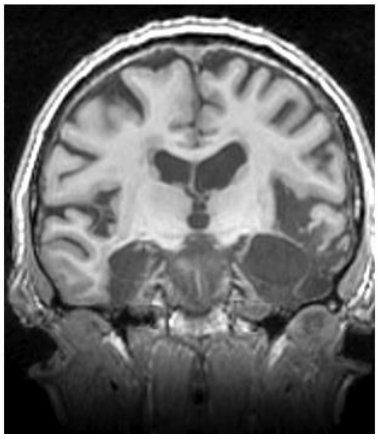
(A) Brain CT of patient 1. Precontrast (left) there is expansion of the right medial temporal lobe with diffuse low density and a focal high density lesion suggestive of a haemorrhage, and right to left shift. After contrast (right) (45 ml niopam) there is peripheral enhancement (single large arrow), and the uncal herniation can be clearly seen (double small arrows). (B) Immunocytochemistry for herpes simplex type 1 virus with a polyclonal antibody (Dako, UK) shows positive reactions in neurons and astrocytes, and widespread inflammation is evident (haematoxylin counterstain; original magnification 250).

Clive

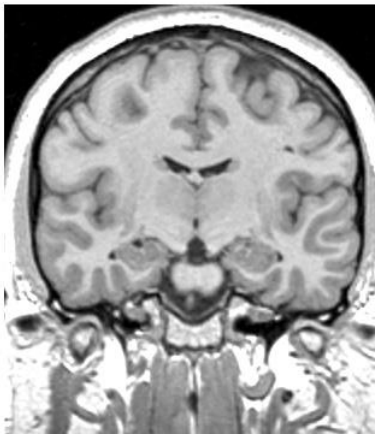
Jul-1991



Jan-2006

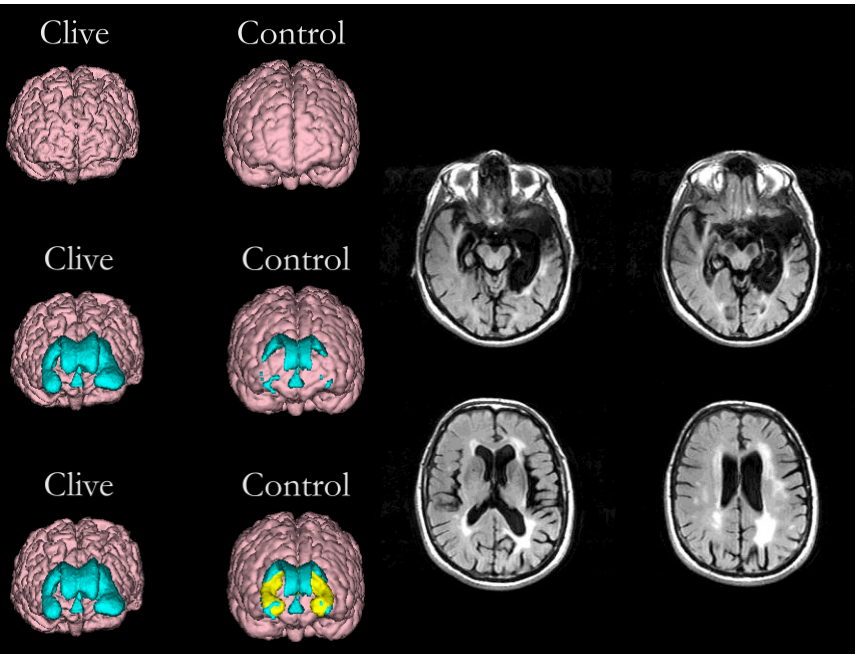


Control



Wilson BA, Baddeley AD, Kapur N. J Clin Exp Neuropsychol. 1995 Oct;17(5):668-81.
Dense amnesia in a professional musician following herpes simplex virus encephalitis.

Interesting 3-D presentation of neuroimaging findings, with quantitative neuroimaging, but what does this tell us about neural systems, networks and neuropsychological outcome?



Amnesia

neur2201.unsw.wikispaces.net/Amnesia

INS Symposium
Barbara Wilson
Morris Moscovitch
Erin Bigler

Fast Forward – 2018: *What is Old, What's New?*

Neuro-inflammation

RESEARCH PAPER ***J Neurol Neurosurg Psychiatry*** 2018;0:1–9.

Beyond the limbic system: disruption and functional compensation of large-scale brain networks in patients with anti-LGI1 encephalitis

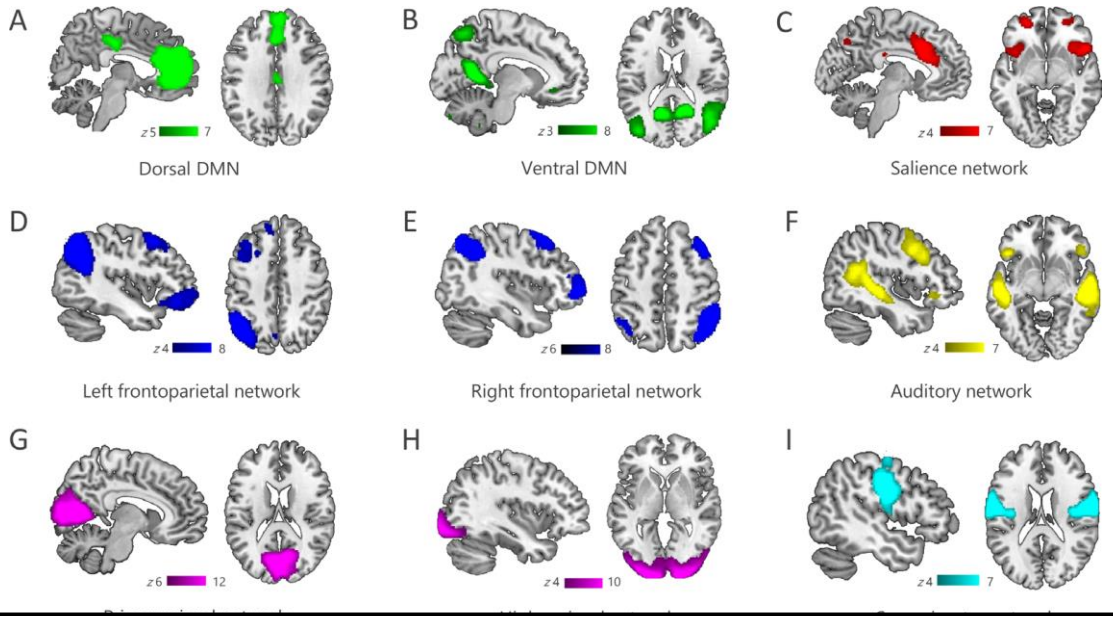
Josephine Heine,[1] Harald Prüss,[1,2] Ute A Kopp,[1] Florian Wegner,[3] Florian Then Bergh,[4] Thomas Münte,[5] Klaus-Peter Wandinger,[5,6] Friedemann Paul,[1,7,8] Thorsten Bartsch,[9] Carsten Finke[1,8,10]

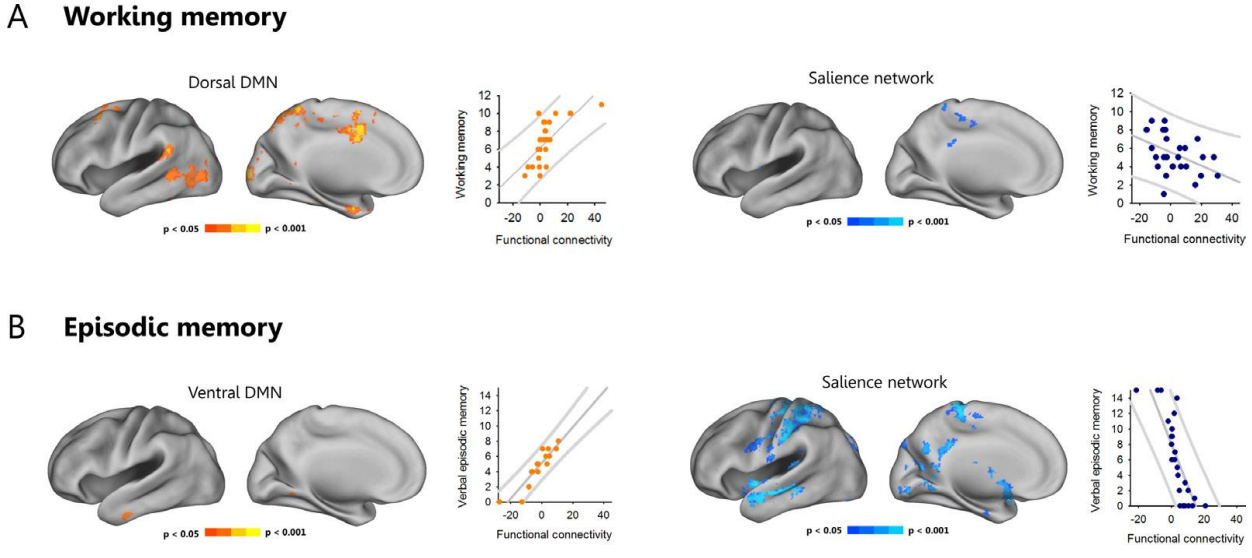
Neuropsychological assessment

In comparison to healthy controls, patients were cognitively impaired in several neuropsychological domains (table 2). Patients had a significantly impaired working memory when compared with healthy controls (digit span test) and a substantial impairment in both verbal and visual learning and episodic memory (RAVLT/ROCF). Executive dysfunction became evident as increased error rate on the Go/No-Go test and a decreased semantic fluency. In contrast, the patients' response times were

OLD

What's New? NETWORKS and Quantitative Neuroimaging!!
How are they derived?

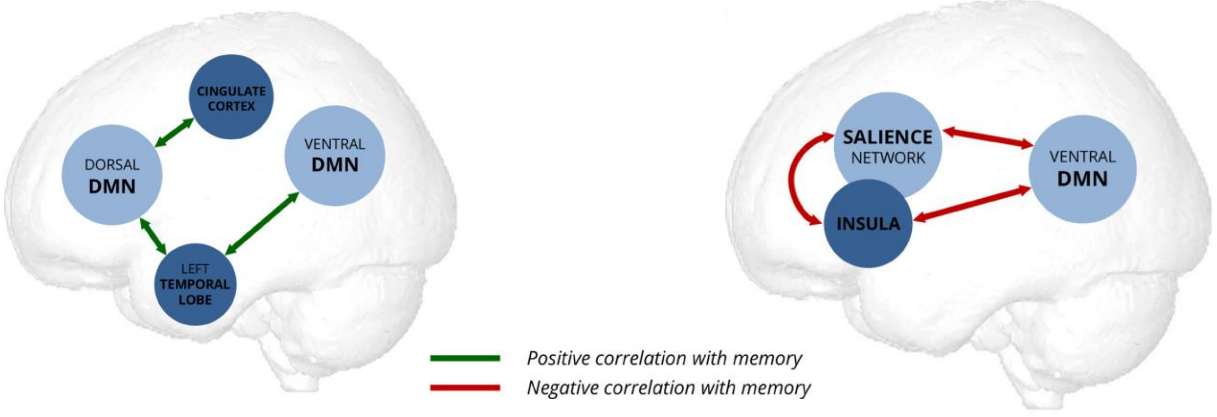




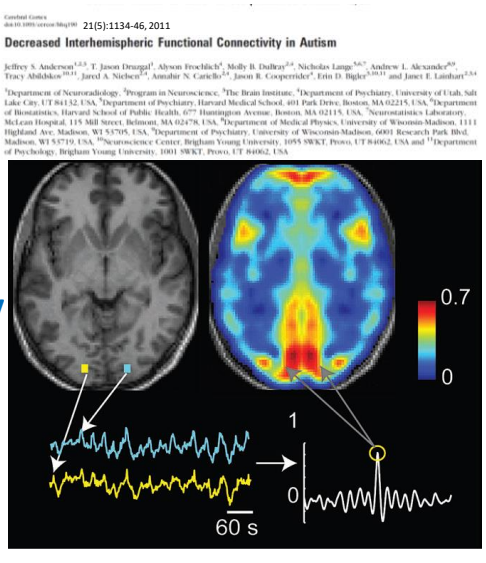
Correlations with memory performance. Alterations in functional connectivity significantly correlated with memory performance in patients with anti-LGI1 encephalitis (p<0.05; corrected for multiple comparisons). (A) Better working memory performance was associated with higher connectivity between the dorsal DMN and the left middle/superior temporal and parahippocampal gyrus, the left temporal pole as well as the cing cortex (digit span test, p=0.012). Likewise, episodic memory function was better with increased connectivity between the ventral fraction of the DI

Structural MRI analyses

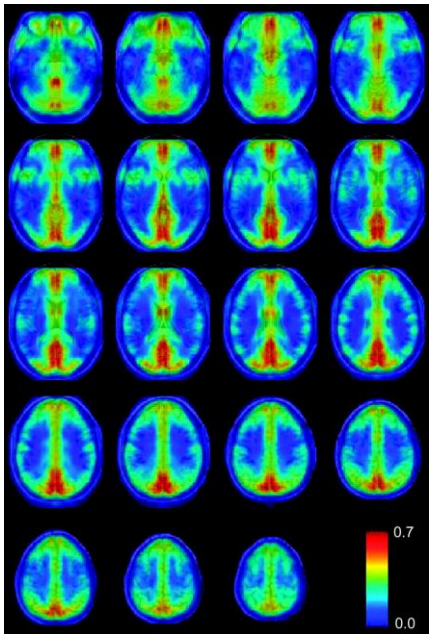
During the acute phase, hippocampal T2/FLAIR hyperintensities on routine MRI were seen in the majority of patients (21/27 patients (77.7%); unilateral in 8/27 patients (29.6%); bilateral in 13/27 patients (48.1%)), while in 6 patients (22.3%) no hippocampal abnormalities were present (table 1). At the time of resting-state data acquisition (follow-up), initial hyperintensities evolved into unilateral (in 33.3%) or bilateral (55.6%) visually detectable hippocampal atrophy, while 11.1% of the patients showed no hippocampal atrophy. Volume measures revealed a significantly reduced right hippocampal volume (table 2). Furthermore, *patients and controls did not differ on global measures of whole brain volume* (1.223×106±0.33×106 mm^3 vs 1.191×106±0.29×106 mm^3, p=0.697) *and total grey matter volume* (0.567×106±0.01×106 mm^3 vs 0.591×106±0.01×106 mm^3, p=0.172) at follow-up. VBM analysis revealed no further cortical volume change and there was *no evidence of structural white matter damage* as assessed using DTI.



Resting State Functional Connectivity Mapping



Calculating interhemispheric correlation. For each voxel in the image, a corresponding voxel in the opposite hemisphere was obtained by inverting the MNI x coordinate. Time series for each pair of voxels was obtained, and the value of the cross-correlogram at zero lag (Pearson correlation coefficient) was used to construct an image of interhemispheric correlation. This image was Fisher transformed by evaluating hyperbolic arctangent and then spatially smoothed.



Interhemispheric correlation averaged over 39 control subjects. Scale bar shows Fisher-transformed correlation (Z-score).

OPEN ACCESS Freely available online

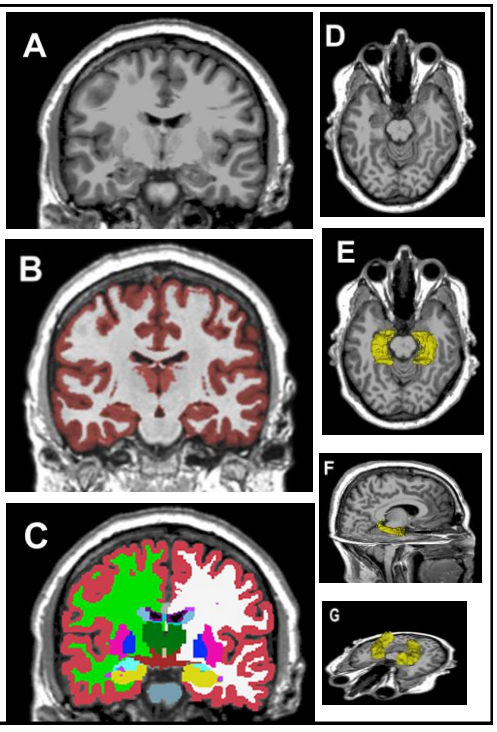
PLOS ONE

scMRI Reveals Large-Scale Brain Network Abnormalities in Autism

Brandon A. Zielinski[1*], Jeffrey S. Anderson[2,3,4], Alyson L. Froehlich[5], Molly B. D. Prigge[5], Jared A. Nielsen[3,5], Jason R. Cooperrider[3,5], Annahir N. Cariello[5], P. Thomas Fletcher[6,7], Andrew L. Alexander[8,9], Nicholas Lange[10,11], Erin D. Bigler[4,12,13], Janet E. Lainhart[3,4,5]

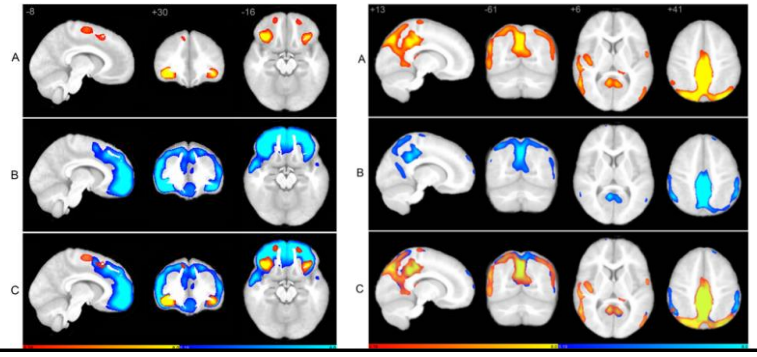
1 Departments of Pediatrics and Neurology, University of Utah, Salt Lake City, Utah, United States of America, 2 Department of Neuroradiology, University of Utah, Salt Lake City, Utah, United States of America, 3 Interdepartmental Program in Neuroscience, University of Utah, Salt Lake City, Utah, United States of America, 4 The Brain Institute at the University of Utah, Salt Lake City, Utah, United States of America, 5 Department of Psychiatry, School of Medicine, University of Utah, Salt Lake City, Utah, United States of America, 6 School of Computing, University of Utah, Salt Lake City, Utah, United States of America, 7 Scientific Computing and Imaging Institute, University of Utah, Salt Lake City, Utah, United States of America, 8 Waisman Laboratory for Brain Imaging and Behavior, University of Wisconsin, Madison, Wisconsin, United States of America, 9 Departments of Medical Physics and Psychiatry, University of Wisconsin, Madison, Wisconsin, United States of America, 10 Departments of Psychiatry and Biostatistics, Harvard Medical School, Boston, Massachusetts, United States of America, 11 Neurostatistics Laboratory, McLean Hospital, Belmont, Massachusetts, United States of America, 12 Department of Psychology, Brigham Young University, Provo, Utah, United States of America, 13 Neuroscience Center, Brigham Young University, Provo, Utah, United States of America

Seed ROIs were selected within right frontoinsular cortex and right posterior cingulate cortex [63]. These regions anchor the salience and default mode networks, respectively.

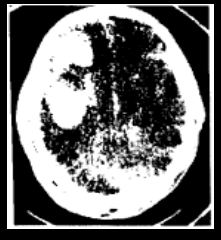


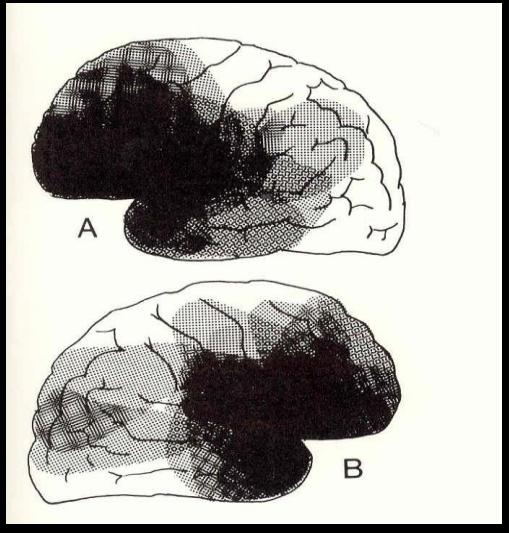
Salience Network

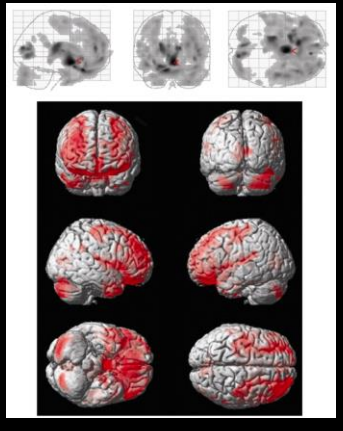
Default Mode Network



Bigler, E.D., Steinman, D.R. & Newton, J.S. (**1981**). Clinical assessment of cognitive deficit in neurologic disorder, I: Cerebral Trauma. ***Clinical Neuropsychology***, *3*, 5 – 13.







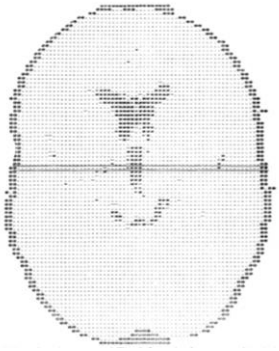
Bigler. 2005

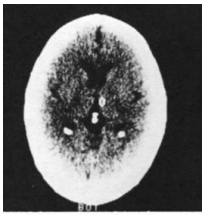
Alcohol, Vol. 1, pp. 133–140, 1984. © Ankho International Inc. Printed in the U.S.A. 0741-8329/84 $3.00 + .00

Computerized Measures of CT Scans of Alcoholics: Thalamic Region Related to Memory[1]

CAROL A. GEBHARDT,*[2] MARGARET A. NAESER† AND NELSON BUTTERS‡

**Psychology Department, Boston University and Psychology Research Boston VA Medical Center, Boston, MA*
†Psychology Research, Boston VA Medical Center and Department of Neurology Boston University School of Medicine, Boston, MA
‡Psychology Service, San Diego VA Medical Center and Psychiatry Department University of California (San Diego) Medical School, La Jolla, CA





Results showed that alcoholics' long-term (but not short-term) memory performance correlates significantly with thalamic CT density numbers in the region of the dorsomedial nucleus and with third ventricle/intracranial width ratio.

Behavior Research Methods & Instrumentation
1983, 15 (4), 471-473

Digital planimetry in APLSF

ERIC TURKHEIMER and RONALD A. YEO
University of Texas, Austin, Texas
and
ERIN D. BIGLER
University of Texas and Austin Neurological Clinic, Austin, Texas

The need to compute the area of complex polygons arises in diverse scientific applications. This is usually accomplished by reproducing the polygon on paper of known density and weighing it, by use of a mechanical device known as a polar planimeter, or by various methods of numerical integration. These methods all have obvious drawbacks. Weighing paper is inconvenient, inelegant, and of questionable accuracy; polar planimeters are difficult to find and cumbersome to use; numerical integration is more suited to finding the area under a function than it is to finding the area of complex closed curves, and it is often computationally slow because of the many iterations required for sufficient accuracy.

This paper describes a noniterative APL program that employs the digital algorithm on which the mechanical planimeter is based and computes the exact area of any polygon. The program is most conveniently used in conjunction with a digitizing device such as a Summagraphics Bit Pad, which writes x and y coordinates as a cursor is moved around the perimeter of a figure, but it is easily used with data generated by other means as well.

The algorithm employed by the program was originally described by the Russian mathematician Lopshitz (1963). Referring to Figure 1, notice that the area of the figure ABCD is equal to the sum of the four triangles created when each of the vertices of the polygon is connected with an interior point N. In Figure 2, in which N has been placed outside the polygon, the area of the polygon is equal to the sum of the areas of the triangles NAB, NBC, and NCD, minus the area of the triangle NDA. NDA differs from the other three triangles in that when it is traced in the order described, the pen moves clockwise; for the other triangles, the pen moves counterclockwise. Lopshitz shows that if the vertices of any polygon are connected to any point N, the area of the polygon is equal to the sum of all the counterclockwise triangles, minus the sum of all the clockwise triangles.

The area of each triangle is computed from the x and y coordinates of its vertices by using the formula

$$\tfrac{1}{2}[(x_2 - x_1)(y_3 - y_1) - (x_3 - x_1)(y_2 - y_1)]. \quad (1)$$

This formula results in a negative value for clockwise triangles and in a positive value for counterclockwise ones; the area of the polygon is therefore equal to the

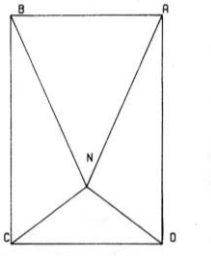


Figure 1. Illustration of Lopshitz's technique with internal point N.

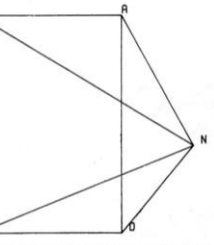
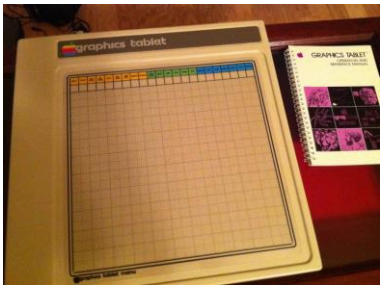


Figure 2. Illustration of Lopshitz's technique with external point N.

The authors are with the Department of Psychology, University of Texas, Austin, Texas 78712. E. D. Bigler is also at the Austin Neurological Clinic, Austin, Texas 78705.



Journal of Neurology, Neurosurgery, and Psychiatry 1984;**47**:1314–1318

Quantifying cortical atrophy

ERIC TURKHEIMER, C MUNRO CULLUM, DONN W HUBLER, SYDNEY W PAVER, RONALD A YEO, ERIN D BIGLER

From the University of Texas at Austin, Texas, USA

SUMMARY Most of the methods of quantifying cortical atrophy that have been proposed involve the estimation of the volume of enlarged sulci in the cerebral cortex. The authors propose that the surface area of the sulci is a more valid measure of cortical atrophy, and describe a system for measuring the surface area of the cortex, and present data in support of the method's reliability and validity.

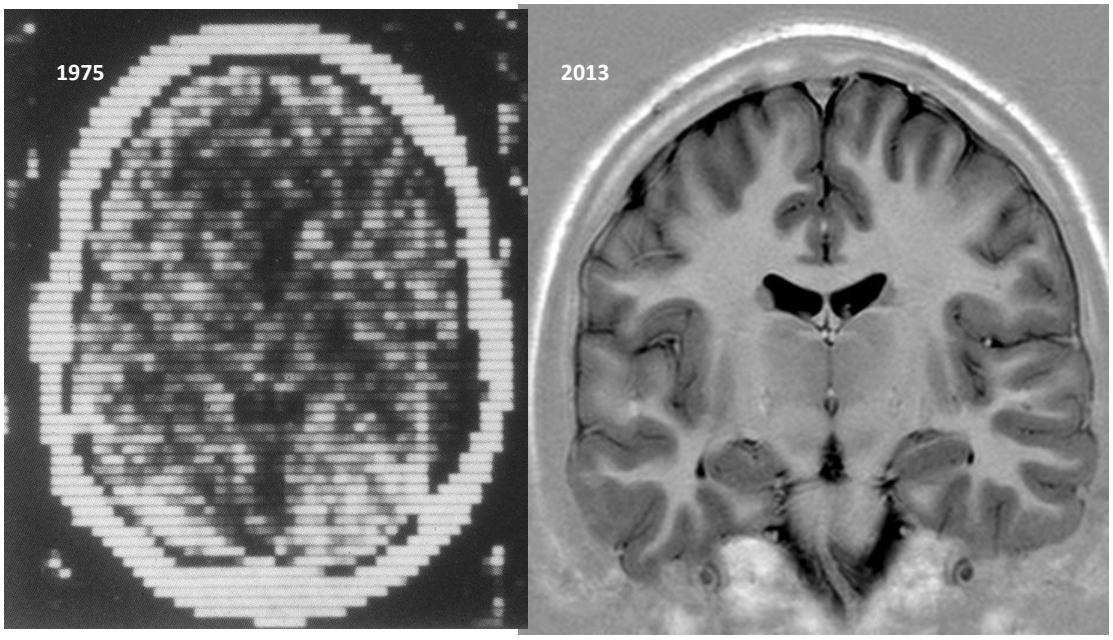
Fig *Computer drawn representation of slice from CT scan of a brain with significant cortical atrophy.*

1984

Nuclear Magnetic Resonance Imaging/Magnetic Resonance Imaging

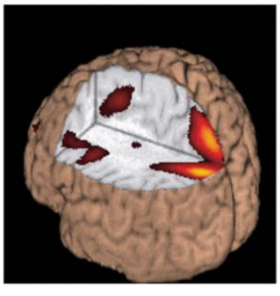
Mallard, J.R. (1984). **The Wellcome Foundation lecture, 1984. Nuclear magnetic resonance imaging in medicine: medical and biological applications and problems,** *Proc R Soc Lond B Biol Sci.* 226(1245), 391 – 41

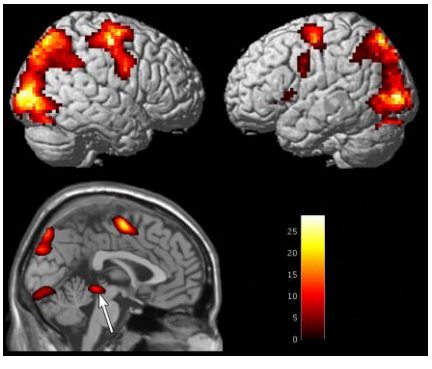
From early biological work and the first T1 nuclear magnetic resonance (n.m.r.) animal image in 1974, whole-body patient images, by using a two-dimensional Fourier transform method were achieved in Aberdeen in 1980 with a **0.04 T vertical resistive magnet**. Different pulse sequences produce images dependent by different amounts on proton density, T1 and T2, and for clinical work it is advantageous to use more than one pulse sequence to image pathology. The slow improvement of spatial resolution with increasing standing magnetic field strength is discussed and information on the T1 and T2 contrast dependence is reviewed: it suggests that the gains from high fields may be less than believed hitherto. Electrocardiogram gating can be used to produce moving images of the beating heart; blood flow can be imaged and surface radiofrequency coils are used for improved detail. N.m.r. imaging has considerable potential for studying response to therapy; mental states and dementia; tissue generation; discriminating body fat and body fluids. Other nuclei such as 23Na can be imaged and the potential to image fluorine-labelled pharmaceuticals could be very exciting; n.m.r. contrast agents are now being developed. Images formed from T1 values measured for each pixel are very useful for diagnosis, but the numerical values themselves are less valuable for distinctive pathological identification. With 15 companies manufacturing n.m.r. imagers and over 200 in use in hospitals, the technique is rapidly becoming established in diagnostic clinical practice and some typical uses are presented.

