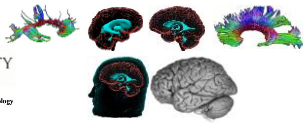
UPDATED 9.1.18

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

BECOMING AGENTS OF CHANGE
38TH ANNUAL CONFERENCE
OCTOBER 17-20, 2018
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.

1996

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

Funding/Acknowledgements

MRI in Autism

Erin D. Bigler, Ph.D., Andrew L. Alexander, Ph.D.,
Joe 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

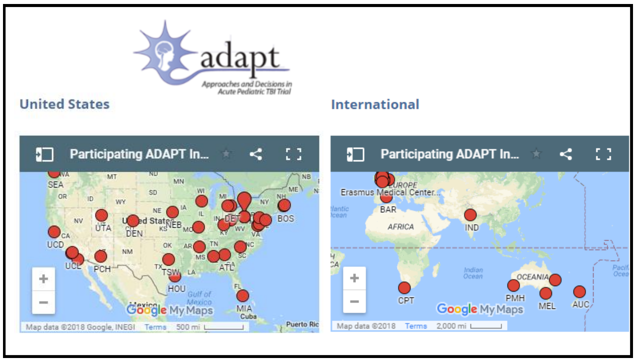
WISCONSIN
UNIVERSITY OF WISCONSIN-MADISON

MRI Markers of Outcome After Severe Pediatric TBI

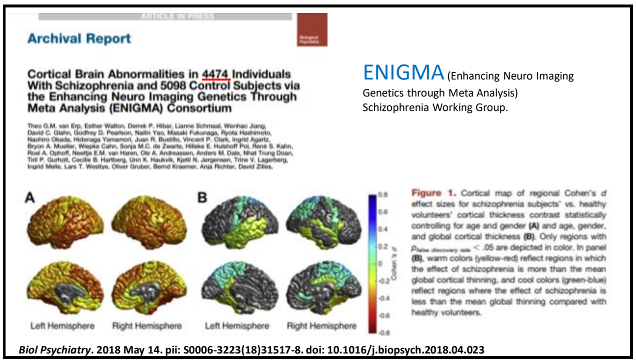
Children 8 to 17 years of age with acute and follow-up MRI at one year of greater post-injury

Comprehensive Neuropsychological Follow-Up

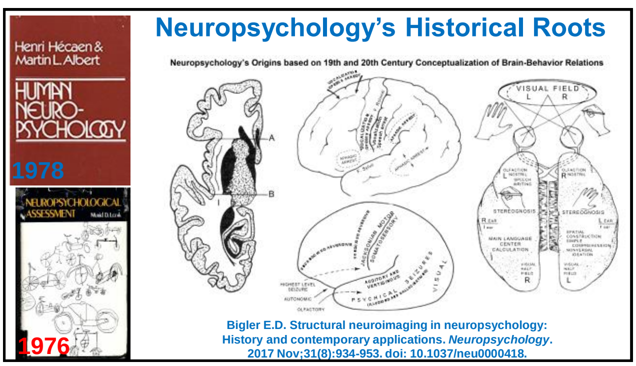
Approaches and Decisions in Acute Pediatric TBI Trial (ADAPT) is an international research study designed to evaluate the impact of interventions on the outcomes of children with severe traumatic brain injury.

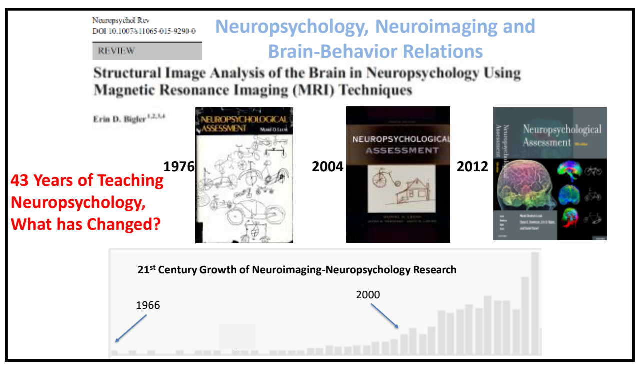

adapt
Approaches and Decisions in Acute Pediatric TBI Trial
United States
International
Participating ADAPT In...
Participating ADAPT In...
Erasmus Medical Center
BOS
Google My Maps
Google My Maps


Current Enrollment: 1,677
CENC
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
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
e·nig·ma
a person or thing that is mysterious, puzzling, or difficult to understand.