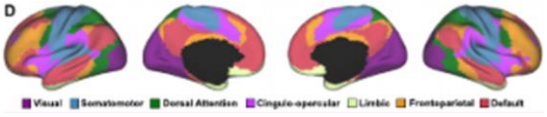


Allen, M.D. & Fong, A.K. Clinical applications of functional brain magnetic resonance imaging (fMRI): I. Matrix Reasoning. II. Verbal Fluency. Behavioral Neurology, 20, 127-140; 141-152, 2009.

Trail Making Test







Why it is important to view Neuropsychologica Tests In terms of Networks?

Luria et al. "…each kind of mental activity has a distinct psychological structure … through **joint activity of discrete cortical zones.**"

Norman **Geschwind** wrote that **"every behavior has an anatomy"** [The borderland of neurology and psychiatry: some common misconceptions. In: Benson DF, Blumer D, editors. Psychiatric aspects of neurologic disease. Vol 1. New York: Grune and Stratton; 1975.].

Available online at www.sciencedirect.com

ScienceDirect

Journal homepage: www.elsevier.com/locate/cortex

Research report

Processing speed and the relationship between Trail Making Test-B performance, cortical thinning and white matter microstructure in older adults

Sarah E. MacPherson [a,b,*], Simon R. Cox [a,b,c], David A. Dickie [c,d], Sherif Karama [e,f], John M. Starr [a,g], Alan C. Evans [e], Mark E. Bastin [a,c,d], Joanna M. Wardlaw [a,c,d] and Ian J. Deary [a,b]

[a] Centre for Cognitive Ageing and Cognitive Epidemiology, University of Edinburgh, UK
[b] Department of Psychology, University of Edinburgh, UK
[c] Scottish Imaging Network, a Platform for Scientific Excellence (SINAPSE) Collaboration, Edinburgh, UK
[d] Department of Neuroimaging Sciences, Centre for Clinical Brain Sciences, University of Edinburgh, UK
[e] Department of Neurology and Neurosurgery, McConnell Brain Imaging Center, Montreal Neurological Institute, McGill University, Montreal, QC, Canada
[f] Department of Psychiatry, Douglas Mental Health University Institute, McGill University, Verdun, QC, Canada
[g] Alzheimer Scotland Dementia Research Centre, The University of Edinburgh, Edinburgh, UK

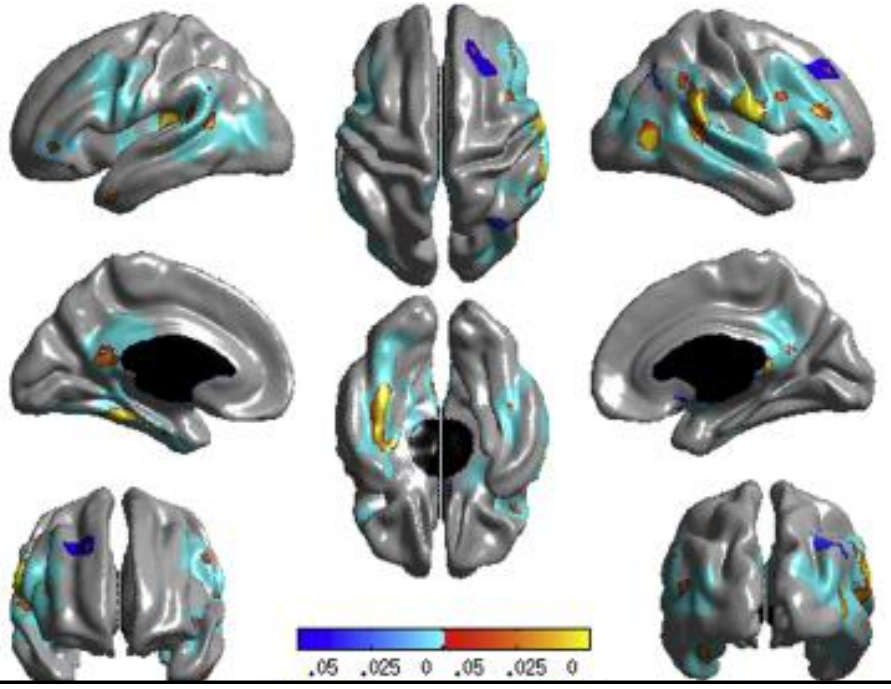


Table 2 – Cognitive test score correlations with N in parentheses.

	1.	2.	3.	4.	5.	6.
1. TMT-B (time to complete in seconds)						
2. TMT-B (total errors)	.37* (411)					
3. Symbol search	−.52* (410)	−.19* (410)				
4. Digit-symbol	−.59* (410)	−.24* (410)	.63* (409)			
5. Simple reaction time	.36* (411)	.18* (411)	−.26* (410)	−.33* (410)		
6. 4-choice reaction time	.51* (411)	.16** (411)	−.47* (410)	−.52* (410)	.44* (411)	
7. Inspection time	−.36* (401)	−.16** (401)	.34* (400)	.35* (400)	−.22* (401)	−.32* (401)

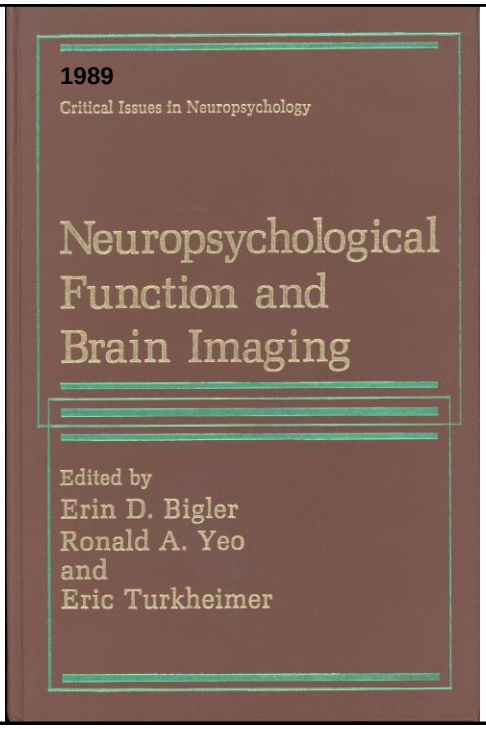
TMT-B – Trail Making Test Part B; *$p < .001$; **$p < .005$.

Table 3 – The results obtained from linear regression models examining the relationship between brain volumetry measures and TMT-B completion time with and without simple and complex processing speed.

	TMT-B		+Simple		+Complex	
	β	p	β	p	β	p
Intracranial volume (cm^3)	−.024	.539	−.014	.747	.031	.543
Whole brain volume (cm^3)	**−.080**	**.0001**	**−.059**	**.001**	−.022*	.302
Grey matter volume (cm^3)	**−.139**	**.0001**	**−.099**	**.002**	−.060	.107
NAWM volume (cm^3)	**−.075**	**.003**	−.030	.283	.039*	.218
WMH volume (cm^3)	**.132**	**.010**	.029	.611	−.064*	.326

β – standardised regression coefficient; NAWM – normal-appearing white matter; WMH – white matter hyperintensity; Simple – Controlling for Simple Reaction Time and Inspection Time; Complex – Controlling for Symbol Search, Digit-Symbol, Simple and 4-Choice Reaction Time and Inspection Time; Bold – significant p-values after FDR correction based on the actual p-values produced; *standardized beta values significantly attenuated ($p < .05$).

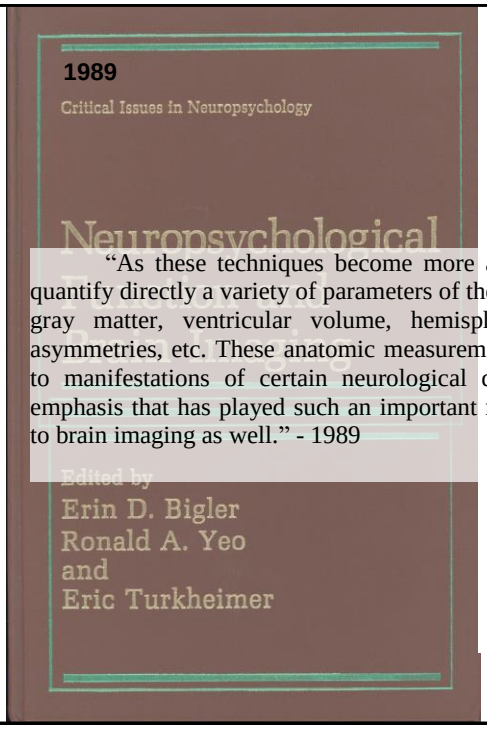
Last Historical Note



ropsychology developed a tradition of localizing dysfunction independent of specific knowledge of precise areas of actual structural damage. Much has changed. We no longer have to wait for the postmortem examination to determine the structural integrity of the brain, as the various neuroimaging techniques that have been discussed in this text are widely available. It is now rare for any patient who has significant neurological abnormality not to have had one of the neuroimaging procedures. Neuroimaging diagnostics have become a standard mode of evaluation of the neurological patient, and one might predict that such procedures will be even more frequently utilized in the future. In fact, the neurological patient of the future may well receive assessment incorporating brain imaging, neuropsychological evaluation, and direct metabolic and physiological functioning (see Gibbins *et al.*, 1987), and the data from each of these will be interfaced together to produce a composite assessment that interrelates all of this information.

Much past research in neuropsychology has been based on standardization of neuropsychometric procedures (see Yeudall, Reddon, Gill, & Stefanyk, 1987). This has been necessary because most neuropsychological diagnostic schemes are based on deviation from "normal." Thus, some level of precision has been achieved in neuropsychology by applying statistical principles to the decision of whether a score is aberrant or not. The same process needs to take place in brain imaging. As discussed by Turkheimer (Chapter 3), a variety of quantification techniques are available, allowing researchers and clinicians to go far beyond simple rating scales. As these techniques become more and more automated, we should be able to quantify directly a variety of parameters of the brain, including the amount of white versus gray matter, ventricular volume, hemispheric volume, subcortical nuclei, normal asymmetries, etc. These anatomic measurements may be critical parameters with respect to manifestations of certain neurological disorder states. Accordingly, the statistical emphasis that has played such an important role in neuropsychology needs to be applied to brain imaging as well.

One goal of this text is to give some direction to future research and practice in neuropsychology and behavioral neurology. It is apparent that the future of neuropsychological assessment will take a very different path than in the past. Much current research in neuropsychology is based on measures that were developed prior to 1965. As brain-imaging techniques became available, it was important first to investigate and quantify the significance of such brain abnormalities as visualized by brain-imaging methods with standardized neuropsychological measures. However, the current neuropsychological armamentarium is somewhat archaic and insufficiently related to current theories of cognitive function (Posner, 1986; Stillings *et al.*, 1987). Further, neuropsychology has just begun to utilize the advances in computer technology. There has been a wave of enthusiasm for computerized assessment, but to date, most have simply put "paper and pencil" tests on the computer without making them adaptive, interactive, or an expert system (see Morrison, Schaeffer, & Russell, 1987; Russel *et al.*, 1987). The assessment battery of the future likely will be, in large part, computer-based and will probably include on-line metabolic (i.e., PET or MRI) and/or physiological (computerized EEG) measurement. Such an evaluation could document anatomic integrity via specific measures of major brain structures and nuclei and integrate this with neuropsychological function and associated metabolic and physiological activity that correspond with certain cognitive states. This is the future. Such clinical advances will be paralleled by advances in the basic neurosciences, allowing simultaneous assessment of differing facets of brain activity and the development of a more integrated science of the brain.



344 ERIN D. BIGLER *et al.*

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Much past research in neuropsychology has been based on standardization of neuropsychometric procedures (see Yeudall, Reddon, Gill, & Stefanyk, 1987). This has been necessary because most neuropsychological diagnostic schemes are based on deviation from ''normal.'' Thus, some level of precision has been achieved in neuropsychology by applying statistical principles

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"As these techniques become more and more automated, we should be able to quantify directly a variety of parameters of the brain, including the amount of white versus gray matter, ventricular volume, hemispheric volume, subcortical nuclei, normal asymmetries, etc. These anatomic measurements may be critical parameters with respect to manifestations of certain neurological disorder states. Accordingly, the statistical emphasis that has played such an important role in neuropsychology needs to be applied to brain imaging as well." - 1989

Time Consuming Region of interest (ROI) hand tracing in Quantitative Neuroimaging Analysis

Blatter DD, Bigler ED, Gale SD, Johnson SC, Anderson CV, Burnett BM, Parker N, Kurth S, Horn SD. Quantitative volumetric analysis of brain MR: normative database spanning 5 decades of life. *AJNR Am J Neuroradiol*. **1995** Feb;16(2):241-51.

196 Subjects: 4 years of image analysis

Bigler ED, Blatter DD, Anderson CV, Johnson SC, Gale SD, Hopkins RO, Burnett B. Hippocampal volume in normal aging and traumatic brain injury. *AJNR Am J Neuroradiol*. **1997** Jan;18(1):11-23.

200 Subjects: 4 years of image analysis

Bigler ED, Tate DF, Neeley ES, Wolfson LJ, Miller MJ, Rice SA, Cleavinger H, Anderson C, Coon H, Ozonoff S, Johnson M, Dinh E, Lu J, Mc Mahon W, Lainhart JE. Temporal lobe, autism, and macrocephaly. *AJNR Am J Neuroradiol*. **2003** Nov-Dec;24(10):2066-76.

97 Subjects: 3 years of image analysis

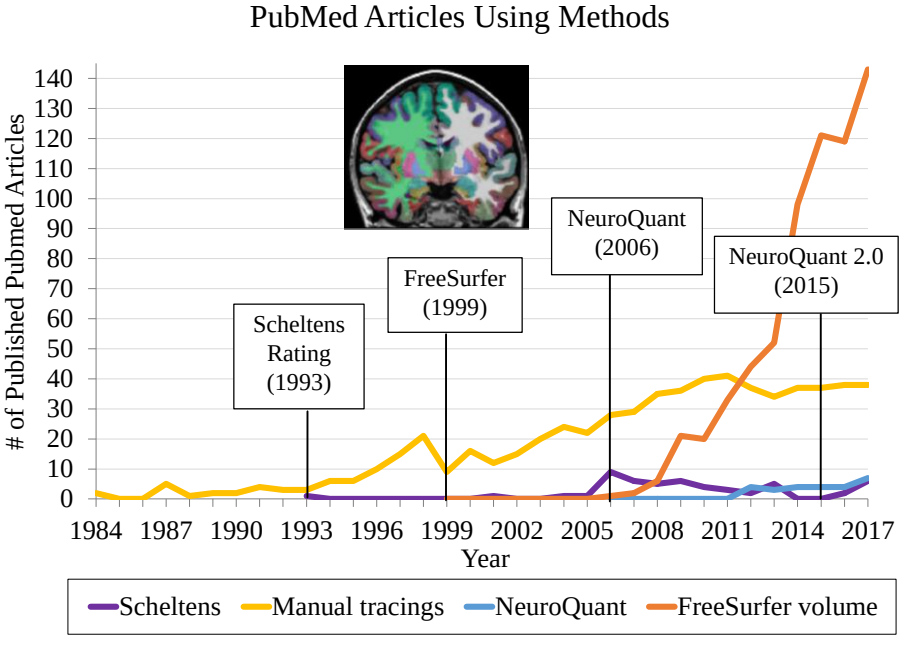
Automated Image Analysis and Supercomputing Game Changers!!

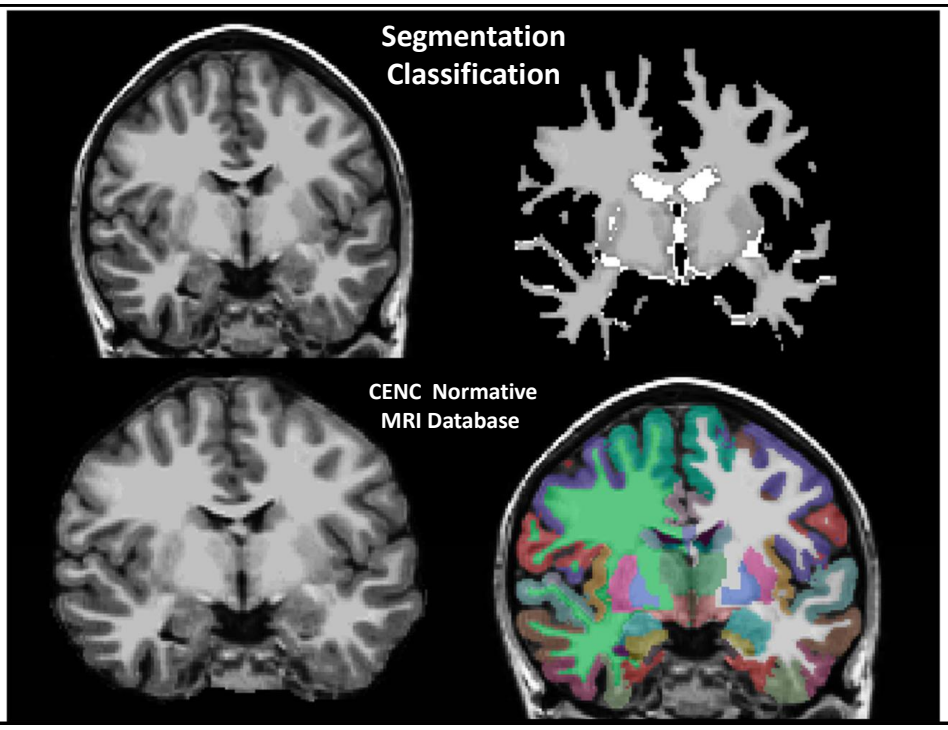
FreeSurfer* as an automated platform introduced in 2003 and BYU's Super Computer comes online in 2006

2008 Use to Date: 320 scans used 21,370 hours or 890 days or 2.45 years of processor "time" based on standard single computer time to calculate the FreeSurfer analysis.

The supercomputer did it in roughly a week's time!

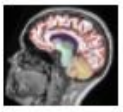
*Fischl B. (2012). FreeSurfer. Neuroimage. 62(2):774-81. doi: 10.1016/j.neuroimage.2012.01.021.





NeuroQuant. Atrophy, Quantified.

Fast, accurate & proven automated brain image analysis.



NeuroQuant is a breakthrough **medical device software** that can make **quantitative MRI measurement** a routine part of clinical practice. It provides neurologists, radiologists, clinical researchers and imaging centers with a **convenient and cost-effective** means to get the reliable and objective results they need. NeuroQuant **automatically segments and measures** volumes of brain structures and **compares these volumes to norms**.

NeuroQuant Output

Comprehensive Volumetric Reports	Custom Volumetric Reports	Color-Coded Brain Segmentation	Exportable CSV file with Raw Data
			
Five standard reports provide supplemental volumetric data in the assessment of neurological conditions.	An alternative to standard NeuroQuant reports, users can create custom volumetric reports relevant to clinical needs.	A color overlay of the 3D MR images enabling closer inspection on a PACS or other DICOM viewer.	Add exportable, thorough CSV file with extensive data for research needs.

Features and Benefits

About NeuroQuant

Benefits of Using NeuroQuant

Longitudinal Reporting

Dynamic Atlas Technology

Normative Reference Data

- Used by medical professionals to aid in quantifying atrophy and assessing neurodegenerative diseases
- First FDA cleared, CE marked, and Health Canada, Australia, and Korea licensed software for volumetric MRI processing
- Provides volumetric measurements of brain structures and compares the volumes to a normative database adjusted for age, gender and intracranial volume
- A powerful tool to help physicians evaluate patients from ages 3 to 100
- Automatic image segmentation from radiographic images (3D T1 MRI)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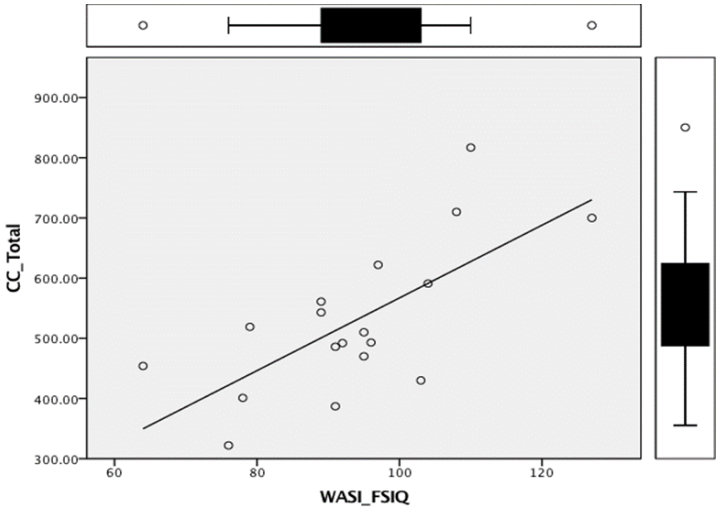
volBrain is an online MRI brain volumetry system. It is intended to help researchers all over the world to obtain automatically volumetric brain information from their MRI data without the need for any infrastructure in their local sites.
volBrain works in a fully automatic manner and is able to provide brain structure volumes without any human interaction. We encourage you to use the system hoping you find it useful.
The number of cases each user can submit daily is limited to 10 cases in order to share our limited computational resources between all users. This evaluation version of volBrain is free for non-commercial and non-medical purposes. Please contact jmanjon@fis.upv.es or pierrick.coupe@labri.fr for processing large amount of data. We are looking for collaboration to evaluate and improve our platform, please contact us with any feedback.
If you use the system, please cite:
José V. Manjón and Pierrick Coupe. volBrain: an online MRI brain volumetry system. Frontiers in Neuroinformatics. 2016.

Why is image Quantification Important?



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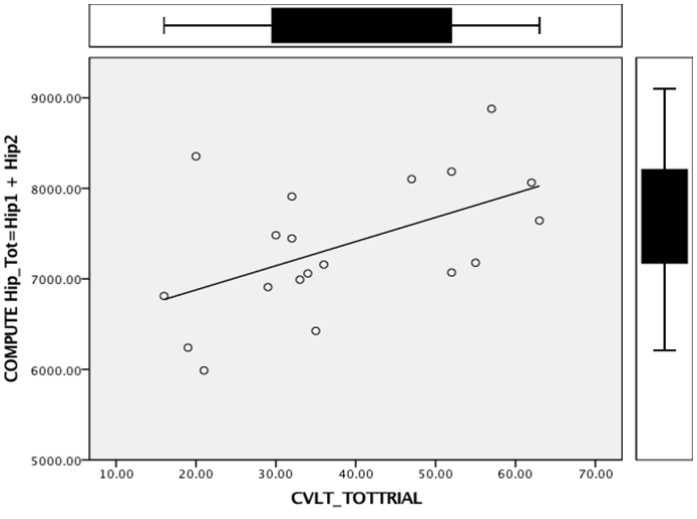
Approaches and Decisions in Acute Pediatric TBI Trial

Why is image Quantification Important?



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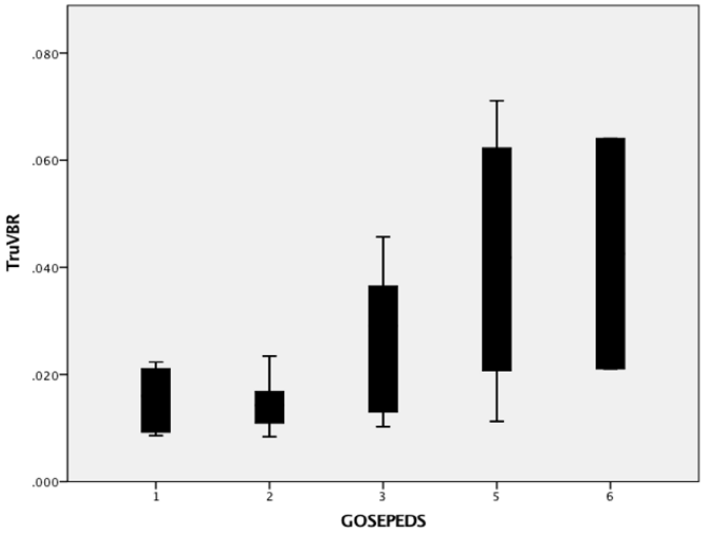

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Approaches and Decisions in Acute Pediatric TBI Trial

Why is image Quantification Important?

Neurobiology of Aging 71 (2018) 179–188

Contents lists available at ScienceDirect

Neurobiology of Aging

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

Proposal for a hierarchical, multidimensional, and multivariate approach to investigate cognitive aging

Alejandra Machado [a,b], José Barroso [b], Yaiza Molina [b,c], Antonieta Nieto [b], Lucio Díaz-Flores [d], Eric Westman [a,1], Daniel Ferreira [a,b,*,1]

[a] Division of Clinical Geriatrics, Center for Alzheimer Research, Department of Neurobiology, Care Sciences and Society, Karolinska Institutet, Stockholm, Sweden
[b] Department of Clinical Psychology, Psychobiology and Methodology, Faculty of Psychology, La Laguna, Tenerife, Spain
[c] Department of Clinical Psychology and Neuropsychology, Faculty of Health Sciences, University Fernando Pessoa Canarias, Las Palmas de Gran Canaria, Spain
[d] Department of Radiology, Hospital Universitario de Canarias, La Laguna, Tenerife, Spain

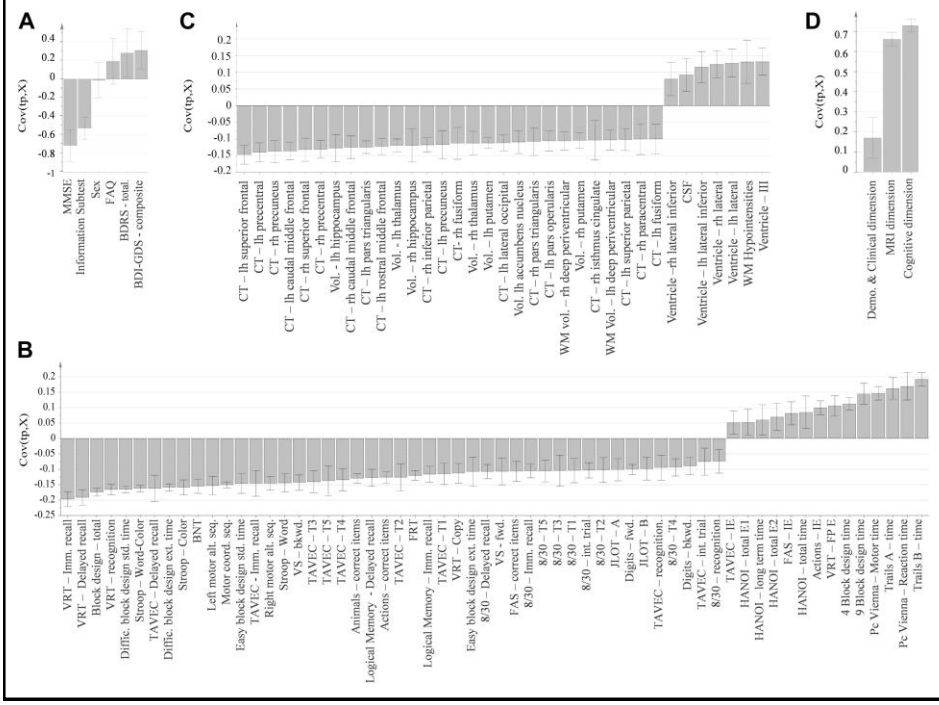
Why is image Quantification Important?

Table 1. Demographic and clinical characteristics

	Whole sample			Subsample with MRI data			Subsample without MRI data			Subsam
	N	M (SD)/count	Range/%	n	M (SD)/count	Range/%	n	M (SD)/count	Range/%	*p*-values ANOVA/ Mann-Whitney
Age, y	460	58.4 (11.4)	35–84	294	54.6 (10.6)	35–79	166	65.2 (10.9)	40–84	<0.001
Sex, female	460	251	54.6%	294	158	53.7%	166	93	56%	0.637
WAIS-III information	452	15.2 (6.2)	5–27	294	16.4 (5.9)	5–27	166	13.0 (6.1)	5–25	<0.001
MMSE	459	28.5 (1.5)	24–30	294	28.8 (1.3)	24–30	165	27.9 (1.6)	24–30	<0.001
BDRS	456	0.9 (1.4)	0–7[a]	290	0.8 (1.3)	0–7	166	1.1 (1.4)	0–7[a]	<0.001
FAQ	459	0.4 (0.8)	0–5	294	0.4 (0.8)	0–5	165	0.4 (0.9)	0–4	0.986

When 2 or more screening tests (MMSE. BDRS and/or FAQ) were not available, participants were excluded from this study.

Key: BDRS, blessed dementia rating scale; FAQ, functional activity questionnaire; M, mean; MMSE, mini–mental state examination; MRI, magnetic resonance imaging; SD, standard deviation; WAIS-III, wechsler adult intelligent scale–third edition.



Why is image Quantification Important?

Why is image Quantification Important?

Table 2. The association of age with MRI measures (OPLS models)

Brain compartment	Model	Marker	Number of measures	N	Q^2	R^2
Gray matter	1	Cortical thickness	68	294	0.388	0.545
	2	Cortical area (+ICV)	68	294	0.156	0.314
	3	Cortical volume (+ICV)	69	294	0.282	0.489
	4	Subcortical structures volume (+ICV)	17	294	0.334	0.372
White matter	5	Volume (+ICV)	77	294	0.384	0.537
Ventricular system	6	Volume (+ICV)	8	294	0.383	0.415
Combined model	7	Cortical thickness (68) + white-matter volume (76) + ventricular system volume (7) + subcortical gray matter structures volume (16) (+ICV)	168	294	0.741	0.561

Key: ICV, intracranial volume; MRI, magnetic resonance imaging; N, sample size; OPLS, orthogonal partial least squares; Q^2, goodness of prediction; R^2, goodness of fit.

Why is image Quantification Important?

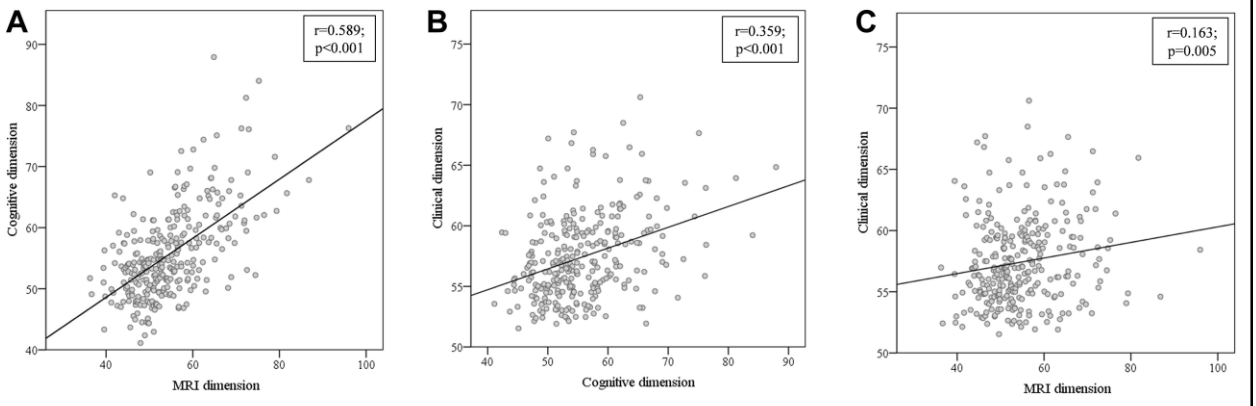
Table 3. Potential effect of sex and the WAIS-III Information subtest on the cognitive and MRI OPLS models

Variables of interest	Extraneous variables	N	Q^2	R^2	Pair	t	*p*
73 cognitive measures	-	460	0.564	0.620			
73 cognitive measures	Sex	460	0.562	0.618	1	0.296	0.767
73 cognitive measures	WAIS-III Information	460	0.590	0.640	2	0.215	0.830
73 cognitive measures	Sex and WAIS-III Information	460	0.586	0.635	3	0.276	0.783
168 MRI measures	-	294	0.561	0.741			
168 MRI measures	Sex	294	0.565	0.743	4	0.142	0.887
168 MRI measures	WAIS-III Information	294	0.565	0.743	5	0.414	0.679
168 MRI measures	Sex and WAIS-III Information	294	0.568	0.745	6	0.393	0.695

Comparison pair 1 (Cognitive vs. Cognitive and sex), pair 2 (Cognitive vs. Cognitive and WAIS-III Information), pair 3 (Cognitive vs. Cognitive, sex, and WAIS-III Information), pair 4 (MRI vs. MRI and sex), pair 5 (MRI vs. MRI and WAIS-III Information), pair 6 (MRI vs. MRI, sex, and WAIS-III Information).

Key: MRI, magnetic resonance imaging; N, sample size; OPLS, orthogonal partial least squares; Q^2, goodness of prediction; R^2, goodness of fit; WAIS-III Information subtest, wechsler adult intelligent scale–third edition.

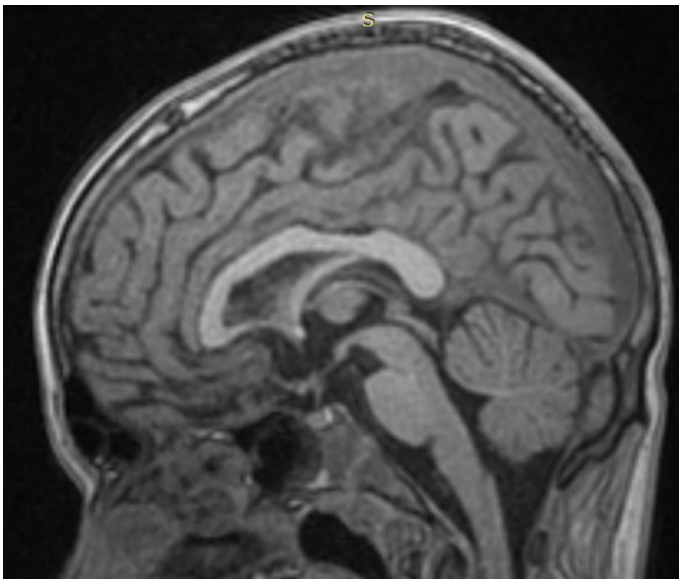
Why is image Quantification Important?



What You Can Do Now!!

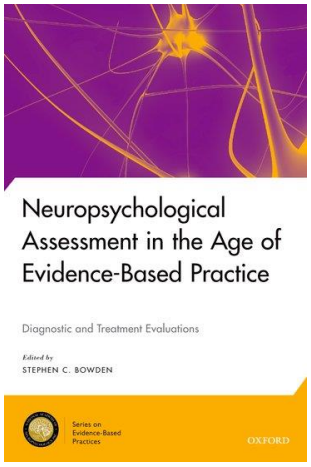
A Semiquantitative Approach

It All Begins with the Digital Imaging and Communications in Medicine (DICOM) File



Neuroimaging, Medical Centers and Hospital File Access: Picture Archiving and Communication Systems (PACS)

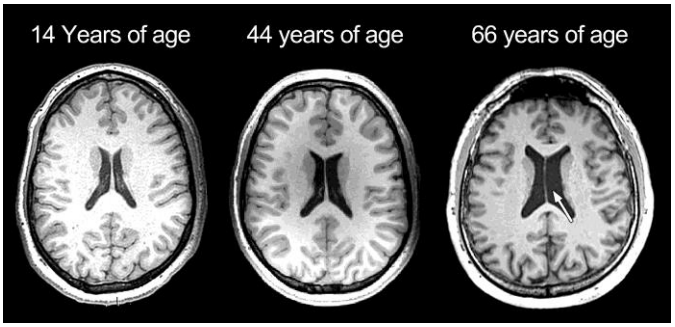
National Academy of Neuropsychology: Series on Evidence-Based Practices



2017

Chapter 8: ***Evidence-Based Integration of Clinical Neuroimaging Findings in Neuropsychology***.
Erin D. Bigler

Clinical Ratings



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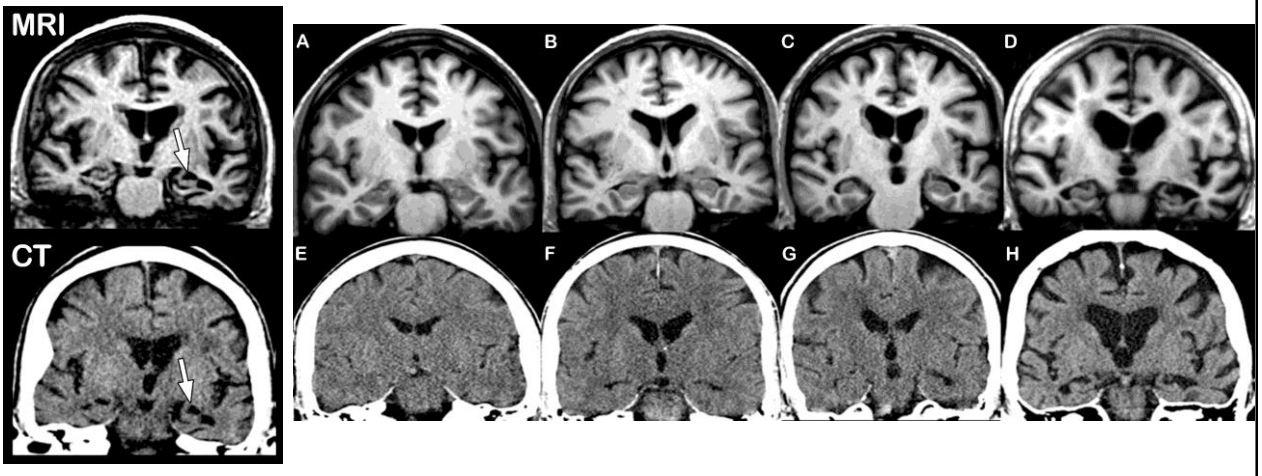
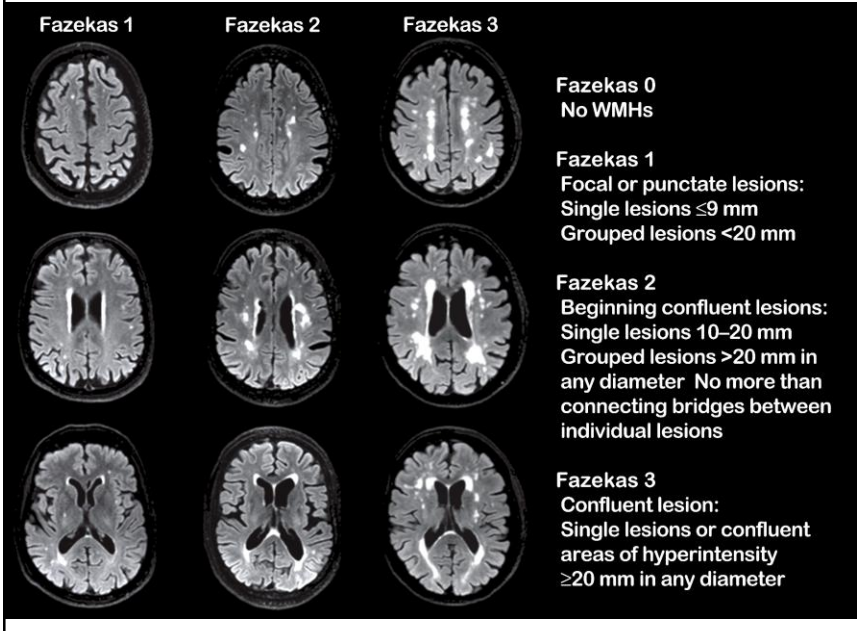
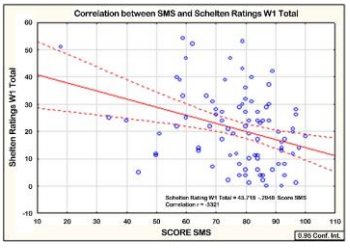
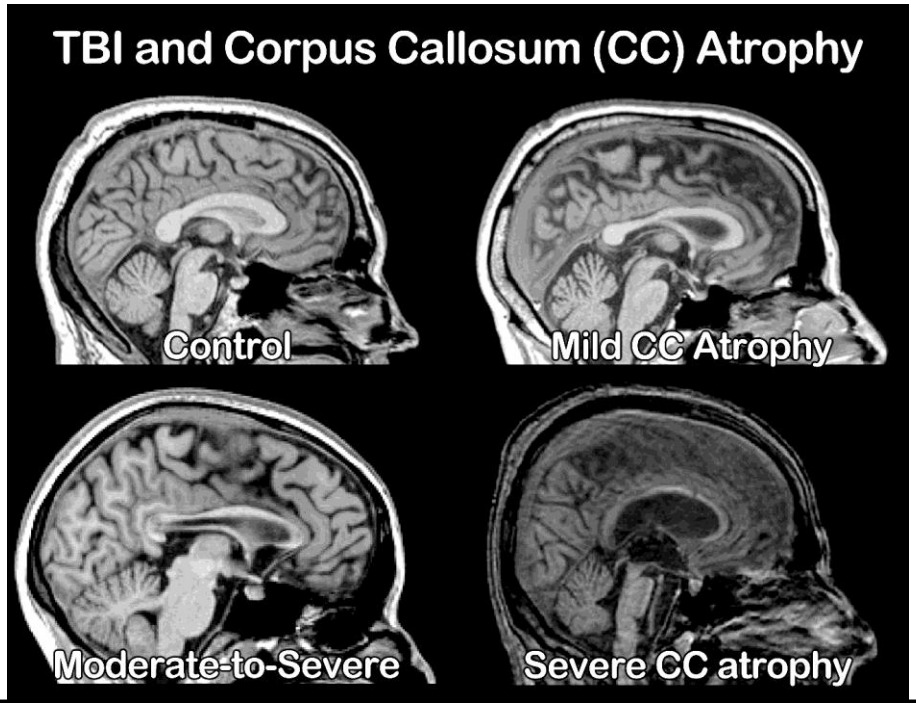




Bigler 2017: *Evidence-Based Integration of Clinical Neuroimaging Findings in Neuropsychology*

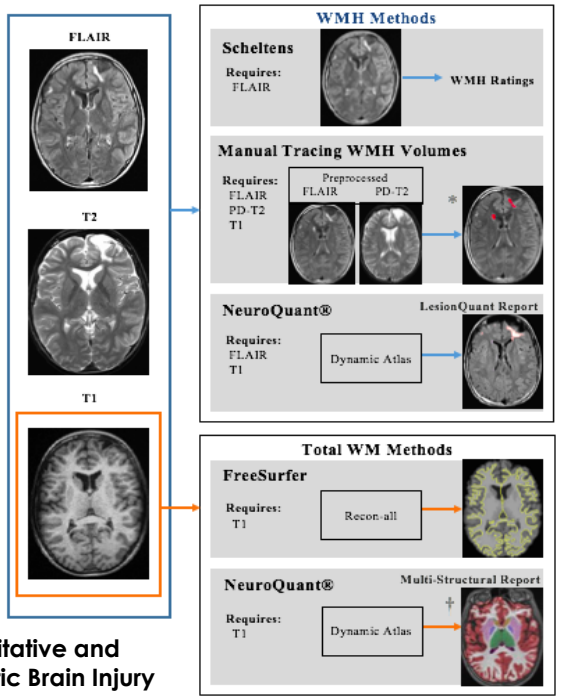




Bigler 2017: *Evidence-Based Integration of Clinical Neuroimaging Findings in Neuropsychology*

White Matter Methods

Method	MRI Sequence	Measures	Unit
Scheltens Ratings (WMH)	FLAIR	WMH ratings	0 to 30
Manual Tracing	FLAIR/T1	WMH volumes	cm3
FreeSurfer	T1	Total WM volumes	cm3
NeuroQuant®	FLAIR/T1	WMH volumes Total WM volumes	cm3



Kacie L. Wright Dissertation 2018 A Comparison of Qualitative and Quantitative White Matter Methods in Pediatric Traumatic Brain Injury

Cognitive Function and WM: **Processing Speed**

Methods	Processing Speed	
	r	*p*
Scheltens Ratings	-.41	.004
NeuroQuant® WMH	-.38	.000
Manual tracing	-.44	.002

APPLIED NEUROPSYCHOLOGY: ADULT
2017, VOL. 24, NO. 2, 140–151
http://dx.doi.org/10.1080/23279095.2015.1113536

Routledge
Taylor & Francis Group

Neuropsychological Assessment of Hippocampal Integrity

Jean-Michel Saury[a] and Ingrid Emanuelson[b]

[a]Division of Rehabilitation Medicine, Department of Clinical Sciences, Karolinska Institutet, Danderyd University Hospital, Stockholm, Sweden; [b]Institution for Clinical Sciences, Department of Pediatrics, University of Gothenburg, Gothenburg, Sweden

ABSTRACT

Finding methods to describe subcortical processes assisting cognition is an important concern for clinical neuropsychological practice. In this study, we reviewed the literature concerning the relationship between a neuropsychological instrument and the underlying neural substructure. We examined evidence indicating that one of the oldest neuropsychological tests still in use, the Rey Auditory Verbal Learning Test (RAVLT), includes reliable indicators of hippocampal integrity. We reviewed studies investigating the neural structures underlying seven tasks generated by the RAVLT, from the perspective of whether the performance of these tasks is dependent on the hippocampus. We found support for our hypothesis in five cases: learning capacity, proactive interference, immediate recall, delayed recall, and delayed recognition. No support for our hypothesis was found with regard to short-term memory and retroactive interference. The RAVLT appears to be a reliable tool for assessing the integrity of the hippocampus and for the early detection of dysfunction. There is a need for such assessments, due to the crucial role of the hippocampus in cognition, for instance, in terms of predicting future outcomes.

KEYWORDS
Diagnosis; RAVLT; tests

Contents lists available at ScienceDirect

NeuroImage: Clinical

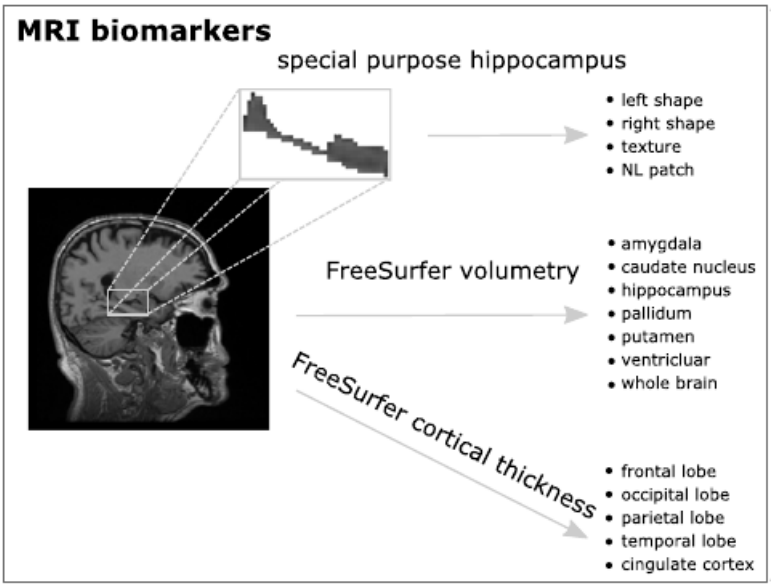
journal homepage: www.elsevier.com/locate/ynicl

Differential diagnosis of mild cognitive impairment and Alzheimer's disease using structural MRI cortical thickness, hippocampal shape, hippocampal texture, and volumetry☆

Lauge Sørensen[a,b,*], Christian Igel[a], Akshay Pai[a,b], Ioana Balas[a], Cecilie Anker[b], Martin Lillholm[a,b], Mads Nielsen[a,b], for the Alzheimer's Disease Neuroimaging Initiative and the Australian Imaging Biomarkers and Lifestyle flagship study of ageing

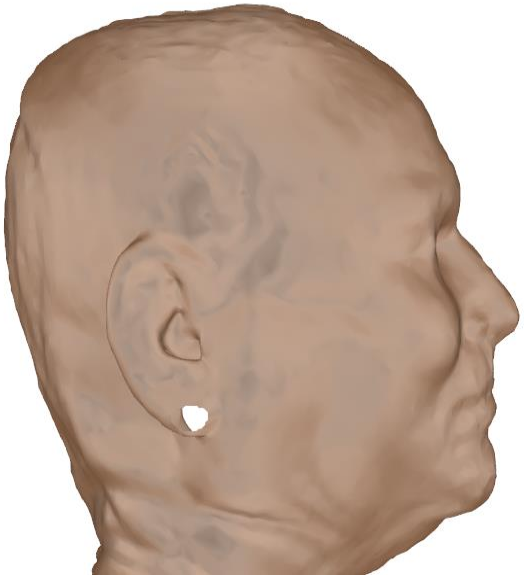
[a]Department of Computer Science, University of Copenhagen, Copenhagen Ø DK-2100, Denmark
[b]Biomedia A/S, Copenhagen Ø DK-2100, Denmark

The hippocampus is affected early and severely in the AD pathological process (Braak and Braak, 1991; West et al., 1994), and the volume of this brain structure is the most widely applied (Jack et al., 2011b) and only qualified (Hill et al., 2014) MRI imaging biomarker in AD (p.480)."

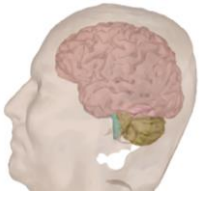


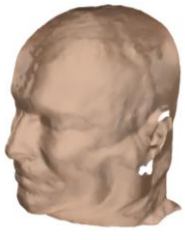
A Truly Quantitative Approach

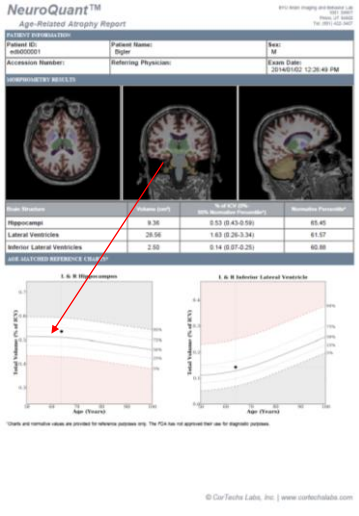
Normative FreeSurfer Volumetric and Cortical Thickness Data

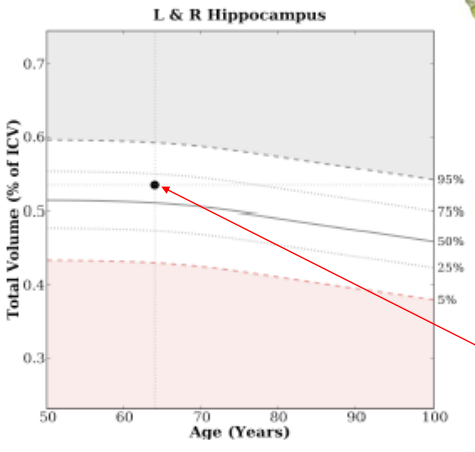


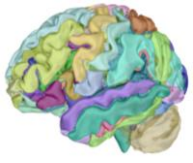
Commercially Available Quantitative Neuroimaging

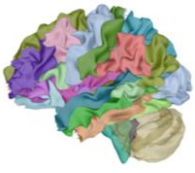


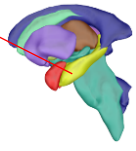


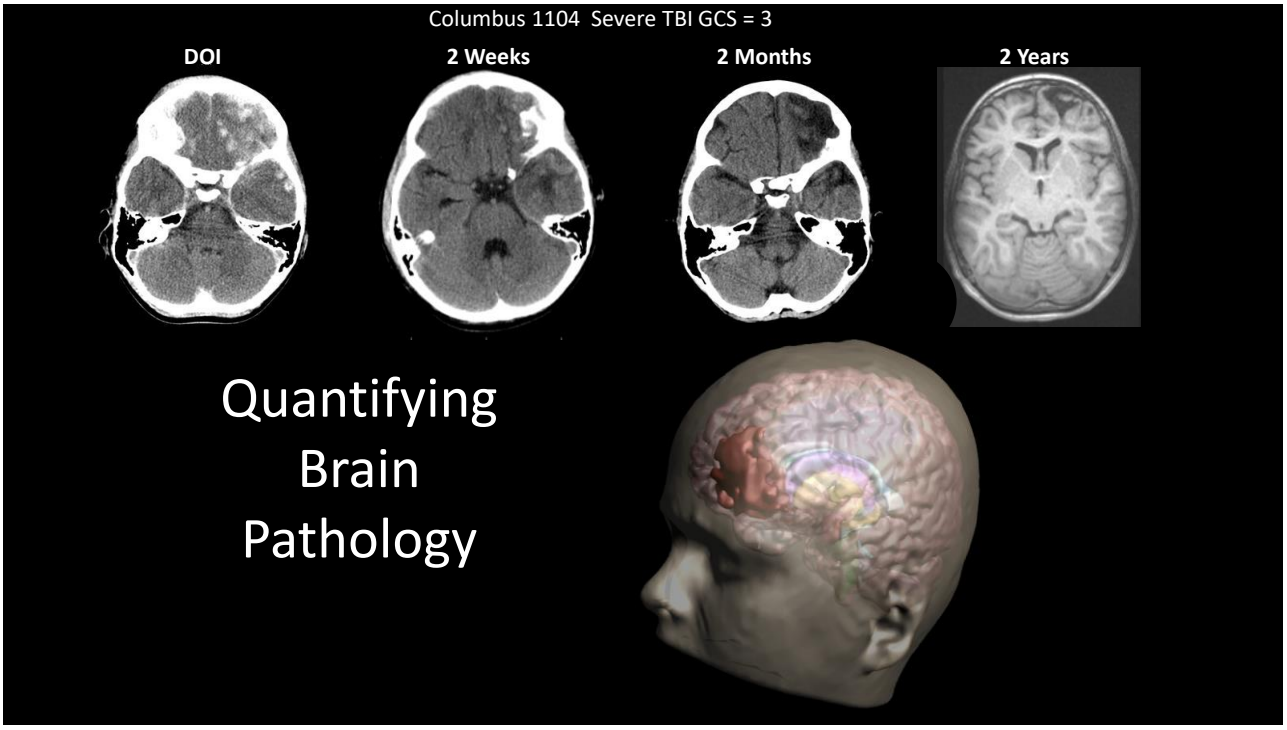


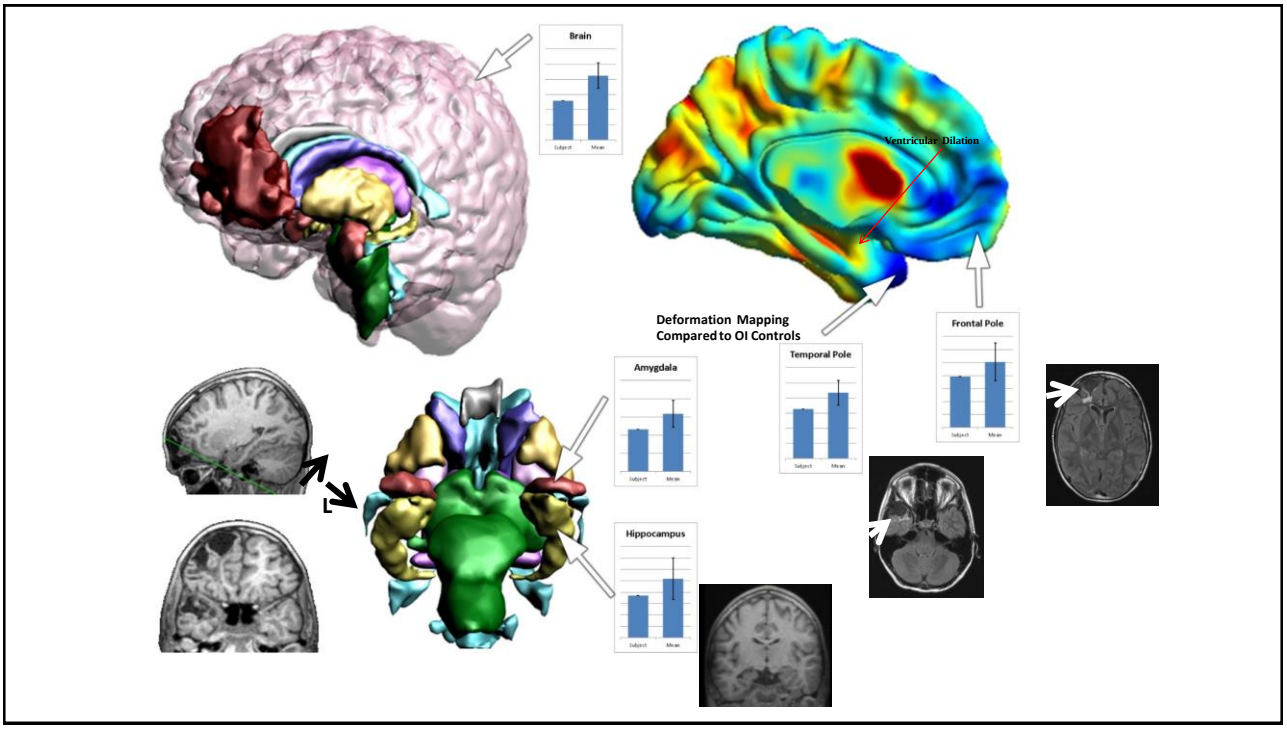


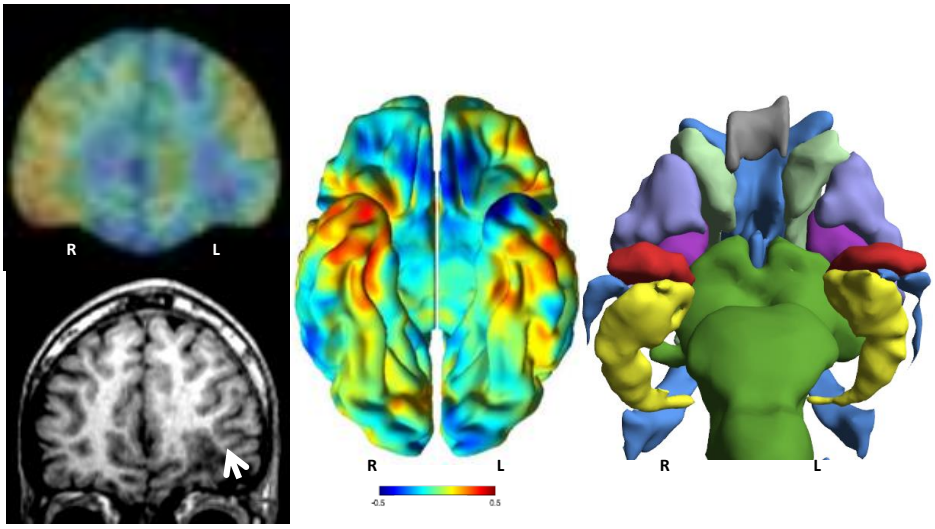







Columbus 1104 Severe TBI GCS = 3
DOI
2 Weeks
2 Months
2 Years
Quantifying Brain Pathology