Archival Report
Cortical Brain Abnormalities in 4474 Individuals With Schizophrenia and 5098 Control Subjects via the Enhancing Neuro Imaging Genetics Through Meta Analysis (ENIGMA) Consortium
ENIGMA (Enhancing Neuro Imaging
Genetics through Meta Analysis)
Schizophrenia Working Group.
Left Hemisphere
Right Hemisphere
Left Hemisphere
Right Hemisphere
Biol Psychiatry. 2018 May 14. pii: S0006-3223(18)31517-8. doi: 10.1016/j.biopsych.2018.04.023


Science
FRONTIERS IN COMPUTATION
Neurotechnology to address big questions
Profiling of single neurons in tissue allows structure and function linkage in brain circuits
Profiling brain tissue


Neuropsychology's Historical Roots
Neuropsychology's Origins based on 19th and 20th Century Conceptualization of Brain-Behavior Relations
Henri Hécaen & Martin L. Albert
HUMAN NEUROPSYCHOLOGY
1978
NEUROPSYCHOLOGICAL ASSESSMENT
1976
Bigler E.D. Structural neuroimaging in neuropsychology: History and contemporary applications. Neuropsychology. 2017 Nov;31(8):934-953. doi: 10.1037/neu0000418.


Neuropsychol Rev
REVIEW
Neuropsychology, Neuroimaging and Brain-Behavior Relations
Structural Image Analysis of the Brain in Neuropsychology Using Magnetic Resonance Imaging (MRI) Techniques
Erin D. Bigler
1976
2004
2012
43 Years of Teaching Neuropsychology, What has Changed?
NEUROPSYCHOLOGICAL ASSESSMENT
Neuropsychological Assessment
21st Century Growth of Neuroimaging-Neuropsychology Research
1966
2000

Neuropsychologia, Volume 8, 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]

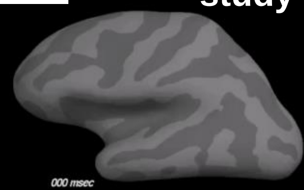
Original article
Scand J Work Environ Health 1984;10(1):33-34

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."

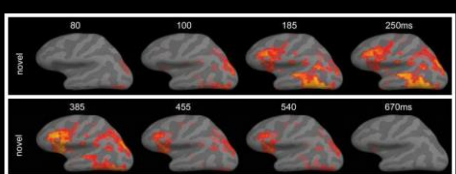
Neurophysiological evidence of these considerations has been found, e.g., in cerebral blood flow studies, and the newest histological findings concerning the diversity of human brains give further support.