Brain
Ventricular Dilation
Deformation Mapping
Compared to OI Controls
Frontal Pole
Temporal Pole
Amygdala
Hippocampus



LesionQuant™
FLAIR Lesion Report PLUS

Brigham Young University
Psychology Dept.
1001 SWKT
Tel: (801) 422-3407

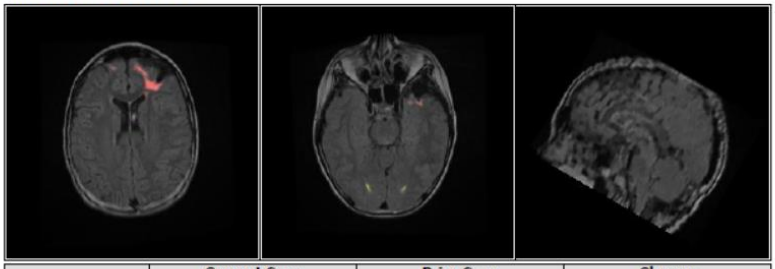
PATIENT INFORMATION

Patient ID:	Patient Name:	Sex:	Age:
1104	1104	M	12
Accession Number:	**Referring Physician:**		
1104	YEATES, KEITH O		

SCANNER INFORMATION

Current Scan Date:	Current Scanner Name:	Prior Scan Date:	Prior Scanner Name:
2008/03/26 07:34:01 AM	SIGNA EXCITE		

MORPHOMETRY RESULTS



	Current Scan			Prior Scan			Change		
Brain Structure	Volume (cm^3)	% ICV	Normative Percentile	Volume (cm^3)	% ICV	Normative Percentile	Volume Change (cm^3)	Volume Change (%)	Norm Percentile Change
Whole Brain	1280.71	82.93	82						
Lateral Ventricles	17.78	1.15	75						
Thalami	18.14	1.17	91						
Cortical Gray Matter	556.39	36.03	10						

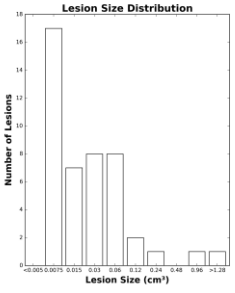
LESION RESULTS (from current scan)

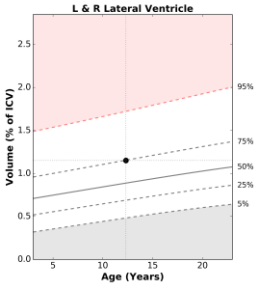
	All Lesions from Current Scan	All Lesions from Prior Scan	Enlarging Lesions	New Lesions	New + Enlarging Lesions
Count	45		0	0	0
Volume (cm³)	6.06		0.00	0.00	0.00
% ICV	0.39		0.00	0.00	0.00
Lesion Burden	1.24				

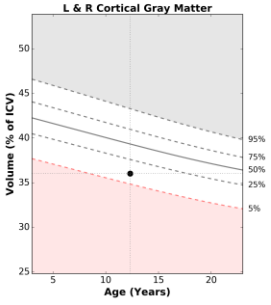
LESION ANATOMICAL DISTRIBUTION (from current scan)

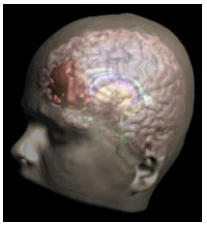
	Leukocortical	Periventricular	Infratentorial	Deep White
Lesion Count	10	28	0	7
New Lesion Count	0	0	0	0
Enlarging Lesion Count	0	0	0	0
New + Enlarging Lesion Count	0	0	0	0
Lesion Volume (cm³)	4.47	1.26	0.00	0.34

A NeuroQuant® Product — CorTechs Labs | cortechslabs.com



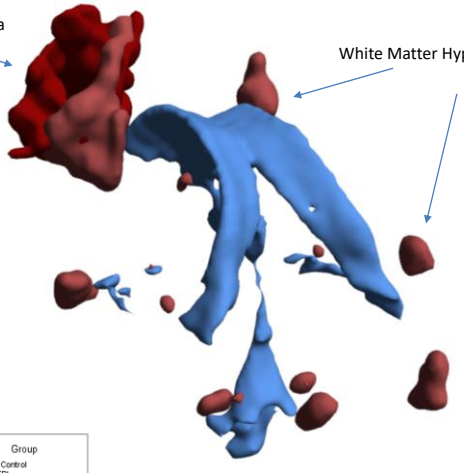


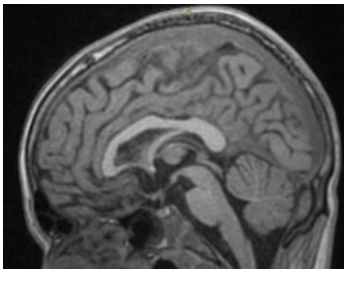


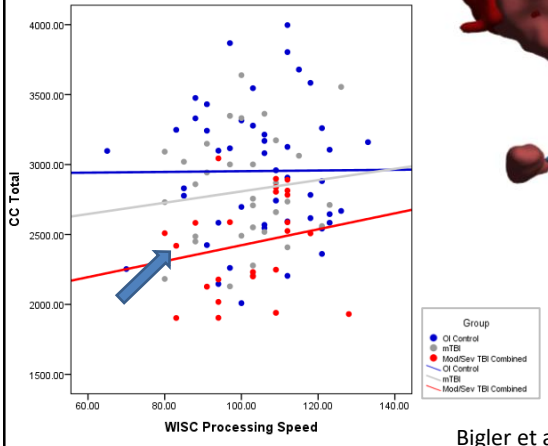


Old Focal Encephalomalacia

White Matter Hyperintensities

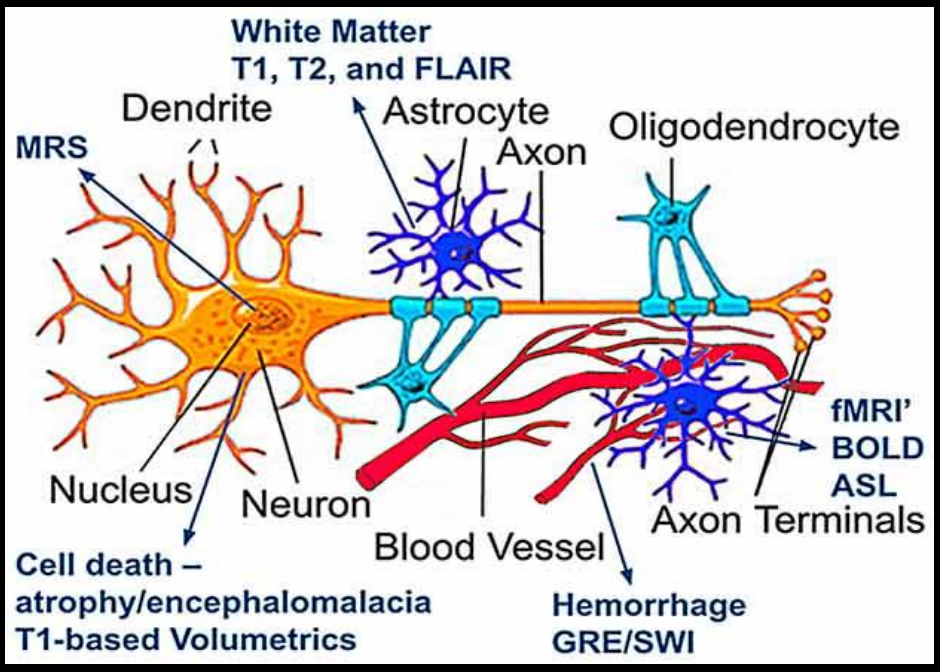


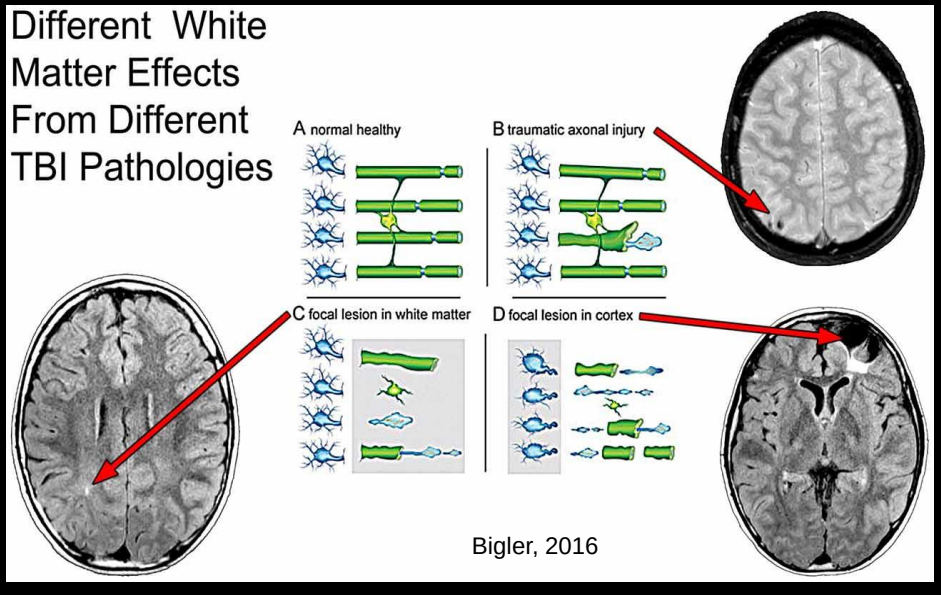




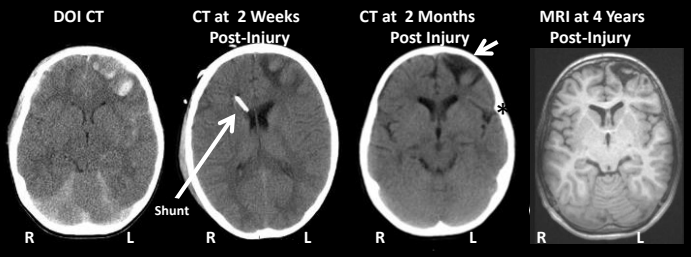
Bigler et al. 2013

What is the LESION?

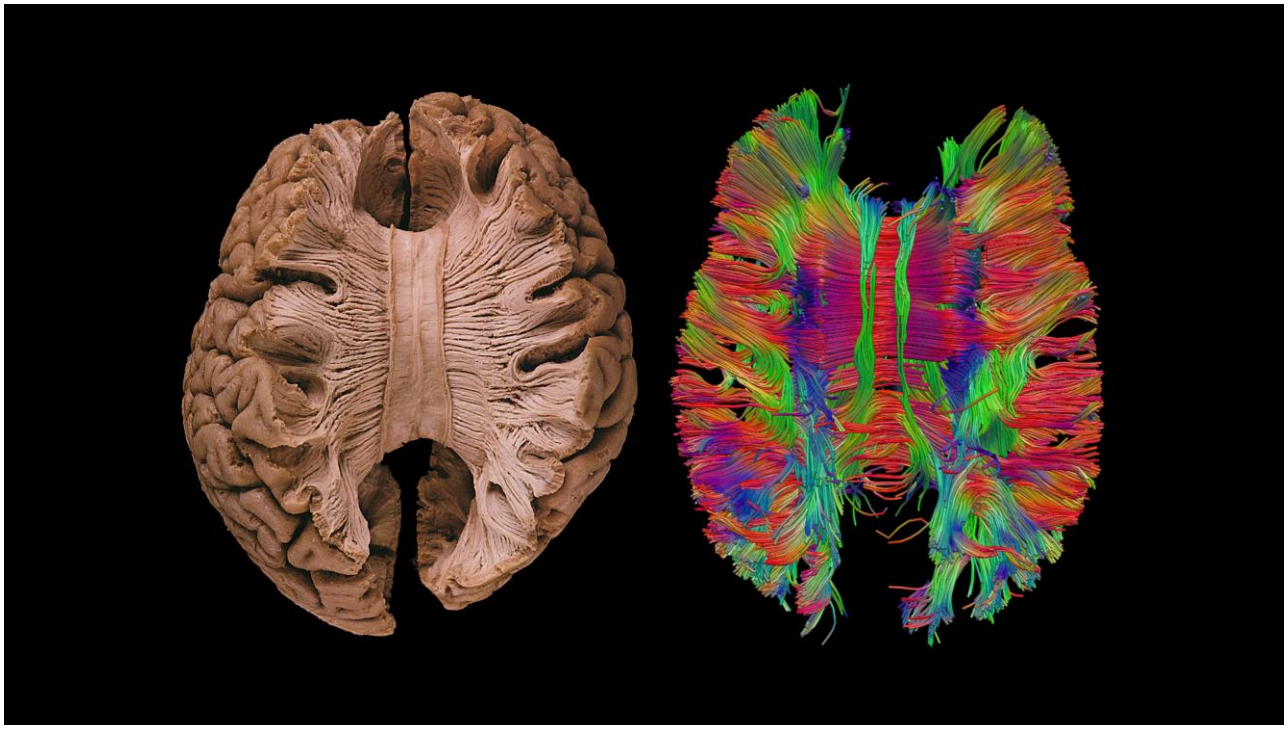


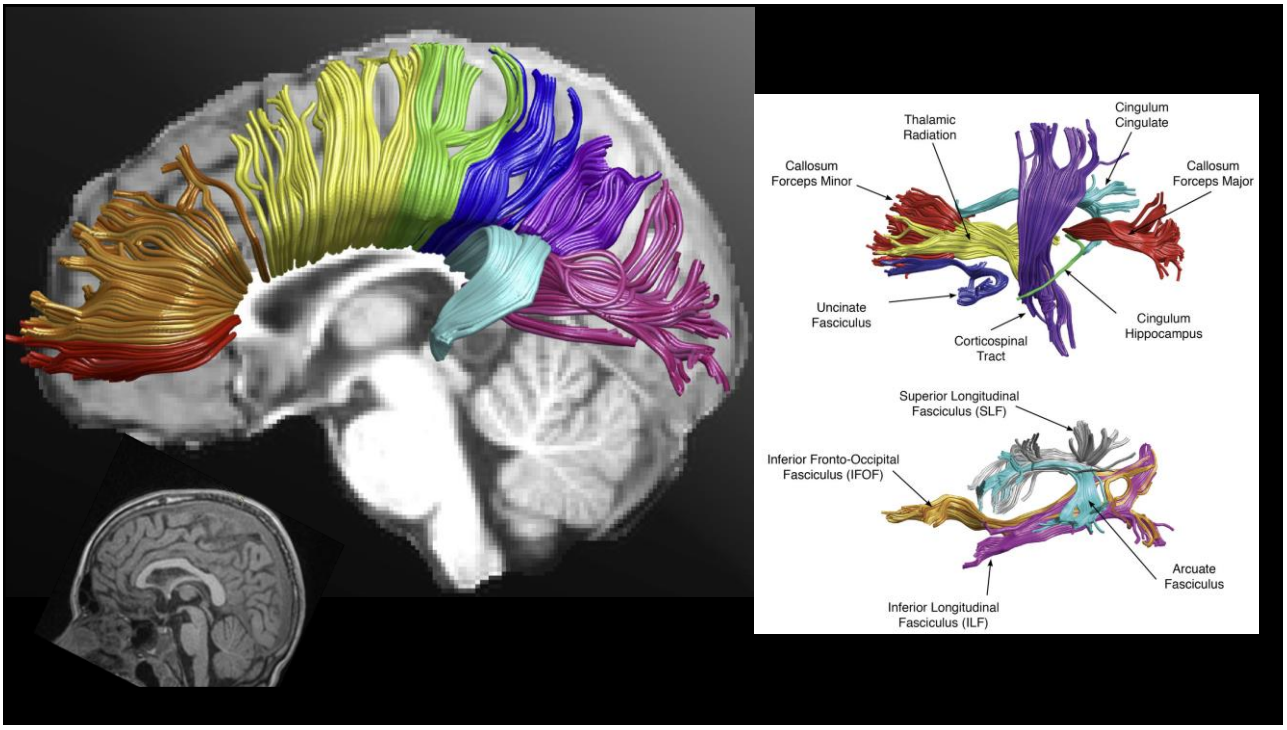


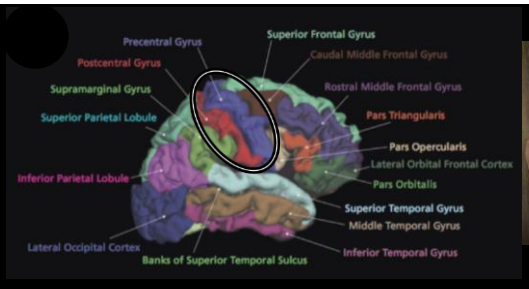
When to measure?

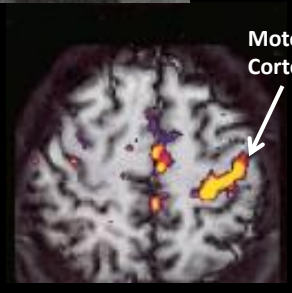


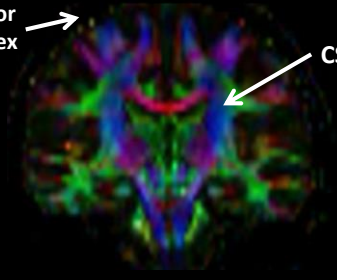
Dynamic Changes – Time post-injury

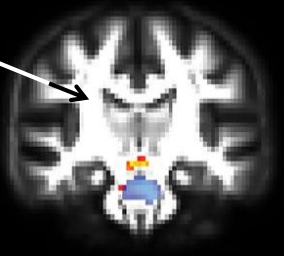












fMRI Contralateral Motor Activation

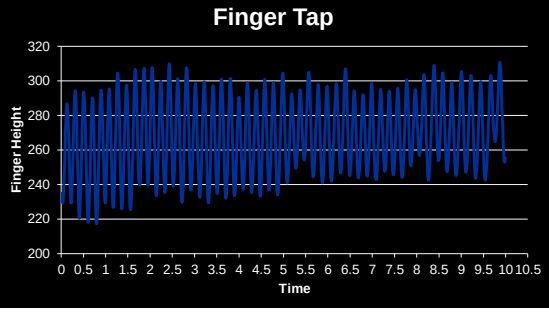
DTI Color Map

Blue – FA Positively Correlated with Motor Function

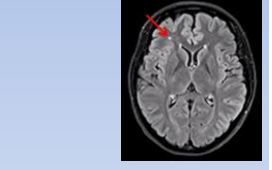
Travers et al., *Developmental Science, 2016 and J Autism Dev Disord., 2015*

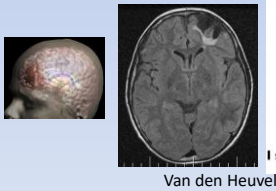
The Future of Assessment – Gaming World, Meets Clinical Assessment and Standardization and Virtual Environments

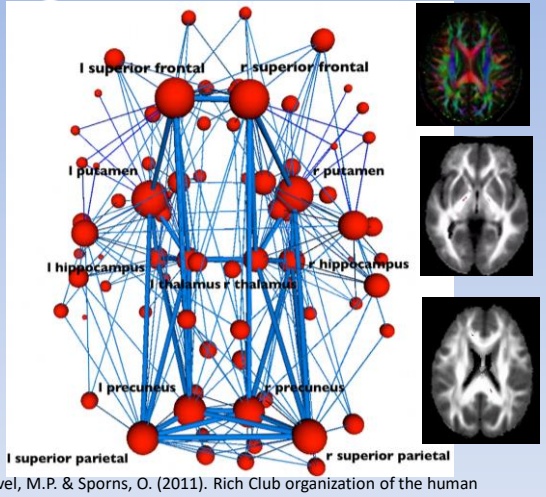
Leap Motion Device



Network Damage and The lesion localization Effects of TBI







Van den Heuvel, M.P. & Sporns, O. (2011). Rich Club organization of the human connectome. ***Journal Of Neuroscience***, 31(44), 15775 – 15786.

Brain Connectivity, VOL. 8, NO. 5 |

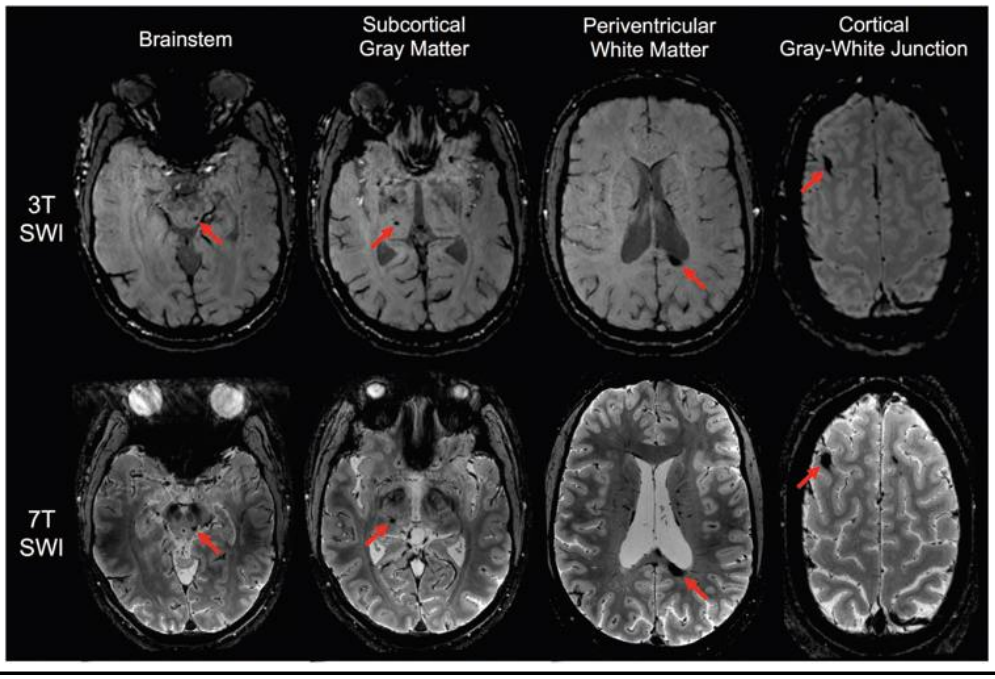
normal

Characterizing Signals Within Lesions and Mapping Brain Network Connectivity After Traumatic Axonal Injury: A 7 Tesla Resting-State FMRI Study

Seul Lee, Jonathan R. Polimeni, Collin M. Price, Brian L. Edlow, and Jennifer A. McNab

Published Online: 1 Jun 2018 | https://doi.org/10.1089/brain.2017.0499

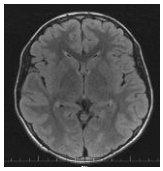
Ever Changing, Improved Technology



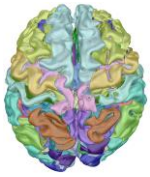
21st Century Neuroimaging Methods

Potential Components to Network Modeling

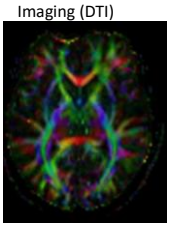
Structural Imaging



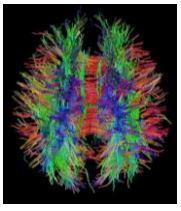
Volumetric/Shape



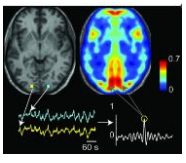
Diffusion Tensor Imaging (DTI)



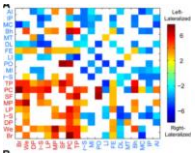
DTI Tractography



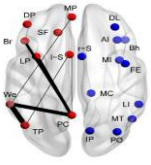
Resting State Functional MRI (rs-*fc* MRI)



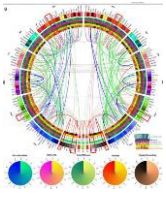
Connectivity Matrix

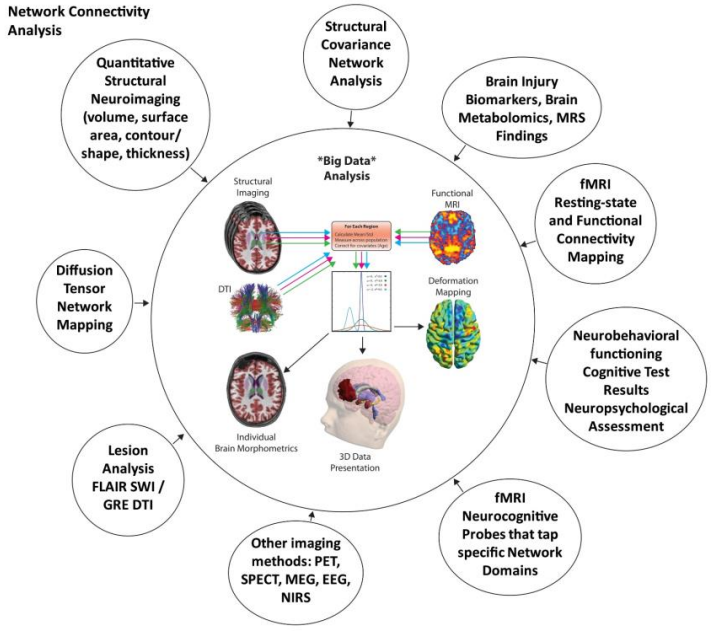


Network Plot

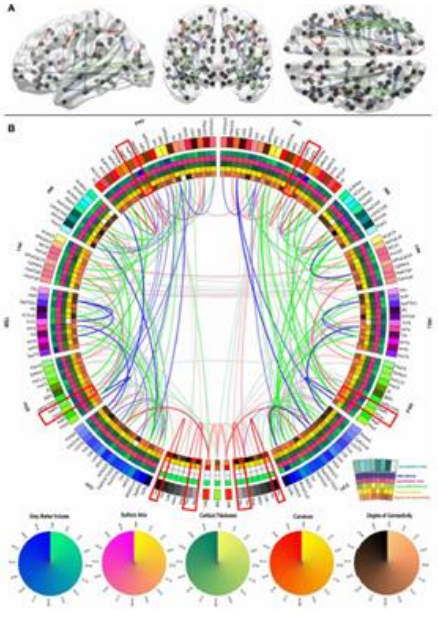


Network Complexity

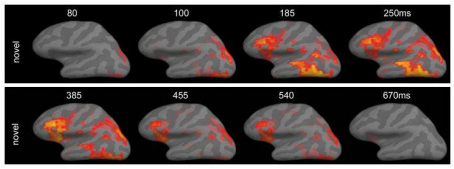




Bigler, E.D. Frontiers of Systems Neuroscience, 2016.



Irimia, A. & Van Horn, J.D. Frontiers in Human Neuroscience, 2014



"Functional Systems" : These systems are organized so that each cortical zone contributes in a specific way in accordance with its position within the cortical hierarchy and in accordance with the rules of innervation and inhibition. Therefore, for a complex behavioral act to be performed in a precise and smooth manner, the coordinated and governed working of all cortical areas responsible for the elements of the act is a necessary condition.

It's Time to Fully Integrate Neuroimaging with Neuropsychology. Clinical Neuropsychology WILL NOT advance without taking this step

Traumatic Brain Injury – Deeper Dive into Clinical Neuropsychological Practice

October 18, 2018

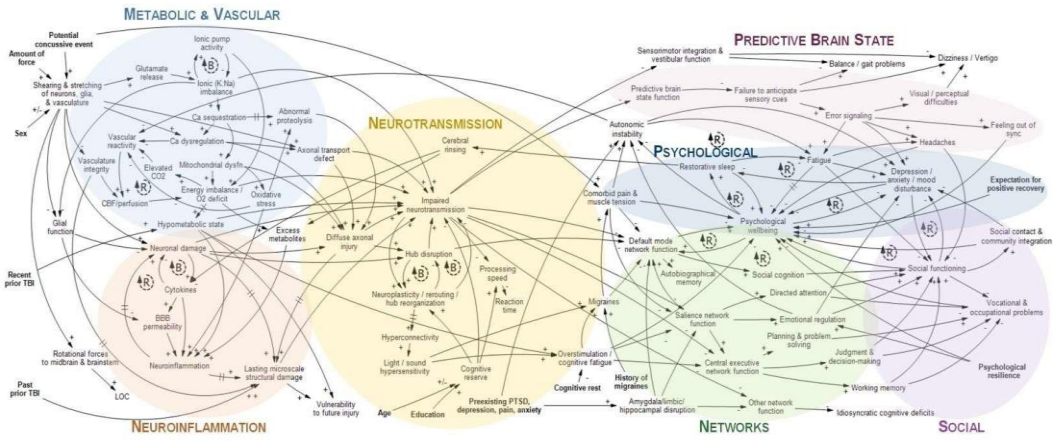
As a singular term, by itself, is the term, TBI meaningful?

frontiers in Systems Neuroscience
2016 Aug 9;10:55. doi: 10.3389/fnsys.2016.00055. eCollection 2016.
HYPOTHESIS AND THEORY
published: 09 August 2016
doi: 10.3389/fnsys.2016.00055

Systems Biology, Neuroimaging, Neuropsychology, Neuroconnectivity and Traumatic Brain Injury

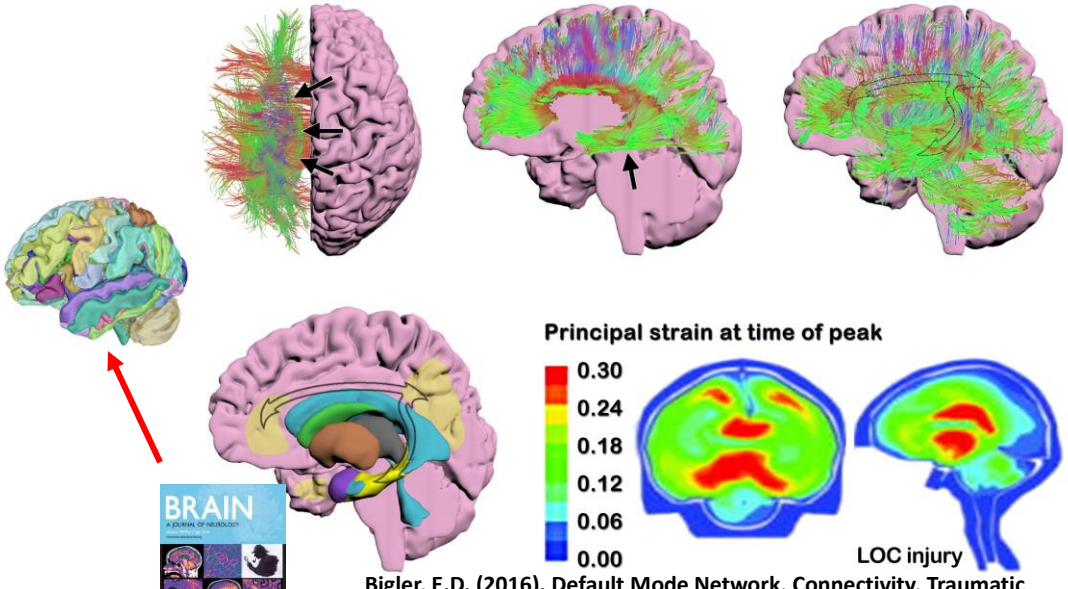
*Erin D. Bigler**

Department of Psychology, Neuroscience Center, Brigham Young University, Provo, UT, USA



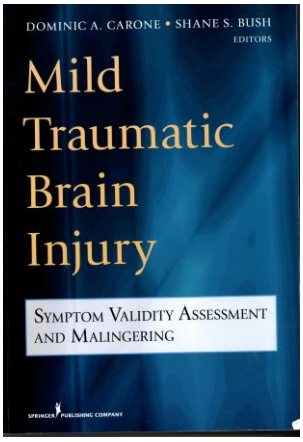
Kenzie, E. et al. Concussion as a multi-scale complex system, *Frontiers of Neurology*, 2017, Front Neurol. 2017 Sep 28;8:513. doi: 10.3389/fneur.2017.00513
Kenzie, E. et al. The Dynamics of Concussion: Mapping Pathophysiology, Persistence, and Recovery With Causal-Loop Diagramming. Front Neurol. 2018 Apr 4;9:203. doi: 10.3389/fneur.2018.00203

Neural Networks, Connectivity and Traumatic Brain Injury



Bigler, E.D. (2016). Default Mode Network, Connectivity, Traumatic Brain Injury and Post-Traumatic Amnesia. *Brain*, Brain. 2016 Dec;139(Pt 12):3054-3057.

Neuropsychology's Failure in Understanding Mild TBI

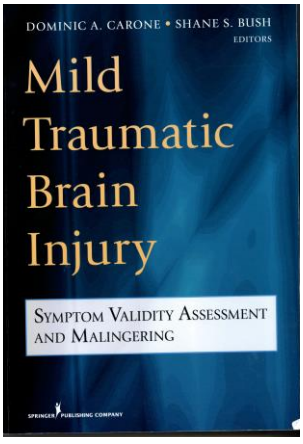


Foreword

"*First, mTBI is a self-contained condition that resolves quickly without special treatment, a generally accepted conclusion by fair-minded neuropsychologists* **(xiii)"**

Manfred F. Greiffenstein, Ph.D

Neuropsychology's Failure in Understanding Mild TBI



Foreword

"*First, mTBI is a self-contained condition that resolves quickly without special treatment, a generally accepted conclusion by fair-minded neuropsychologists* **(xiii)"**

Manfred F. Greiffenstein, Ph.D

Could this possibly be an accurate statement?

If not, why do neuropsychologists believe this to be the case?

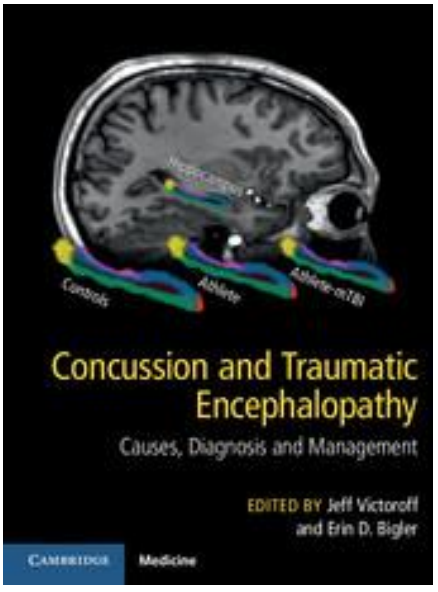
PLOS ONE

RESEARCH ARTICLE

Mild Traumatic Brain Injury (mTBI) and chronic cognitive impairment: A scoping review

Kerry McInnes[1,2], Christopher L. Friesen[1,3], Diane E. MacKenzie[2,4], David A. Westwood[2,3,5], Shaun G. Boe[1,2,3,5]*

"Results indicate that, in contrast to the prevailing view that most symptoms of concussion are resolved within 3 months post-injury, approximately half of individuals with a single mTBI demonstrate long-term cognitive impairment."



***PLoS ONE* 12(4):e0174847.**
https://doi.org/10.1371/journal.pone.0174847

JOURNAL OF NEUROTRAUMA 34:1511–1523 (April 15, 2017)

DOI: 10.1089/neu.2016.4677

Original Articles

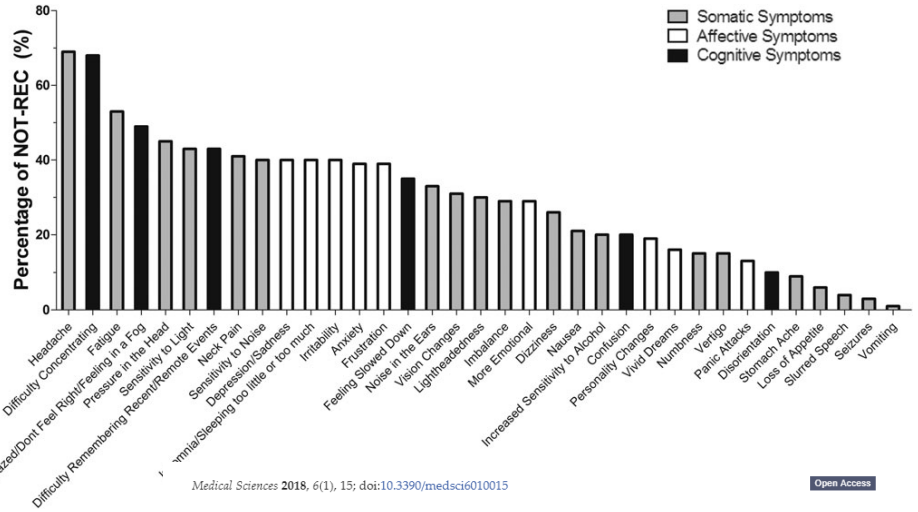
Longitudinal Study of Postconcussion Syndrome: Not Everyone Recovers

Carmen Hiploylee,[1,2] Paul A. Dufort,[2] Hannah S. Davis,[1,2] Richard A. Wennberg,[2,3] Maria Carmela Tartaglia,[2,3] David Mikulis,[2,4] Lili-Naz Hazrati,[2,5] and Charles H. Tator[1,2]

Abstract

We examined recovery from postconcussion syndrome (PCS) in a series of 285 patients diagnosed with concussion based on international sport concussion criteria who received a questionnaire regarding recovery. Of 141 respondents, those with postconcussion symptoms lasting less than 3 months, a positive computed tomography (CT) and/or magnetic resonance imaging (MRI), litigants, and known Test of Memory Malingering (TOMM)-positive cases were excluded, leaving 110 eligible respondents. We found that only 27% of our population eventually recovered and 67% of those who recovered did so within the first year. Notably, no eligible respondent recovered from PCS lasting 3 years or longer. Those who did not recover ($n=80$) were more likely to be non-compliant with a do-not-return-to-play recommendation ($p=0.006$) but did not differ from the recovered group ($n=30$) in other demographic variables, including age and sex ($p \geq 0.05$). Clustergram analysis revealed that symptoms tended to appear in a predictable order, such that symptoms later in the order were more likely to be present if those earlier in the order were already present. Cox proportional hazards model analysis showed that the more symptoms reported, the longer the time to recovery ($p=7.4\times10^{-6}$), with each additional symptom reducing the recovery rate by approximately 20%. This is the first longitudinal PCS study to focus on PCS defined specifically as a minimum of 3 months of symptoms, negative CT and/or MRI, negative TOMM test, and no litigation. PCS may be permanent if recovery has not occurred by 3 years. Symptoms appear in a predictable order, and each additional PCS symptom reduces recovery rate by 20%. More long-term follow-up studies are needed to examine recovery from PCS.

Keywords: definitions, eligibility, and exclusions; number of symptoms; postconcussion syndrome; recovery



Medical Sciences **2018**, *6*(1), 15; doi:10.3390/medsci6010015 Open Access

Review

Traumatic Brain Injury, Sleep Disorders, and Psychiatric Disorders: An Underrecognized Relationship

Anne M. Morse [1,*] and David R. Garner [2]

[1] Janet Weis Children's Hospital, Department of Pediatric Neurology and Sleep Medicine, Geisinger Medical Center, MC 14-12, 100 N Academy Blvd, Danville, PA 17822, USA

[2] Department of Pediatrics, Geisinger Medical Center, Danville, PA 17822, USA

Research

JAMA Neurology | Original Investigation

Association of Mild Traumatic Brain Injury With and Without Loss of Consciousness With Dementia in US Military Veterans

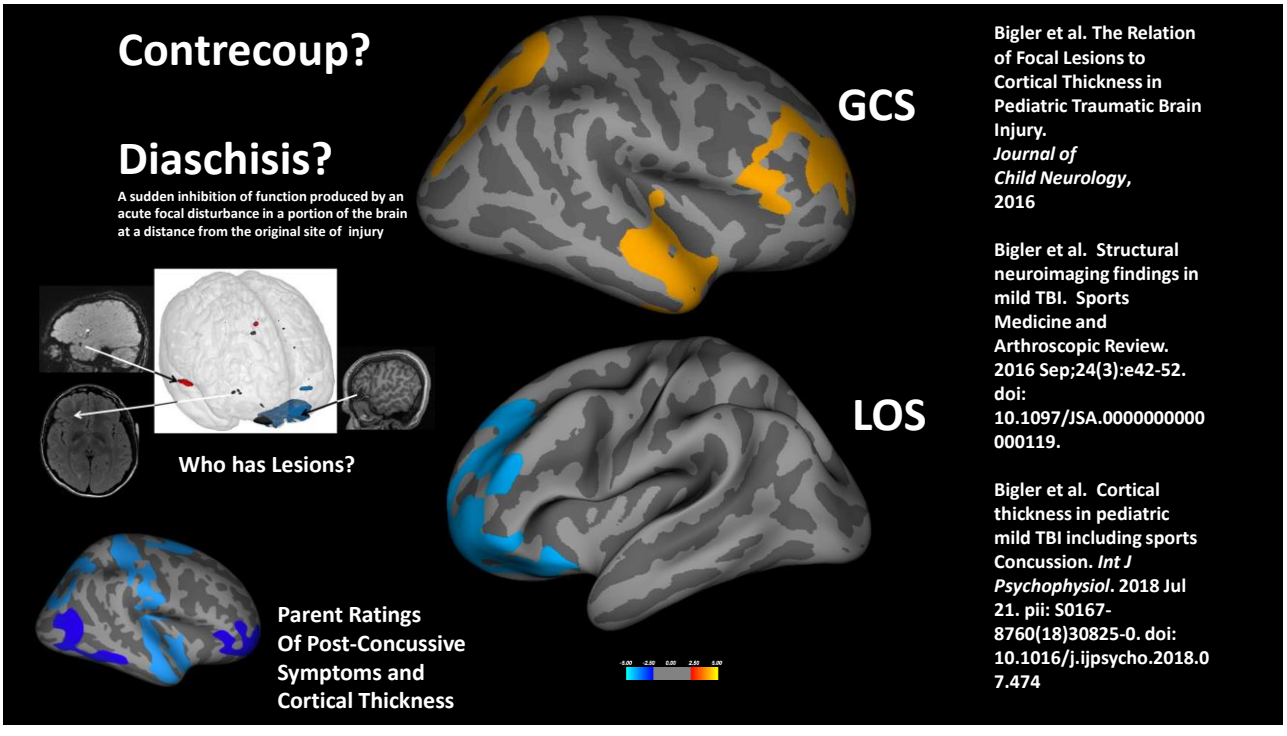
Deborah E. Barnes, PhD, MPH; Amy L. Byers, PhD, MPH; Raquel C. Gardner, MD; Karen H. Seal, MD, MPH; W. John Boscardin, PhD; Kristine Yaffe, MD

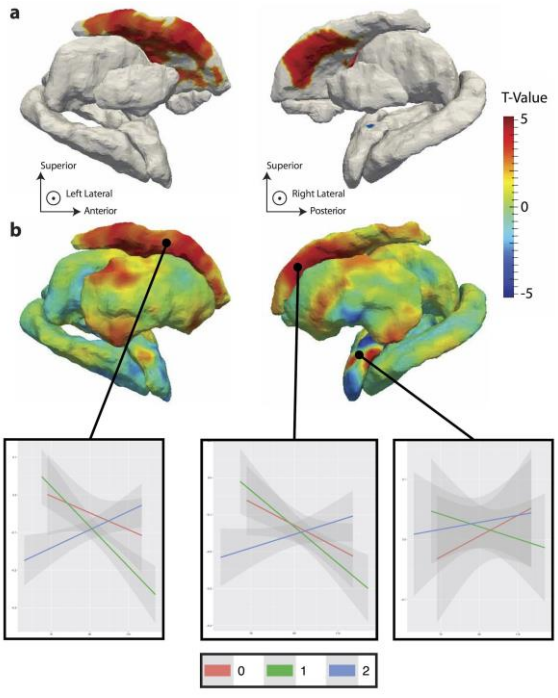
CONCLUSIONS AND RELEVANCE: In this cohort study of more than 350 000 veterans, ***even mild TBI without LOC*** was associated with more than a ***2-fold increase*** in the ***risk of dementia*** diagnosis.

Madsen et al. Traumatic brain injuries (TBIs) can have serious long-term consequences, including psychiatric disorders. However, few studies have assessed the association between TBI and risk of suicide.
***JAMA*. 2018 Aug 14;320(6):580-588. doi: 10.1001/jama.2018.10211.**

CONCLUSIONS AND RELEVANCE:

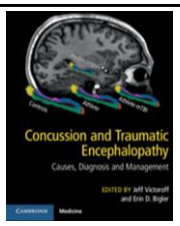
In this nationwide registry-based retrospective cohort study individuals with medical contact for TBI, compared with the general population without TBI, had increased suicide risk.

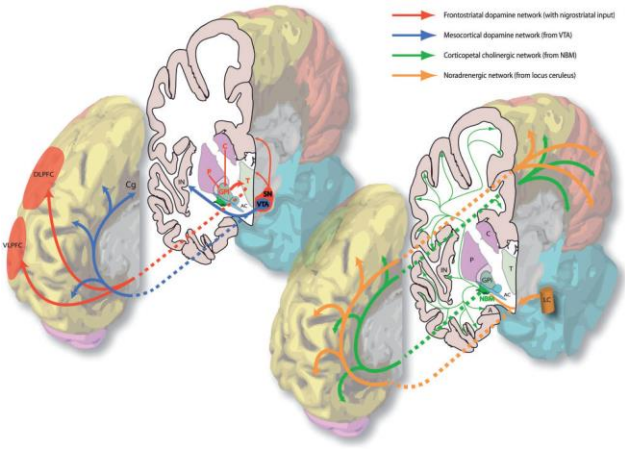




Tate et al. Subcortical shape and neuropsychological function among U.S. service members with mild traumatic brain injury.rain Imaging Behav. 2018 Mar 21. doi: 10.1007/s11682-018-9854-8

Bolzenius et al. J HRelationships Between Subcortical Shape Measures and Subjective Symptom Reporting in US Service Members With Mild Traumatic Brain Injury.ead Trauma Rehabil. 2018 Mar/Apr;33(2):113-122. doi: 10.1097/HTR.0000000000000379





Gratwicke et al. Brain. 2015: 138; 1454–1476

Neuropsychology
2013, Vol. 27, No. 4, 438–451

0894-4105/13/$12.00 DOI: 10.1037/a0032837

Heterogeneity of Brain Lesions in Pediatric Traumatic Brain Injury

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Brigham Young University and University of Utah

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The Hospital for Sick Children, Toronto, Ontario, and University of Toronto

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Case Western Reserve University and Rainbow Babies & Children's Hospital, University Hospitals Case Medical Center, Cleveland, Ohio

Kenneth H. Rubin
University of Maryland

Kathryn Vannatta and Cynthia A. Gerhardt
The Ohio State University and Columbus Children's Research Institute, Columbus, Ohio

Terry Stancin
MetroHealth Medical Center and Case Western Reserve University, Cleveland, Ohio

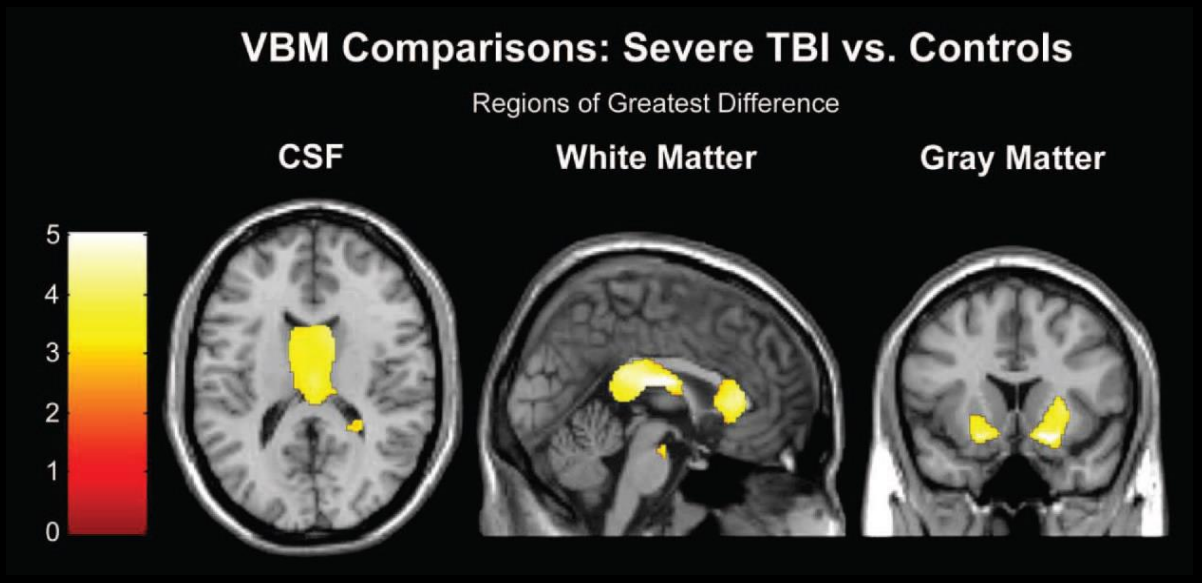
Keith Owen Yeates
The Ohio State University and Nationwide Children's Hospital, Columbus, Ohio

Brain Inj. 2015; 29(9): 1062–1070.
Published online 2015 Jul 17. doi: 10.3109/02699052.2015.1011234

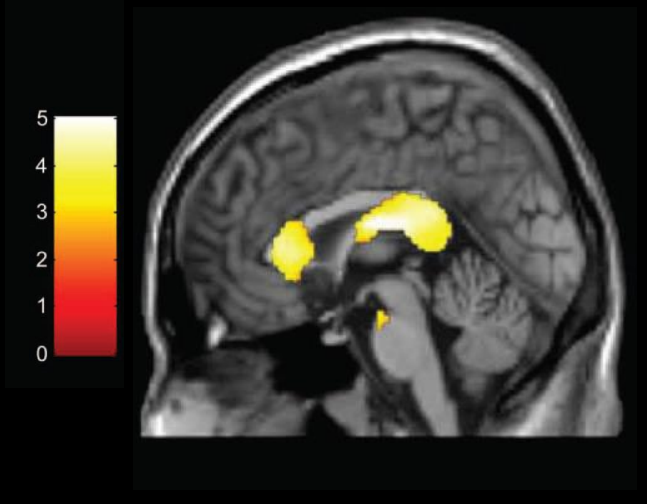
Day of Injury CT and Late MRI Findings: Cognitive Outcome in a Pediatric Sample with Complicated Mild Traumatic Brain Injury

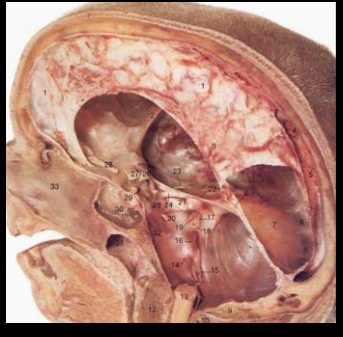
Erin D. Bigler,[✉1] Paul B Jantz,[2] Thomas J. Farrer,[1] Tracy J. Abildskov,[1] Maureen Dennis,[3,^] Cynthia A. Gerhardt,[4] Kenneth H. Rubin,[5] Terry Stancin,[6] H. Gerry Taylor,[7] Kathryn Vannatta,[8] and Keith Owen Yeates[9,10]