Why we need to study networks

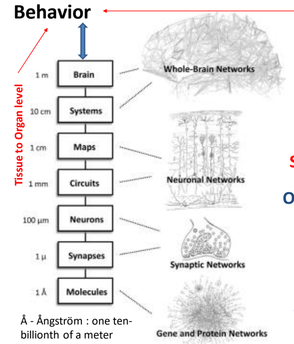


Eric Halgren, University of Utah and Mass General Hospital

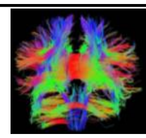
Bigler 2005



Behavior



Å - Ångström : one ten-billionth of a meter

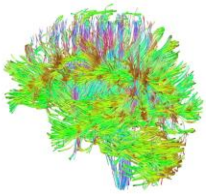


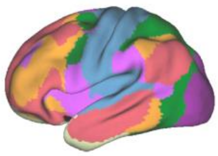
The Challenge of Scale and Complexity

One Cubic Millimeter =

80,000 Neurons
200,000 Glial Cells

4.5 million synapses





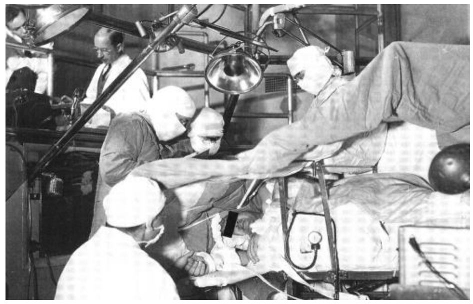
- Purple (Visual)
- Blue (Somatomotor)
- Green (Dorsal Attention)
- Violet (Ventral Attention)
- Cream (Limbic)
- Orange (Frontoparietal)
- Red (Default)

Virtual Dissection of Erin Bigler's Brain

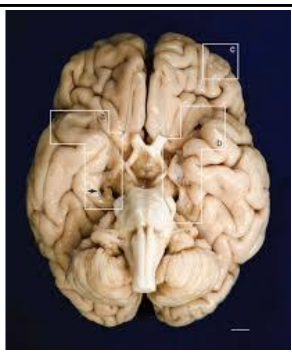
⇩

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	
Verbal IQ	135+	Information (common knowledge)	14
Performance IQ	110	Comprehension (Why? How? What for?)	15
Full Scale IQ	126	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

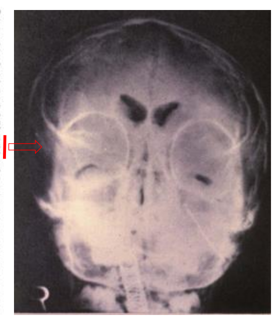
Subtests	Form I*	Form II
Information	1/poss. 6	1/poss. 6
Orientation	4/poss. 5	2/poss. 5
Mental Control (Saying alphabet, counting backwards, and counting by 4s)	no errors; time: 6", 3", 10"; av. score—9	no errors; time: 4", 6", 15"; av. score—9
Memory for connected passages	av. score—6/poss. 46	av. 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 viruses 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.

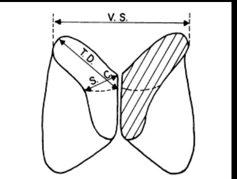


FIG. 2. *Diagram of measures used. V.S. = ventricular span. T.D. = transverse diameter. S.C. = septal-caudate line. Area measured by planimeter is lined.*

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.

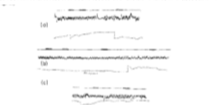
(2) An inability to carry out "symbolic" instructions.

(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

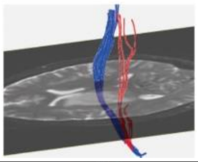


Game Changer

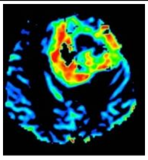
The first EMI scanner designed by Hounsfield in 1971 was disassembled in the late 1970s and transferred from Atkinson Morley's Hospital to the Science Museum in London

Sir Godfrey Hounsfield

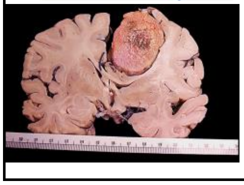
Introduced in the United States In 1973 at the Mayo Clinic

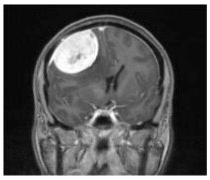


Tractography



Blood Flow



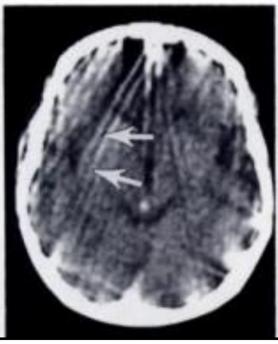


Morphometry

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



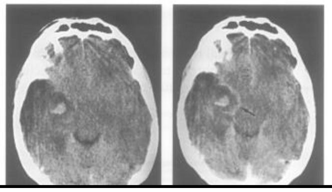
Journal of Neurology, Neurosurgery, and Psychiatry 1994;57:1115–1117 1115