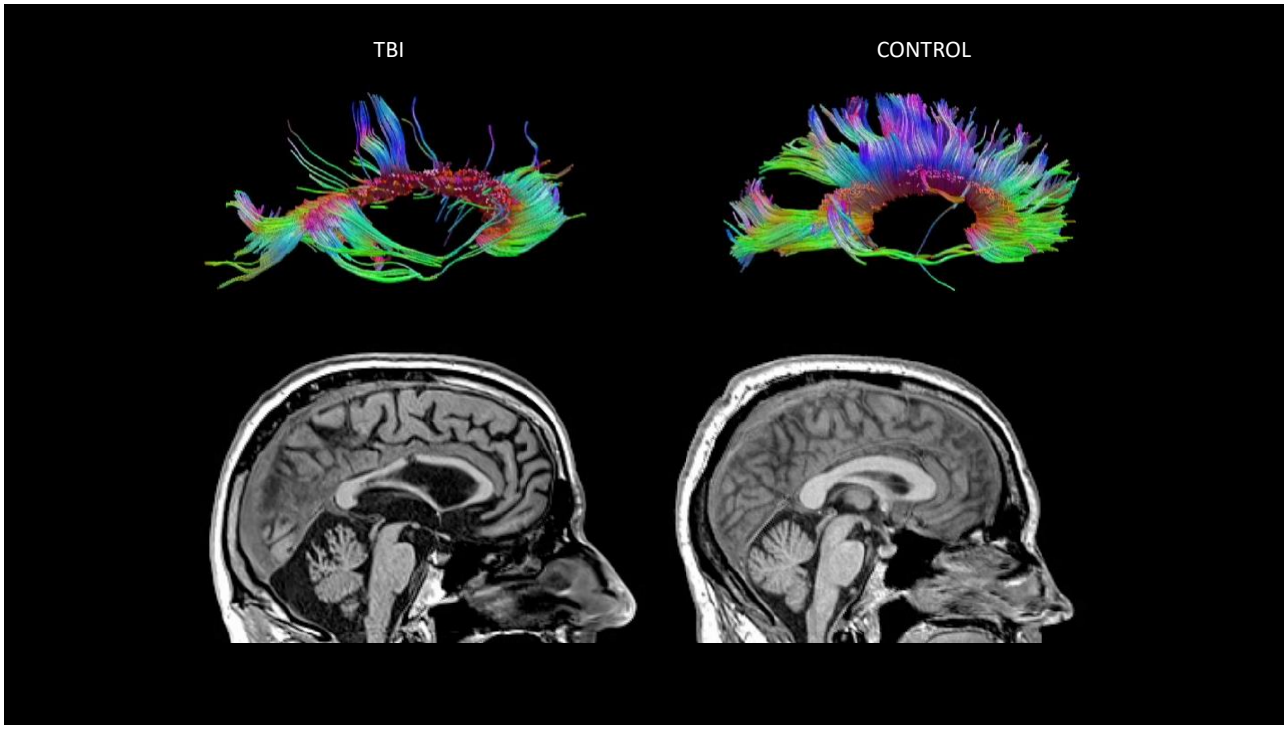
Voxel-Based Morphometry of TBI

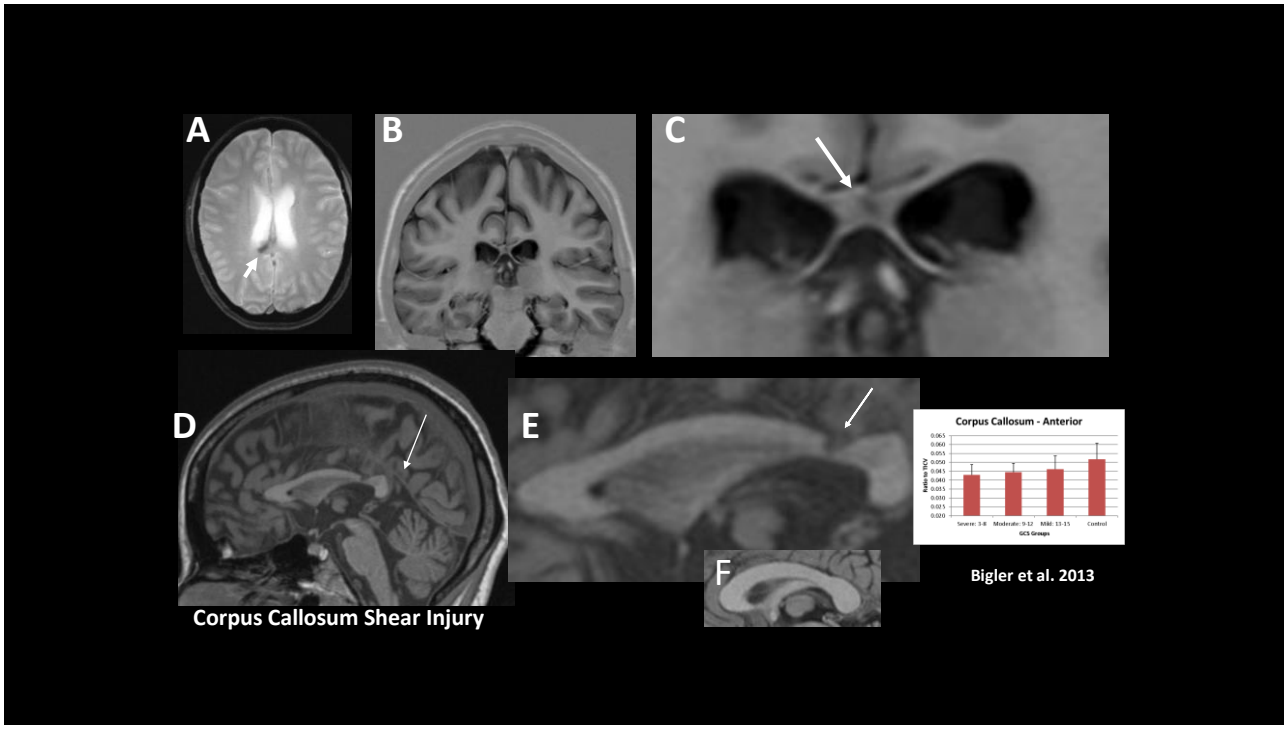


Vulnerability of Corpus Callosum and Fornix in TBI

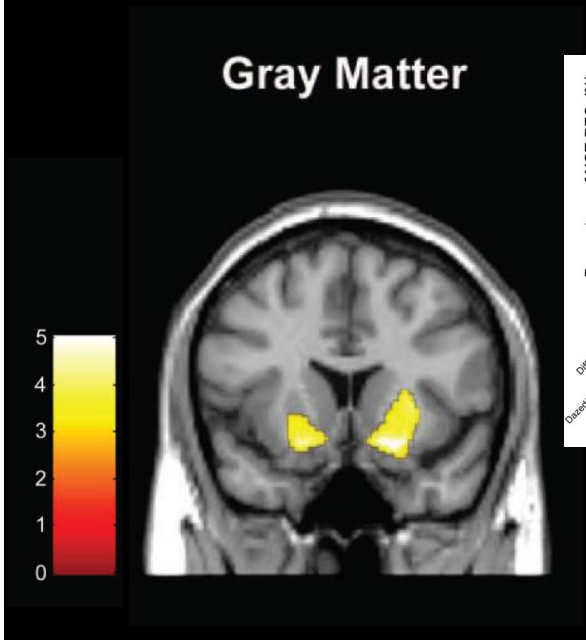


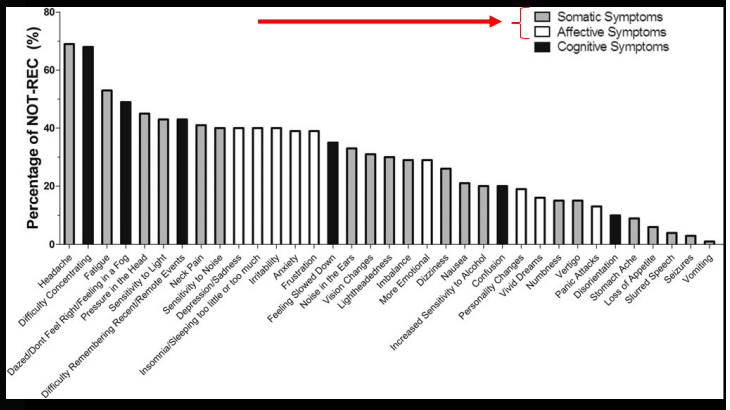



TBI
CONTROL

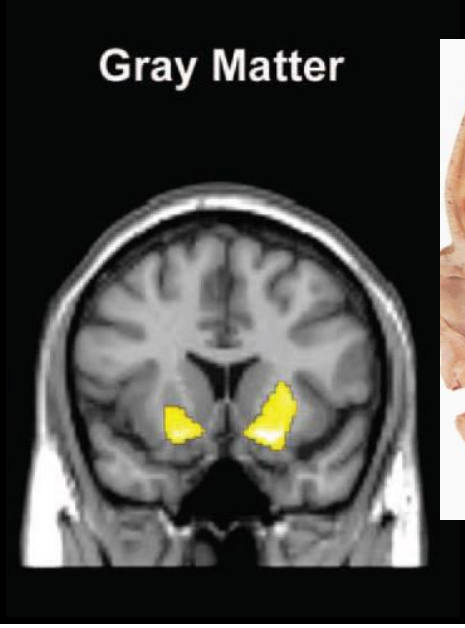

A
B
C
D
E
F
Corpus Callosum - Anterior
Corpus Callosum Shear Injury
Bigler et al. 2013

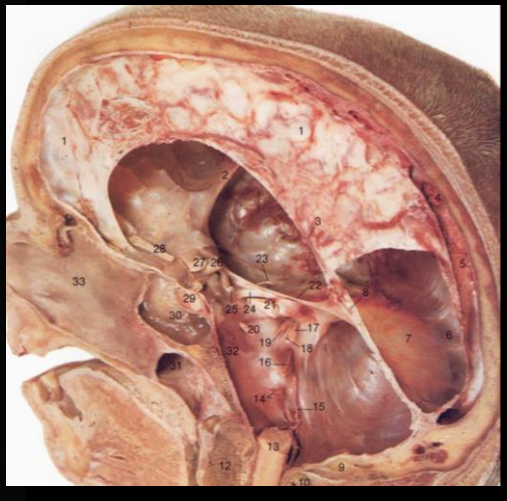
Inferior Frontal Damage - TBI



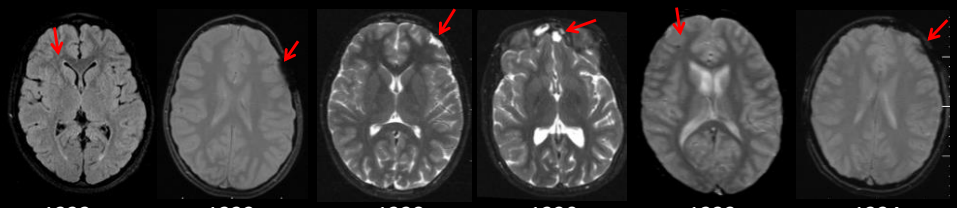


Inferior Frontal Damage - TBI

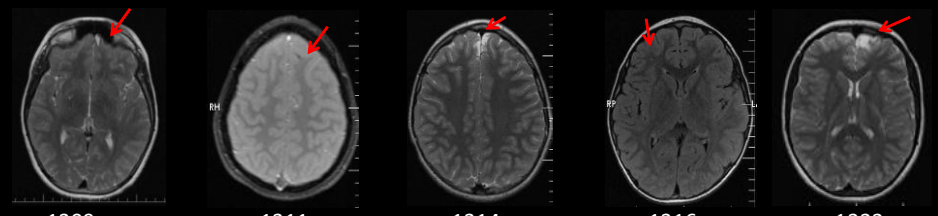




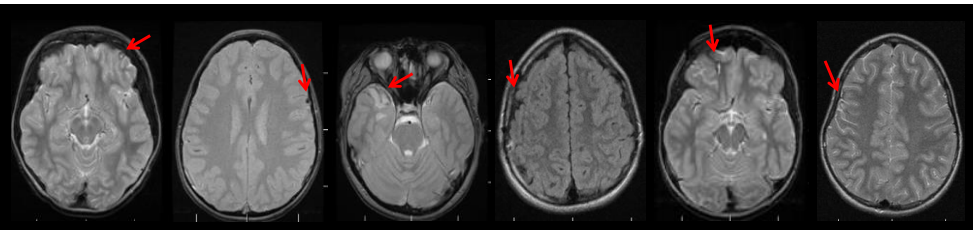
Key: Lfx = Linear Fracture, Bfx = Basilar Skull Fracture , EDH = Epidural Hematoma, SDH = Subdural Hematoma, PH = Petechial Hemorrhage, MS = Midline Shift



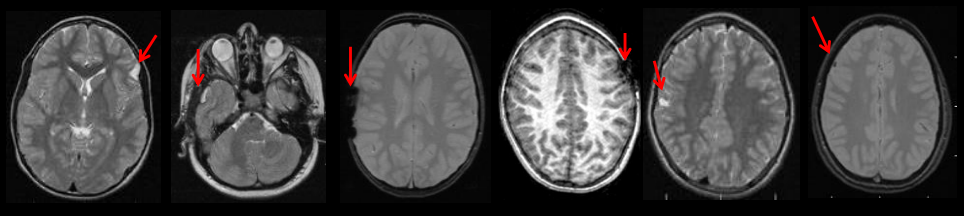
1222 Contusion | 1223 EDH, MS | 1228 Contusion, SDH, MS | 1230 Lfx,Bfx | 1233 Lfx, Contusion | 1234 PH, Edema



1309 Lfx, Bfx, PH, SDH, Edema | 1311 PH | 1314 Lfx, Bfx, PH, Contusion | 1316 Lfx, EDH, PH, Contusion | 1322 Lfx, Contusion, SDH



1105 Lfx, EDH, Edema | 1111 Lfx, EDH, Contusion | 1112 SDH, Edema, PH | 1113 Lfx, SDH, Edema | 1117 Lfx, Bfx,Contusion, SDH | 1203 lfx, Conutsion



1204 Lfx, SAH, Contusion, Edema | 1209 Contusion | 1210 Lfx, SDH, EDH | 1217 Lfx | 1218 Lfx, PH, Edema | 1219 Lfx, SDH

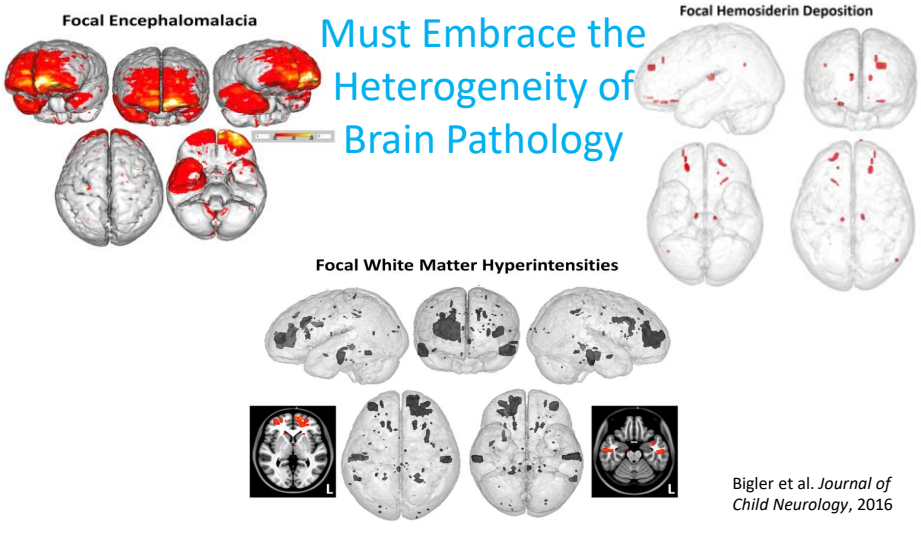
Original Article

The Relation of Focal Lesions to Cortical Thickness in Pediatric Traumatic Brain Injury

Journal of Child Neurology
2016, Vol. 31(11) 1302-1311

DOI: 10.1177/0883073816654143
jcn.sagepub.com
SAGE

Erin D. Bigler, PhD[1,2], Brandon A. Zielinski, MD, PhD[3], Naomi Goodrich-Hunsaker, PhD[4], Garrett M. Black, BS[4], B. S. Trevor Huff, BS[4], Zachary Christiansen, BS[4], Dawn-Marie Wood, MS[4], Tracy J. Abildskov[4], Maureen Dennis, PhD[5,6], H. Gerry Taylor, PhD[7], Kenneth Rubin, PhD[8], Kathryn Vannatta, PhD[9,10], Cynthia A. Gerhardt, PhD[9,10], Terry Stancin, PhD[7,11], and Keith Owen Yeates, PhD[9,12]

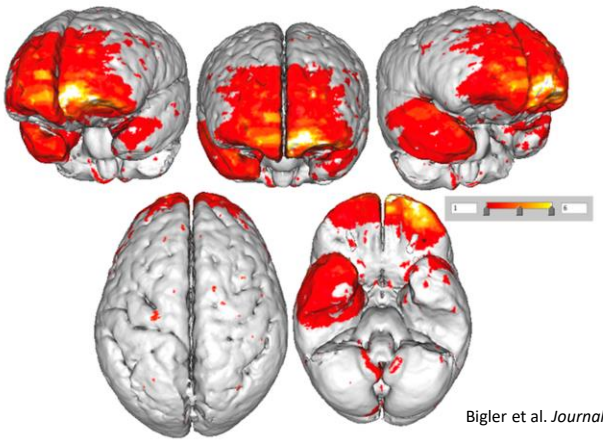


Must Embrace the Heterogeneity of Brain Pathology

Bigler et al. *Journal of Child Neurology*, 2016

Heterogeneity in TBI

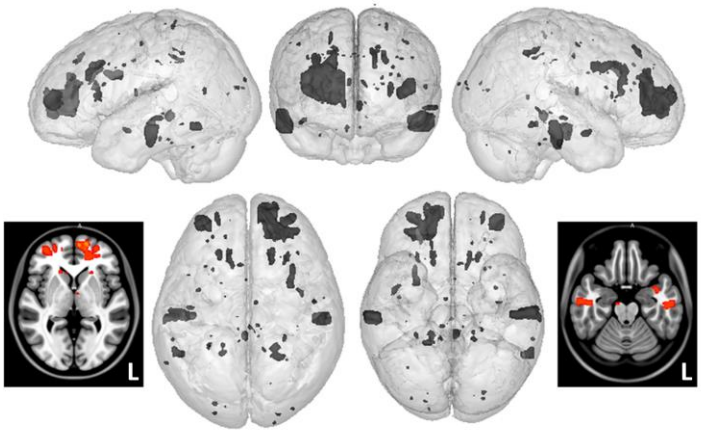
Focal Encephalomalacia



Bigler et al. *Journal of Child Neurology*2016

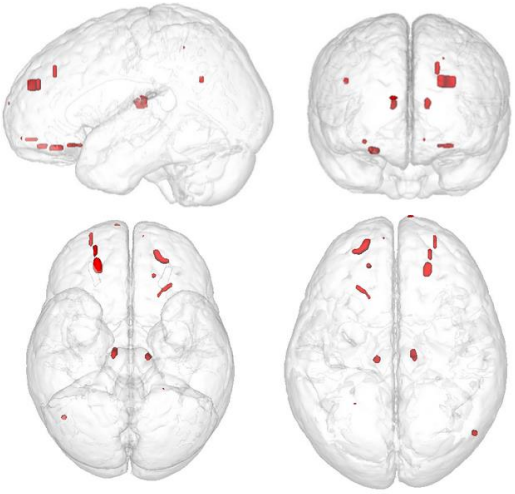
Heterogeneity in TBI

Focal White Matter Hyperintensities

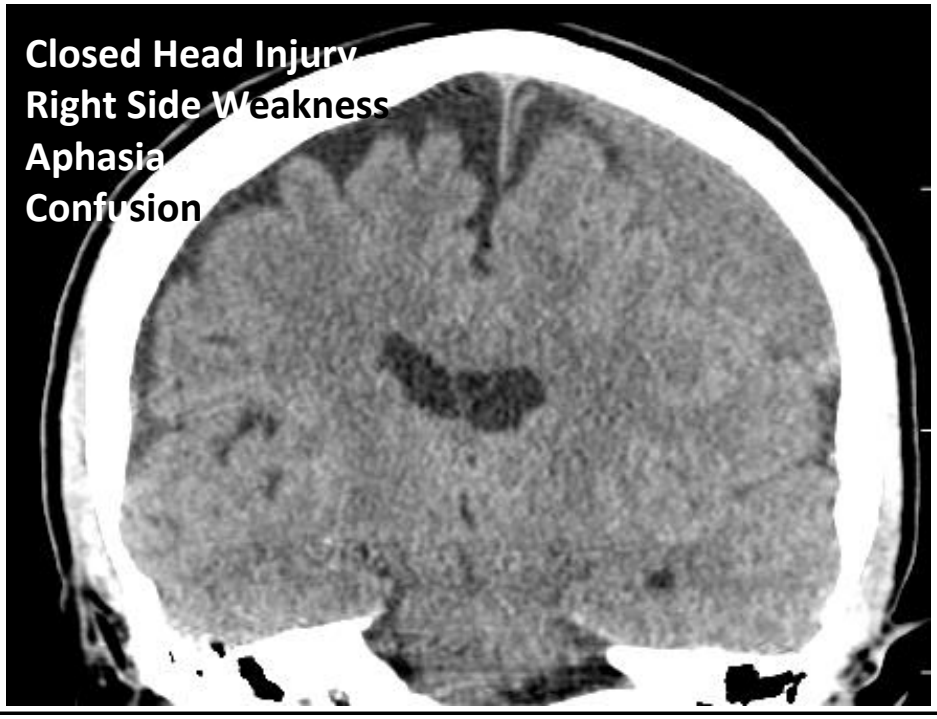


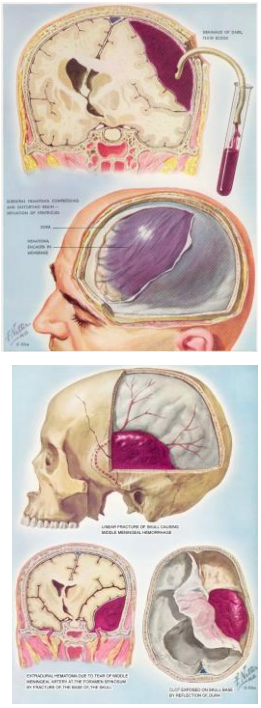
Heterogeneity in TBI

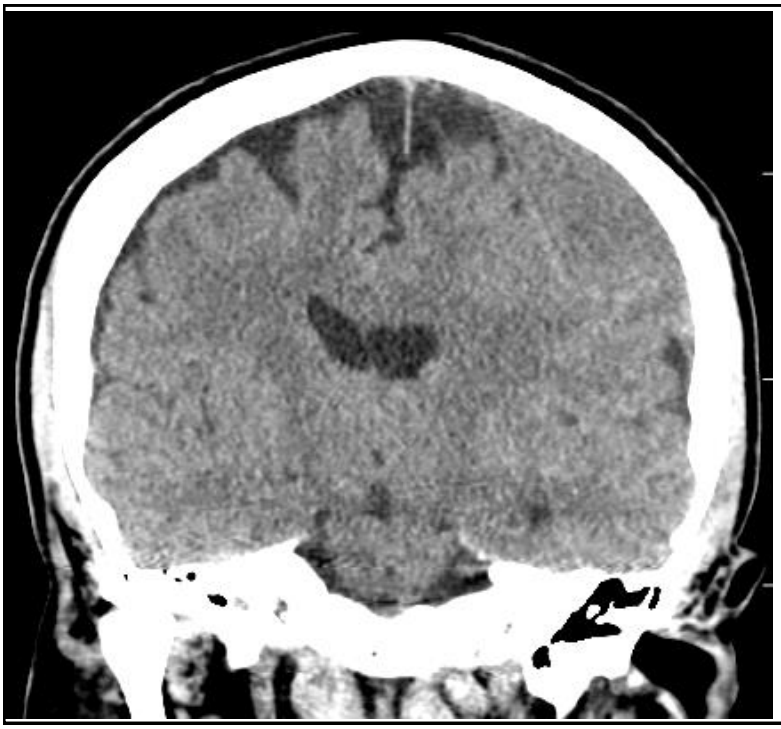
Focal Hemosiderin Deposition



Closed Head Injury
Right Side Weakness
Aphasia
Confusion



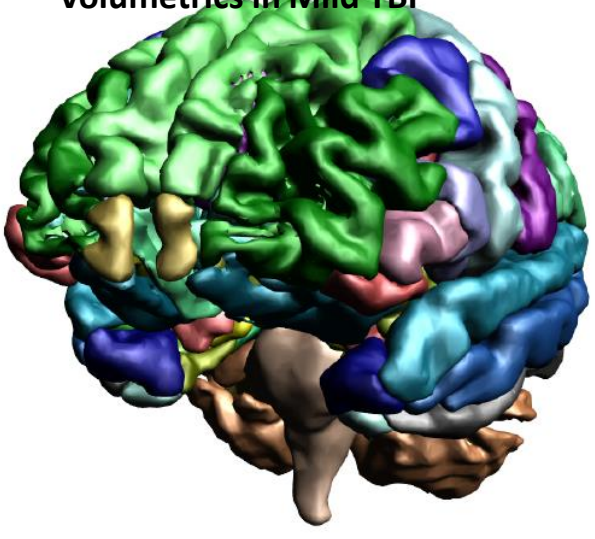




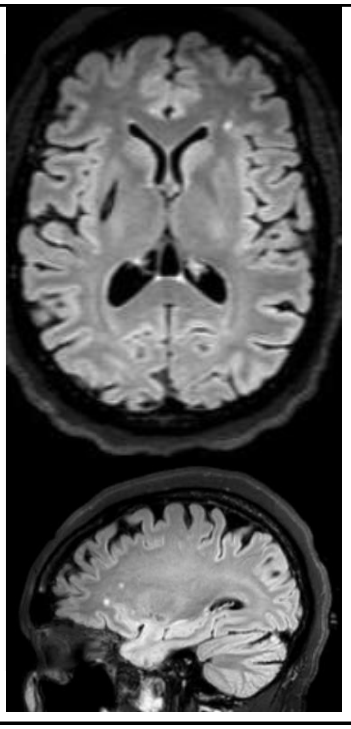
The Integration of Neuropathological with the Neuroimaging and Neuropsychological Outcome

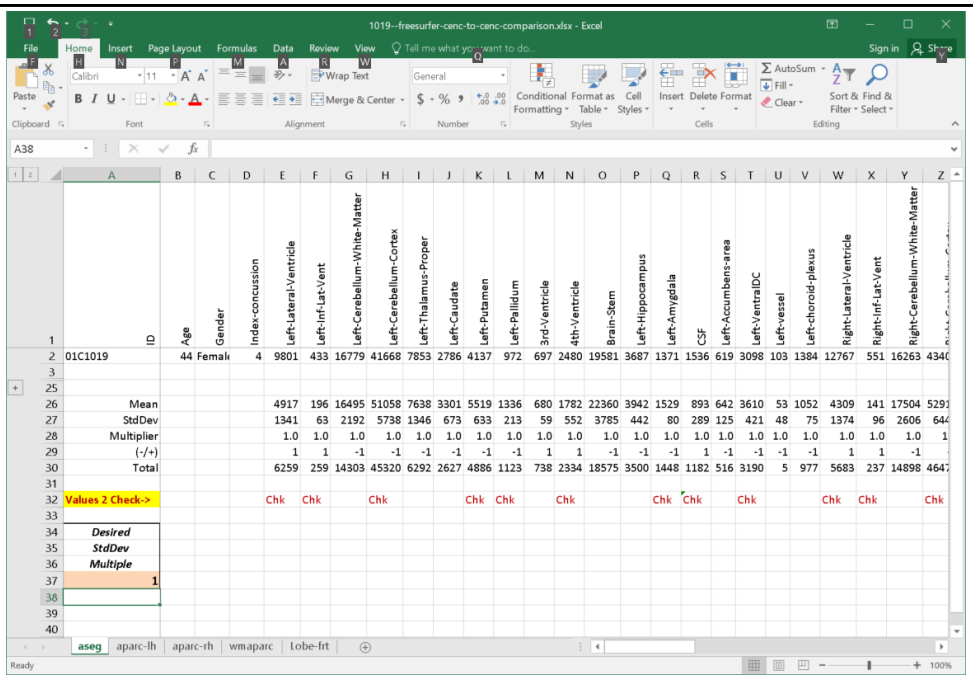
How nice would it be?

White Matter Hyperintensity and Volumetrics in Mild TBI



CENC Study





1019--freesurfer-cenc-to-cenc-comparison.xlsx - Excel

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z
1	ID	Age	Gender	Index-concussion	Left-Lateral-Ventricle	Left-Inf-Lat-Vent	Left-Cerebellum-White-Matter	Left-Cerebellum-Cortex	Left-Thalamus-Proper	Left-Caudate	Left-Putamen	Left-Pallidum	3rd-Ventricle	4th-Ventricle	Brain-Stem	Left-Hippocampus	Left-Amygdala	CSF	Left-Accumbens-area	Left-VentralDC	Left-vessel	Left-choroid-plexus	Right-Lateral-Ventricle	Right-Inf-Lat-Vent	Right-Cerebellum-White-Matter	
2	01C1019	44	Female	4	9801	433	16779	41668	7853	2786	4137	972	697	2480	19581	3687	1371	1536	619	3098	103	1384	12767	551	16263	4340
3																										
25																										
26	Mean				4917	196	16495	51058	7638	3301	5519	1336	680	1782	22360	3942	1529	893	642	3610	53	1052	4309	141	17504	5291
27	StdDev				1341	63	2192	5738	1346	673	633	213	59	552	3785	442	80	289	125	421	48	75	1374	96	2606	644
28	Multiplier				1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1
29	(-/+)				1	1	-1	-1	-1	-1	-1	-1	1	1	-1	-1	-1	1	-1	-1	-1	-1	1	1	-1	
30	Total				6259	259	14303	45320	6292	2627	4886	1123	738	2334	18575	3500	1448	1182	516	3190	5	977	5683	237	14898	4647
31																										
32	Values 2 Check->				Chk	Chk		Chk			Chk	Chk		Chk			Chk	Chk		Chk			Chk	Chk		Chk
33																										
34	Desired																									
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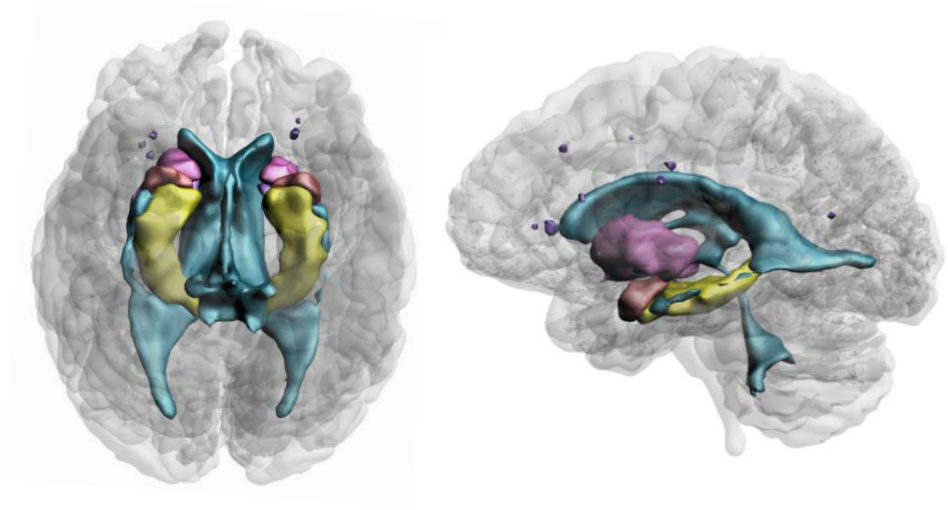
Ready

Where Volumetric Differences Reside in CENC Case



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Neurobiology of Aging

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

Cerebral tract integrity relates to white matter hyperintensities, cortex volume, and cognition

Stephan Seiler [a,b,c,*], Evan Fletcher [a,b], Kinsy Hassan-Ali [a,b], Michelle Weinstein [a,b], Alexa Beiser [d,e,f], Jayandra J. Himali [d,e,f], Claudia L. Satizabal [d,e], Sudha Seshadri [d,e], Charles DeCarli [a,b], Pauline Maillard [a,b]

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[b] Imaging of Dementia and Aging (IDeA) Laboratory, University of California at Davis, Davis, CA, USA
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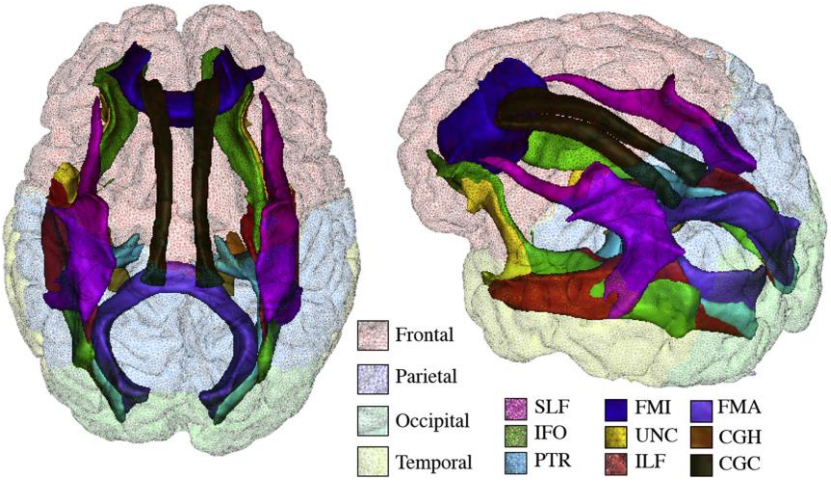
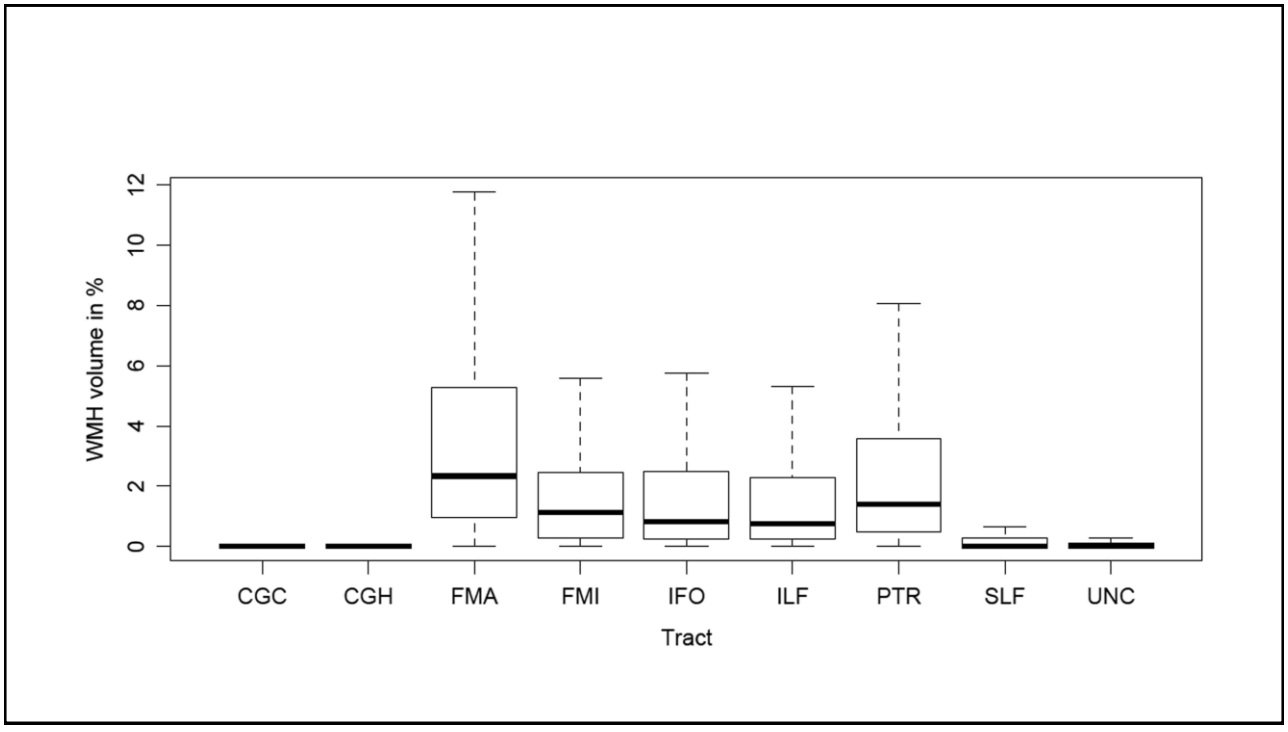
[d] The Framingham Heart Study, Framingham, MA, USA
[e] Department of Neurology, Boston University School of Medicine, Boston, MA, USA
[f] Department of Biostatistics, Boston University School of Public Health, Boston, MA, USA




WMH volume in %
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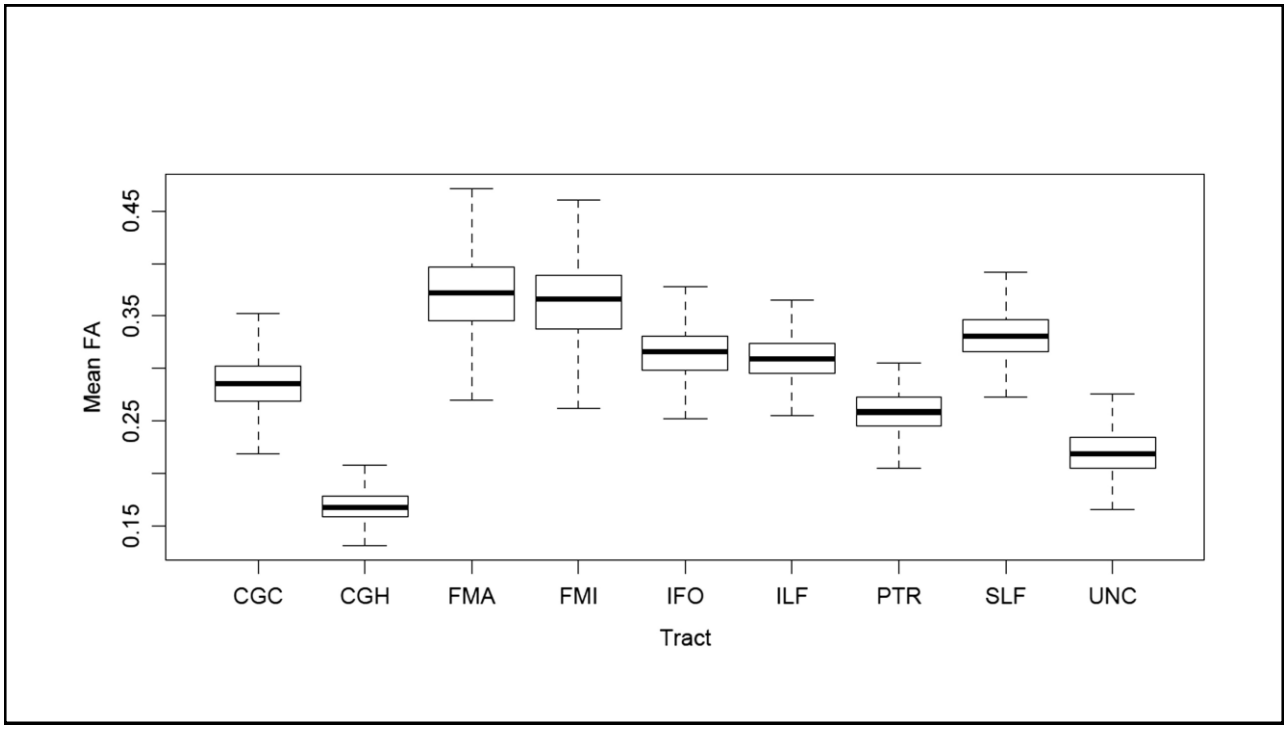
6
8
10
12
CGC
CGH
FMA
FMI
IFO
ILF
PTR
SLF
UNC
Tract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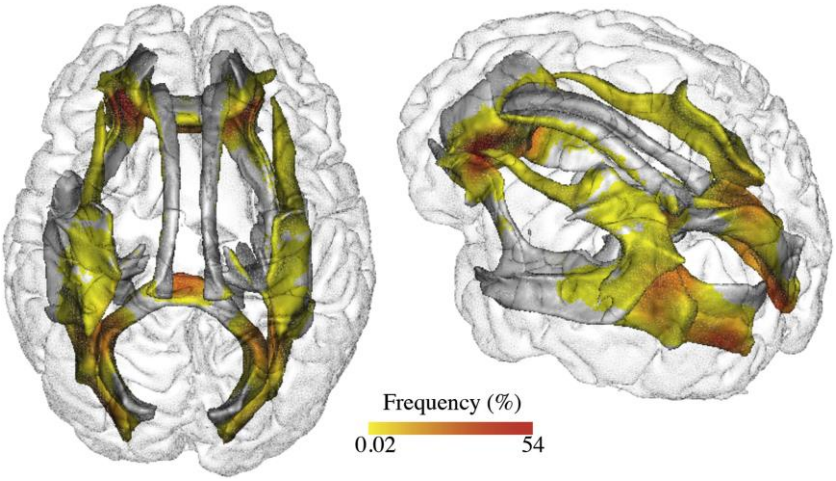
UNC
Tract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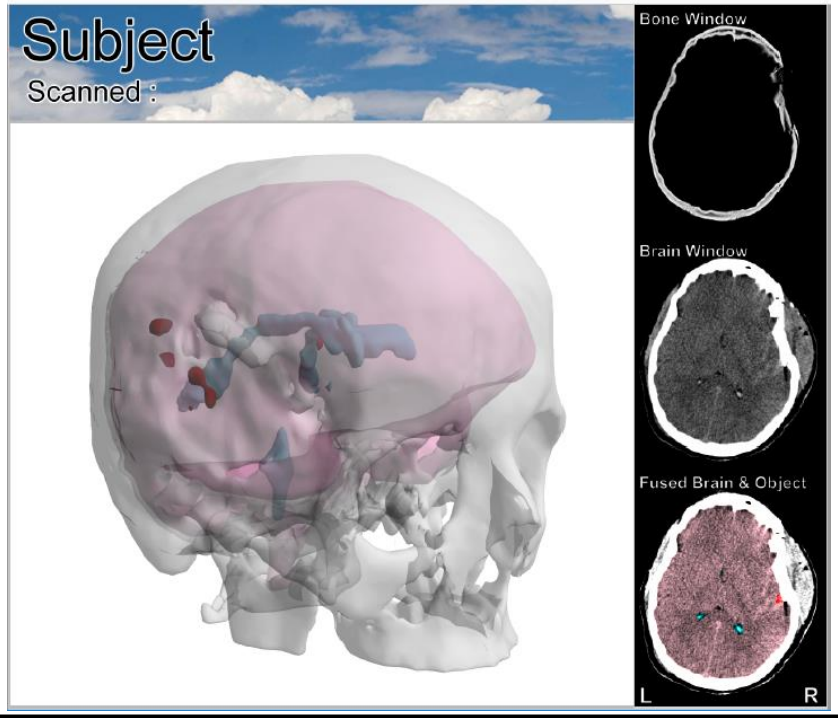
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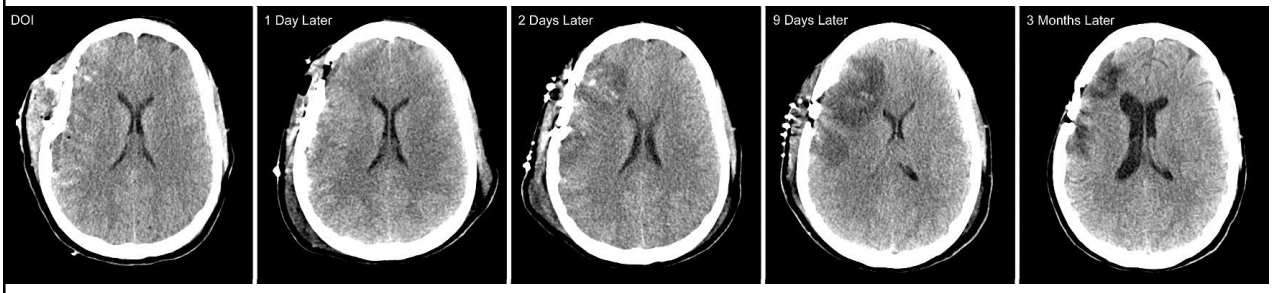
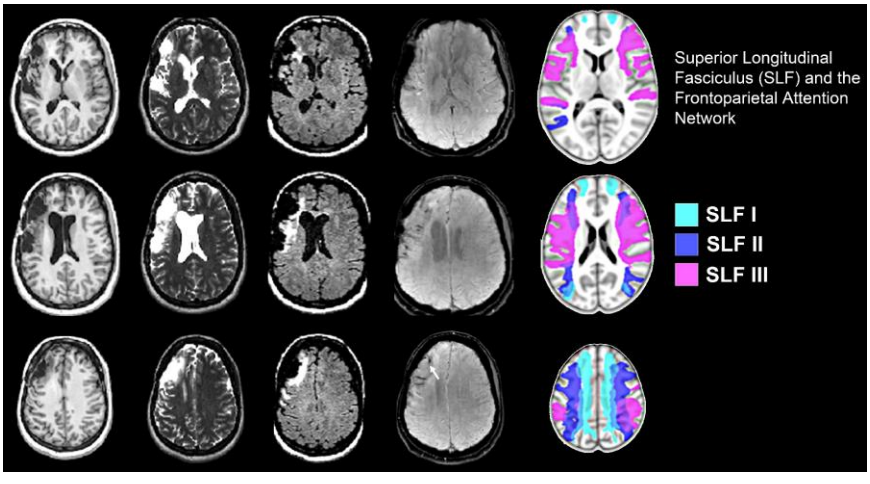
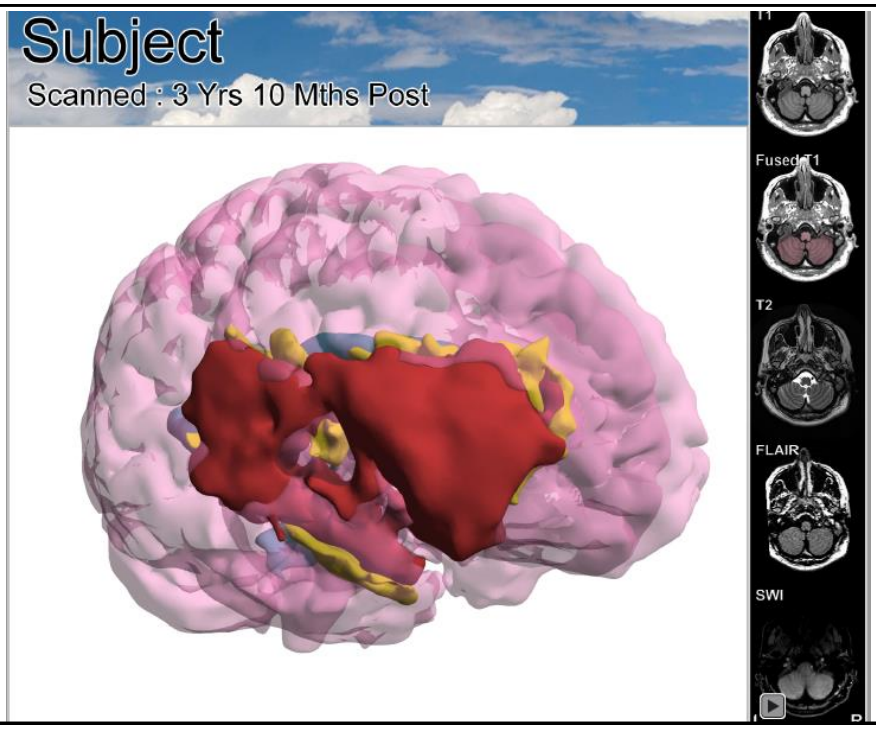
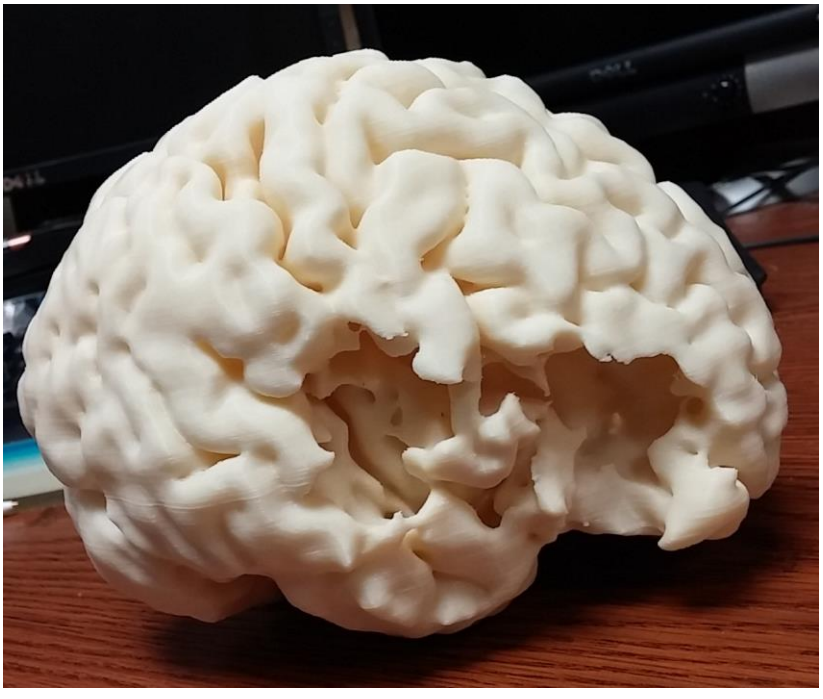
Bone Window
Brain Window
Fused Brain & Object
L
R

What Should We Measure and When?

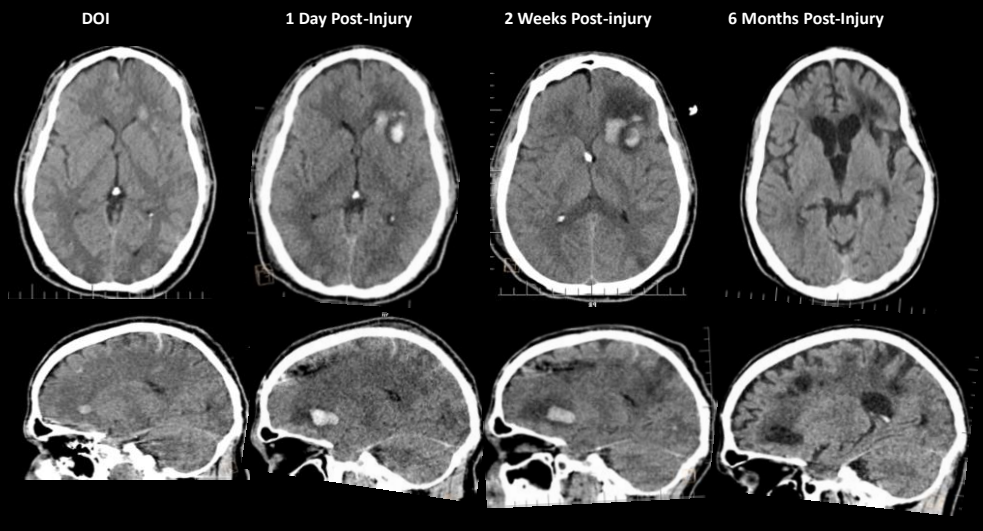


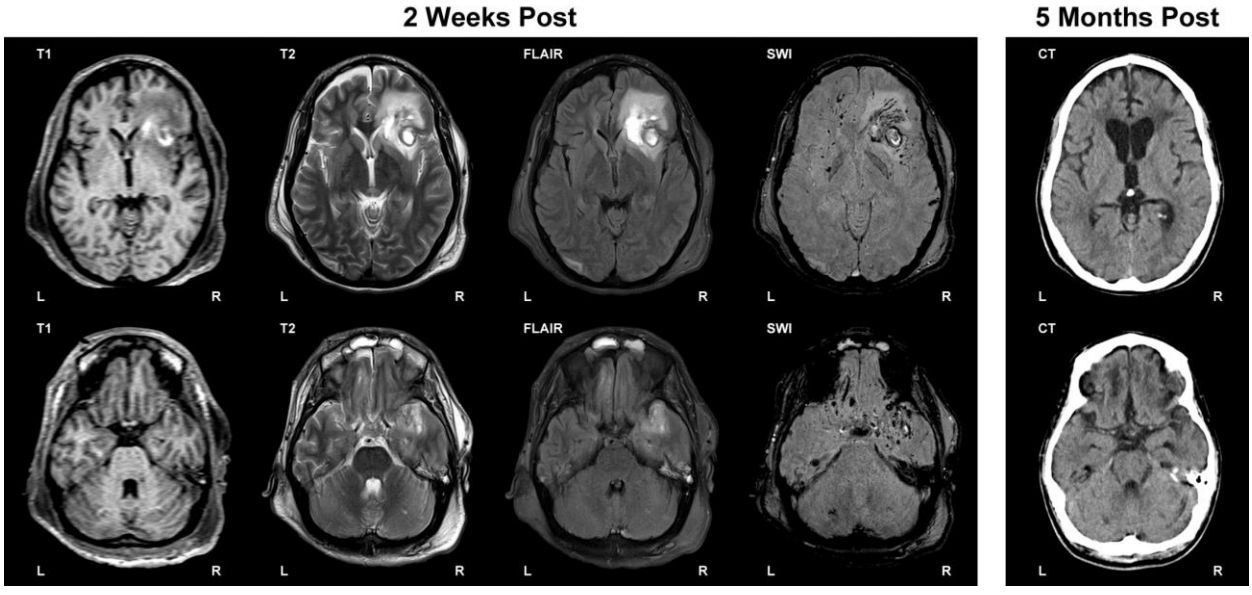


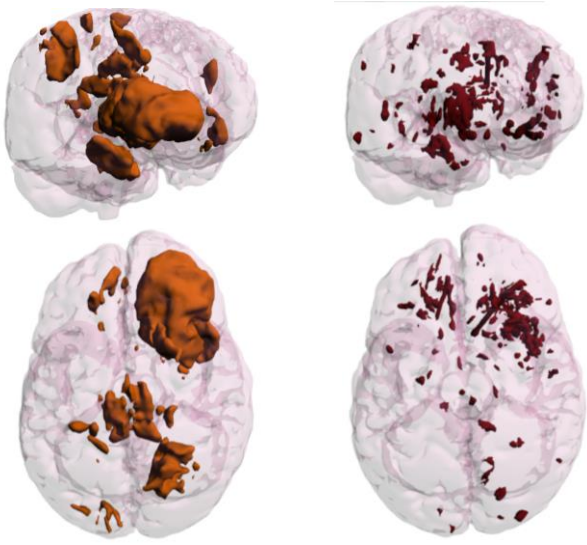

Subject
Scanned : 3 Yrs 10 Mths Post
T1
Fused T1
T2
FLAIR
SWI

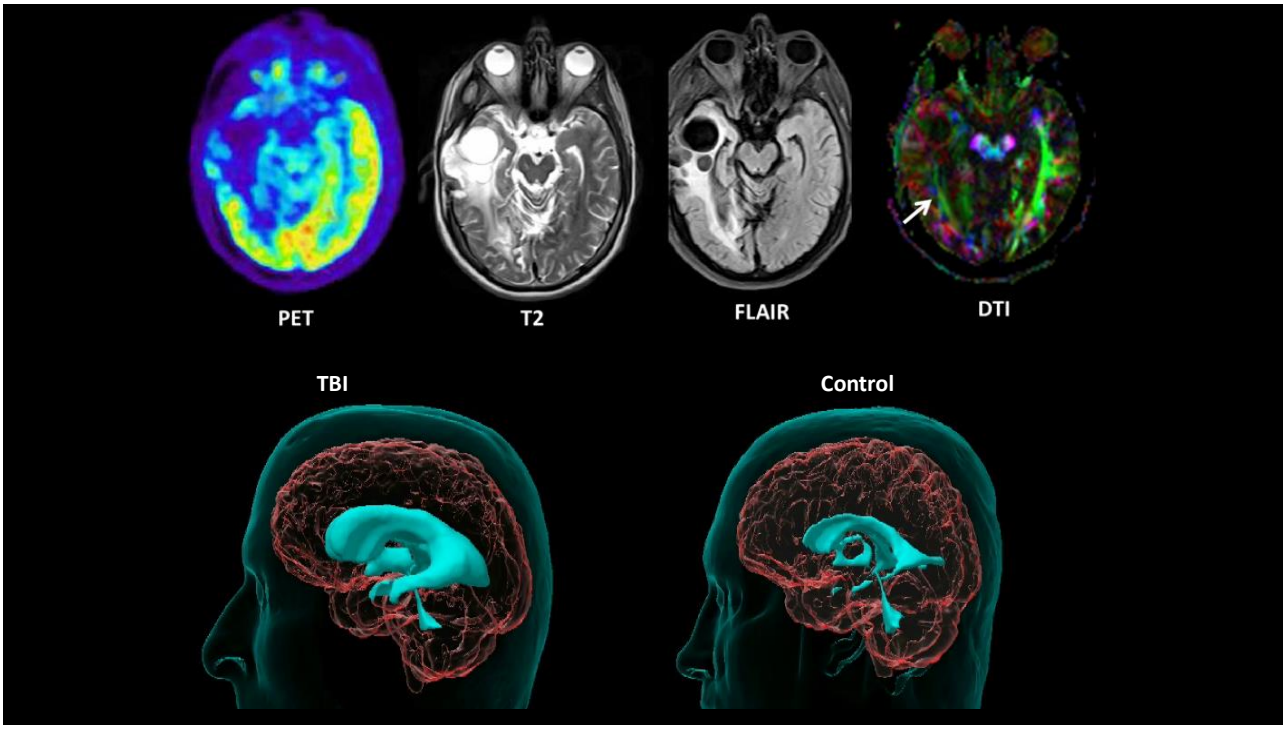


What Neuroimaging Modality Should Be Used

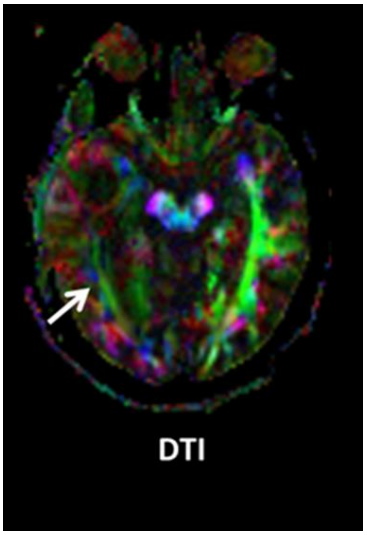


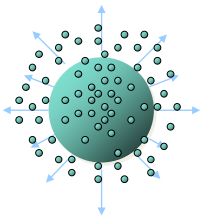





PET
T2
FLAIR
DTI
TBI
Control

Diffusion Tensor Imaging





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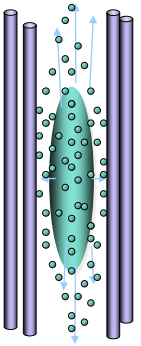
ADC = high



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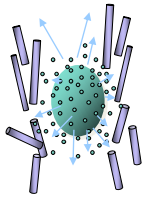

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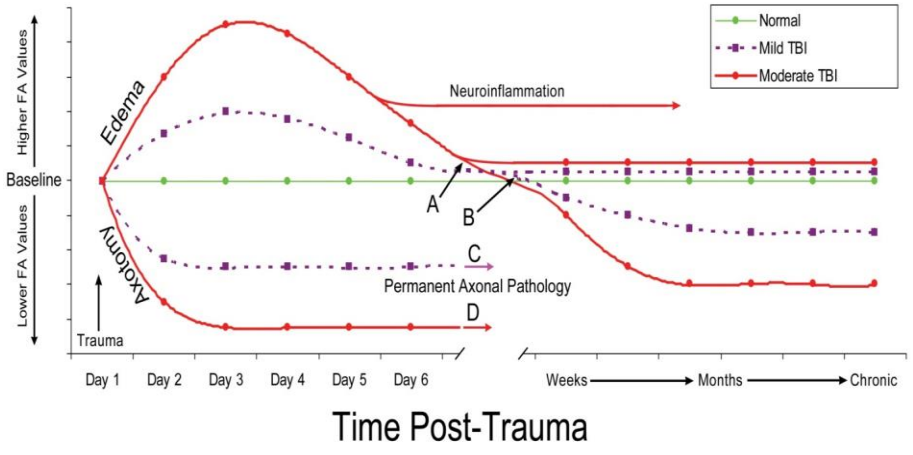
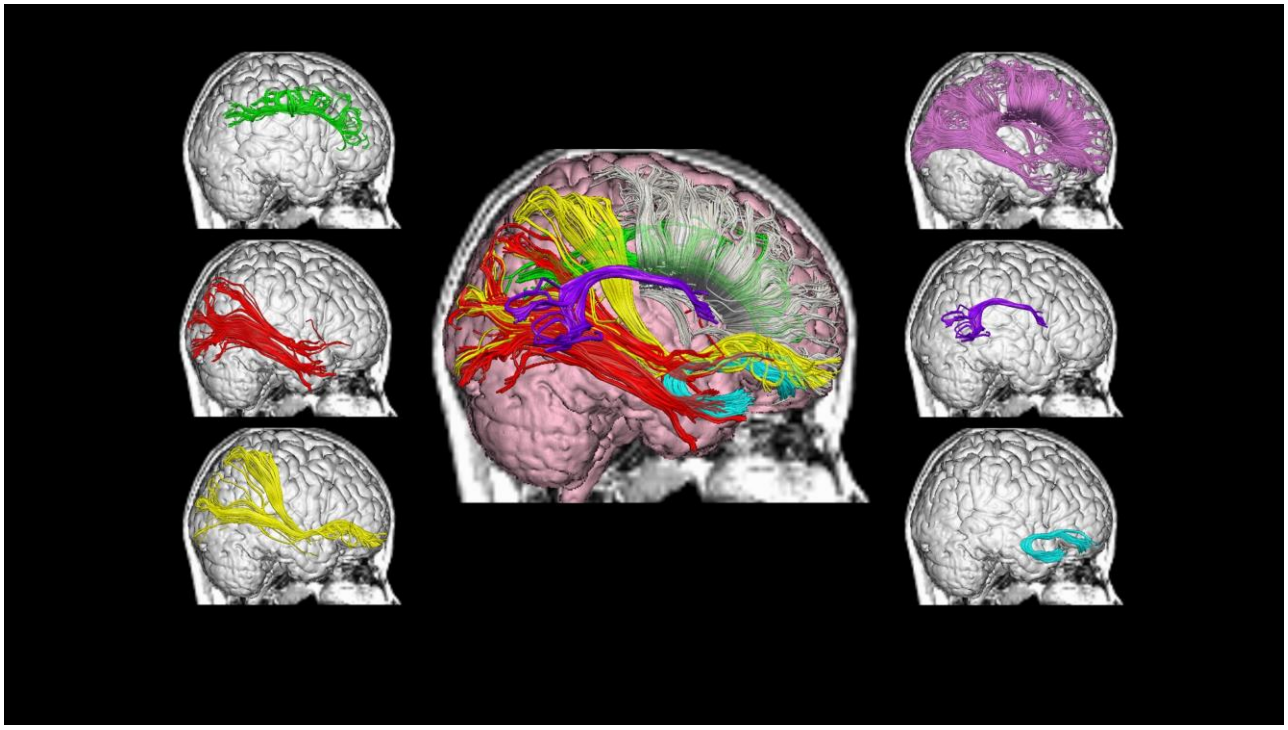
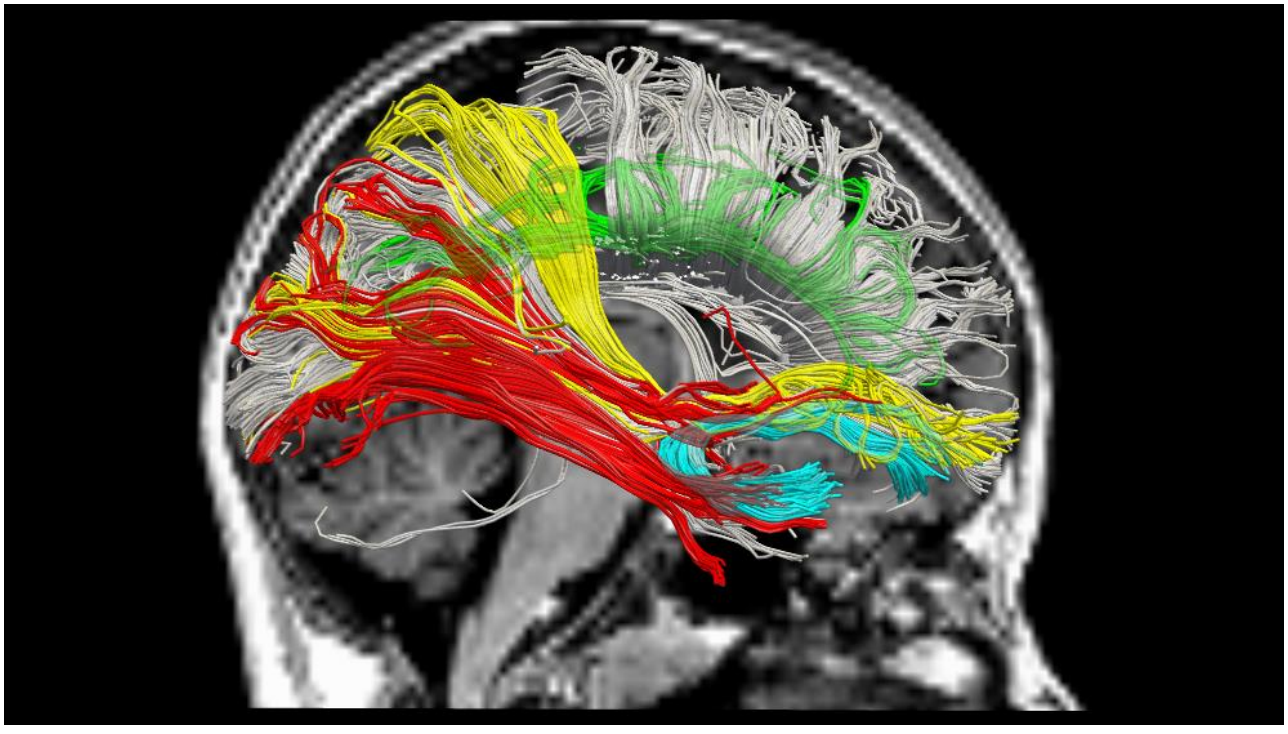
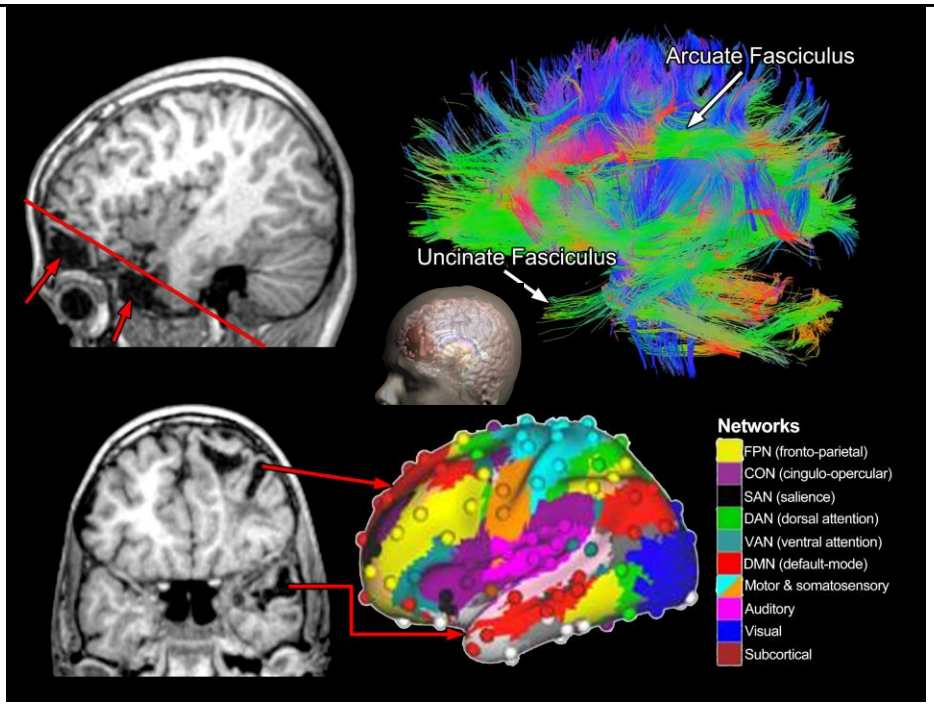


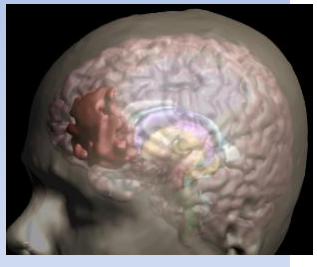
Time Post-Trauma

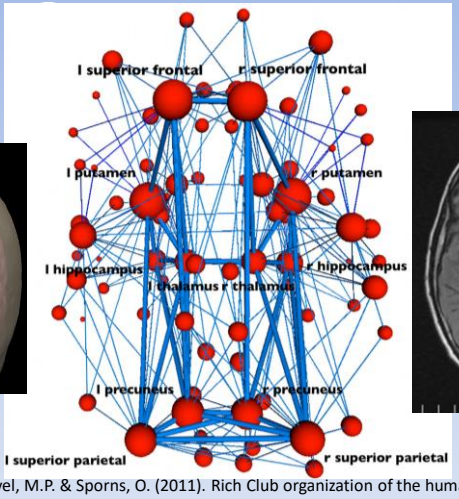


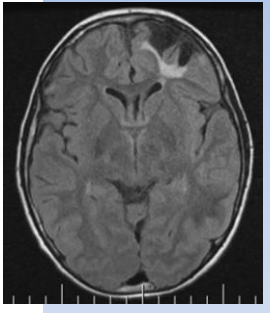




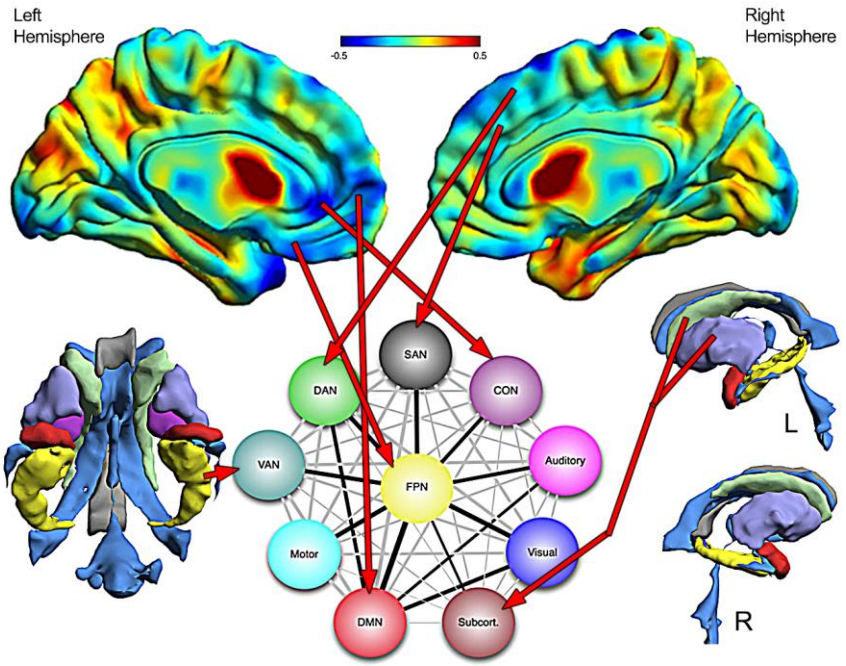
Network Damage and the lesion localization Effects of TBI







Van den Heuvel, M.P. & Sporns, O. (2011). Rich Club organization of the human connectome. ***Journal Of Neuroscience***, 31(44), 15775 – 15786.



Handbook of Clinical Neurology, Vol. 128 (3rd series)
Traumatic Brain Injury, Part II
J. Grafman and A. Salazar, Editors

Chapter 43

Traumatic brain injury and reserve

ERIN D. BIGLER[1,2]* AND YAAKOV STERN[3]

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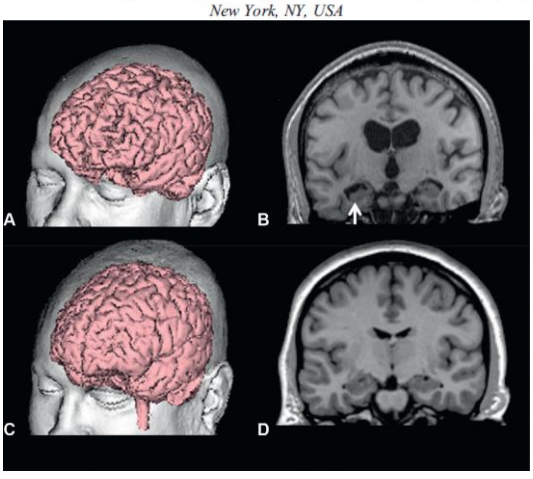
[2]*Department of Psychiatry, University of Utah, Salt Lake City, UT, USA*

[3]*Cognitive Neuroscience Division, Department of Neurology, Columbia University College of Physicians and Surgeons, New York, NY, USA*



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HUMAN NEUROSCIENCE

REVIEW ARTICLE
published: 06 August 2013
doi: 10.3389/fnhum.2013.00395

Traumatic brain injury, neuroimaging, and neurodegeneration

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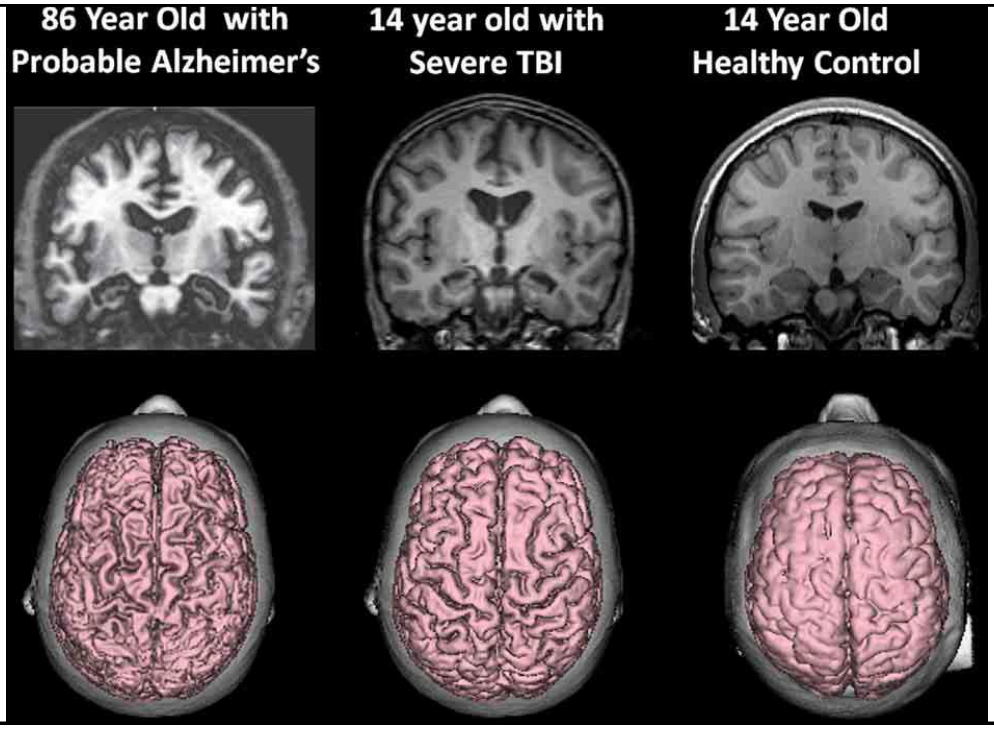
Depending on severity, traumatic brain injury (TBI) induces immediate neuropathological effects that in the mildest form may be transient but as severity increases results in neural damage and degeneration. The first phase of neural degeneration is explainable by the primary acute and secondary neuropathological effects initiated by the injury; however, neuroimaging studies demonstrate a prolonged period of pathological changes that progressively occur even during the chronic phase. This review examines how neuroimaging may be used in TBI to understand (1) the dynamic changes that occur in brain development relevant to understanding the effects of TBI and how these relate to developmental stage when the brain is injured, (2) how TBI interferes with age-typical brain development and the effects of aging thereafter, and (3) how TBI results in greater frontotemporolimbic damage, results in cerebral atrophy, and is more disruptive to white matter neural connectivity. Neuroimaging quantification in TBI demonstrates degenerative effects from brain injury over time. An adverse synergistic influence of TBI with aging may predispose the brain injured individual for the development of neuropsychiatric and neurodegenerative disorders long after surviving the brain injury.

Keywords: traumatic brain injury, TBI, brain development, neuroimaging, neurodegeneration, neuropsychiatric disorders



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Review

Cerebral microhemorrhages due to traumatic brain injury and their effects on the aging human brain

Andrei Irimia [a,*], John D. Van Horn [b], Paul M. Vespa [c]

[a] Ethel Percy Andrus Gerontology Center, USC Leonard Davis School of Gerontology, University of Southern California, Los Angeles CA, USA
[b] USC Mark & Mary Stevens Neuroimaging and Informatics Institute, Keck School of Medicine of USC, Los Angeles, CA, USA
[c] Departments of Neurosurgery and Neurology, David Geffen School of Medicine, University of California, Los Angeles, Los Angeles, CA, USA

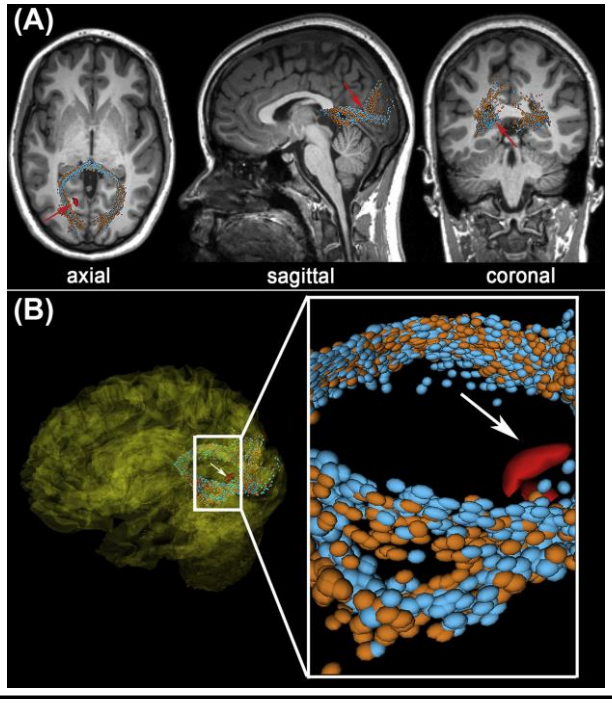
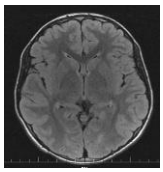


Fig. 1. Representative example of DTI streamlines passing through the vicinity of a ~4 mm3 CMB (red) in an old adult victim of mTBI. Arrows indicate a CMB in the left hemisphere, close to a streamline bundle belonging to the splenium of the corpus callosum. (A) Standard views (coronal, sagittal, and axial) of T1-weighted MRI are shown in addition to DTI glyphs associated with perilesional WM streamline bundles imaged acutely (orange) and approximately 6 months after injury (light blue). The splenium is notably asymmetric at both time points, with the asymmetry being most pronounced close to the CMB (inset). (B) Splenial streamlines ipsilateral to the CMB diverge briefly in its vicinity, and this is not found to occur contralateral to the CMB (inset). This asymmetry is also found at the time of the chronic scan. Abbreviations: DTI, diffusion tensor imaging; CMB, cerebral microbleed; mTBI, mild traumatic brain injury; MRI, magnetic resonance imaging; WM, white matter.

21st Century Neuroimaging Methods

Potential Components to Network Modeling

Structural Imaging



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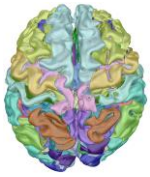
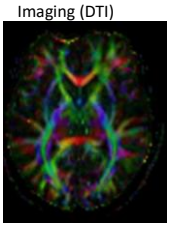
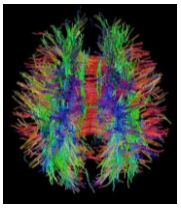


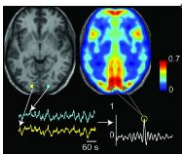
Diffusion Tensor Imaging (DTI)



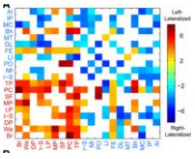
DTI Tractography



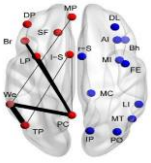
Resting State Functional MRI (rs-*fc* MRI)



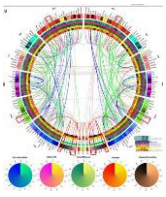
Connectivity Matrix

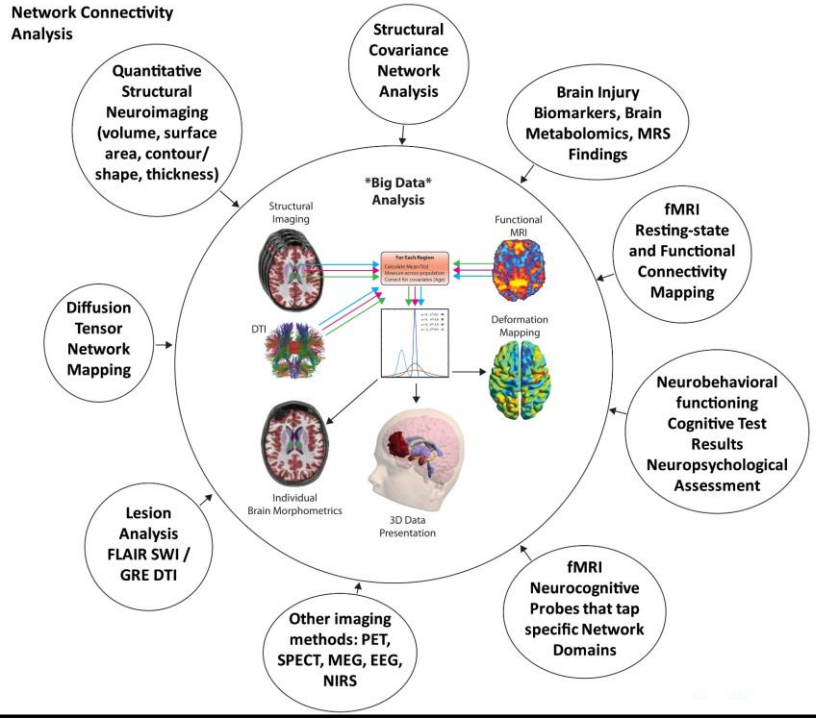


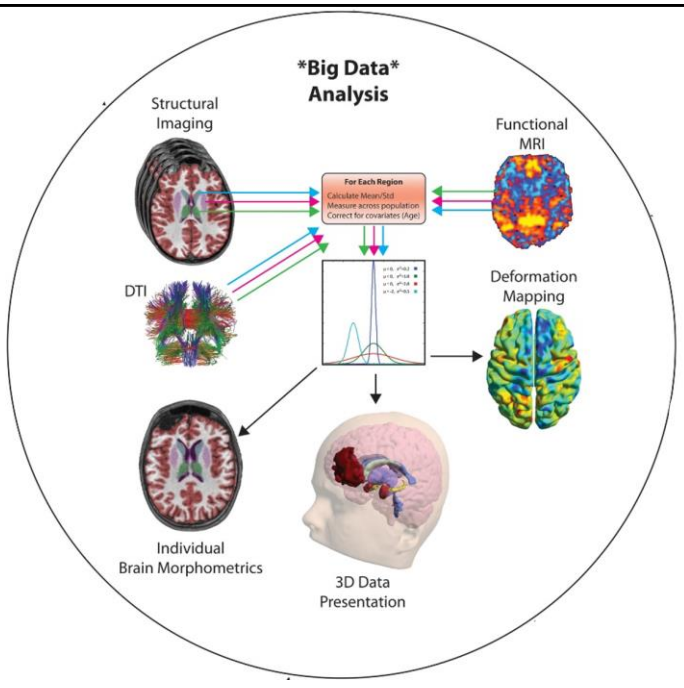
Network Plot



Network Complexity

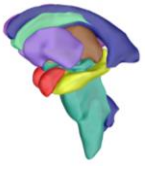






J Int Neuropsychol Soc. 2016 Feb;22(2):120-37. doi: 10.1017/S1355617715000740.

doi:10.1017/S1355617715000740

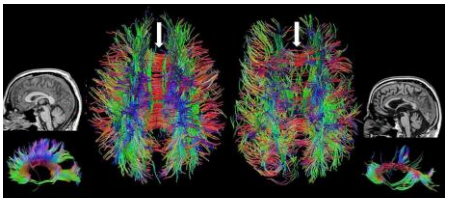


Traumatic Brain Injury as a Disorder of Brain Connectivity

Jasmeet P. Hayes,[1,2,3] Erin D. Bigler,[4,5,6] AND Mieke Verfaellie[2,7]

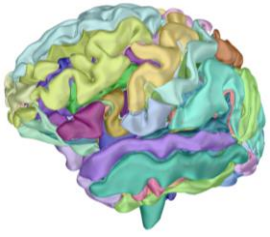
[1]National Center for PTSD, VA Boston Healthcare System, Boston, Massachusetts
[2]Department of Psychiatry, Boston University School of Medicine, Boston, Massachusetts
[3]Neuroimaging Research for Veterans Center, VA Boston Healthcare System, Boston, Massachusetts
[4]Department of Psychology, Brigham Young University, Provo, Utah
[5]Neuroscience Center, Brigham Young University, Provo, Utah
[6]Department of Psychiatry, University of Utah, Salt Lake City, Utah
[7]Memory Disorders Research Center, VA Boston Healthcare System, Boston, Massachusetts

(Received April 3, 2015; Final Revision August 4, 2015; Accepted August 11, 2015)



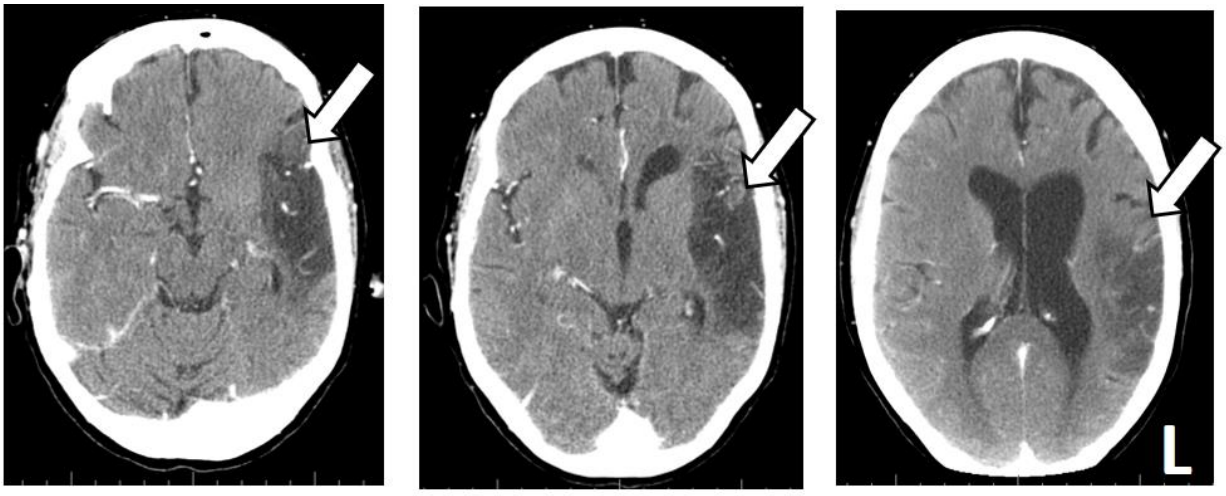
Abstract

Recent advances in neuroimaging methodologies sensitive to axonal injury have made it possible to assess in vivo the extent of traumatic brain injury (TBI) -related disruption in neural structures and their connections. The objective of this study is to review studies examining connectivity in TBI with an emphasis on structural and functional MRI methods that have proven to be valuable in uncovering neural abnormalities associated with this condition. We review studies that have examined white matter integrity in TBI of varying etiology and levels of severity, and consider how findings at different times post-injury may inform underlying mechanisms of post-injury progression and recovery. Moreover, in light of recent advances in neuroimaging methods to study the functional connectivity among brain regions that form integrated networks, we review TBI studies that use resting-state functional connectivity MRI methodology to examine neural networks disrupted by putative axonal injury. The findings suggest that TBI is associated with altered structural and functional connectivity, characterized by decreased integrity of white matter pathways and imbalance and inefficiency of functional networks. These structural and functional alterations are often associated with neurocognitive dysfunction and poor functional outcomes. TBI has a negative impact on distributed brain networks that lead to behavioral disturbance. (*JINS*, 2015, *21*, 1–18)



Keywords: Diffusion tensor imaging, white matter, fMRI, neural networks, corpus callosum, diffuse axonal injury

Why Neuroimaging is Critical in understanding SVT/PVT findings



Bigler ED. Structural Image Analysis of the Brain in Neuropsychology Using Magnetic Resonance Imaging (MRI) Techniques. *Neuropsychology Review*. 2015 Sep;25(3):224-49. doi: 10.1007/s11065-015-9290-0

society
communities
relationships
behaviors
thoughts
feelings
experience
neural systems
tracts
nuclei
networks
neurons
molecules
proteins
genes

"Every Behavior Has an Anatomy" –
Norman Geschwind, M.D.


TEDx JacksonHole
x = independently organized TED event
hhttps://www.youtube.com/watch?v=uh8cCA2kxkgps
TEDx
0:07 / 15:24


IT'S MUCH MORE COMPLICATED IN THERE THAN WE THOUGHT
BRAIN BOX