SHORT REPORT

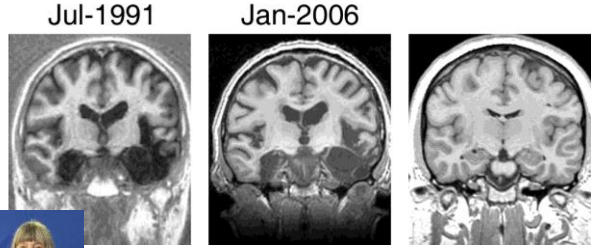
Focal necrotising herpes simplex encephalitis: a report of two cases with good clinical and neuropsychological outcomes

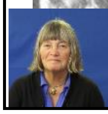
C E Counsell, R Taylor, I R Whittle

(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).



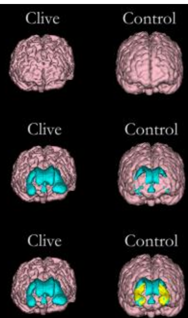
Clive — Control

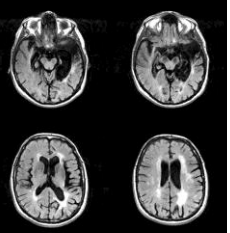




Wilson BA, Baddeley AD, Kapur N. J Clin Exp Neuropsychol. 1995 Oct;17(5):668-81. Dense amnesia in a professional musician following herpes simplex virus encephalitis.

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

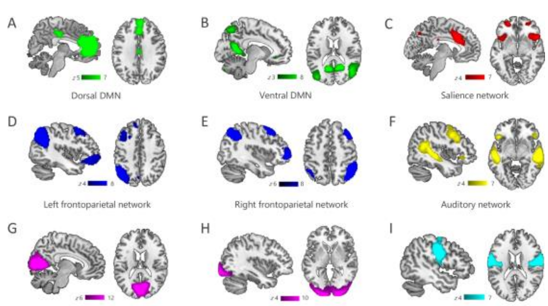
Josephine Heine,[1] Harald Prüss,[1,2] Ute A Kopp,[1] Florian Wegner,[3] Florian Then Bergh,[4] Thomas Münte,[5] Klaus-Peter Wandinger,[5,6] Friedemann Paul,[1,7,8] Thorsten Bartsch,[9] Carsten Finke[1,8,10]

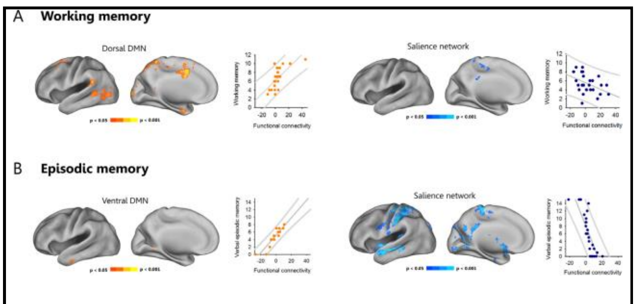
Neuropsychological assessment

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?

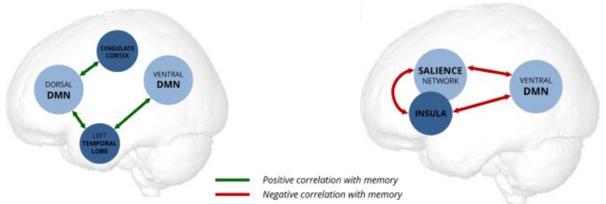




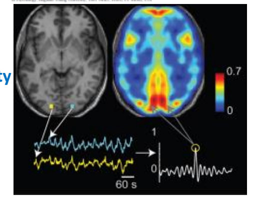
Correlations with memory performance. Alterations in functional connectivity significantly correlated with memory performance in patients with anti-LGI1 encephalitis ($p<0.05$; corrected for multiple comparisons). (A) Better working memory performance was associated with higher connectivity between the 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 D

Structural MRI analyses

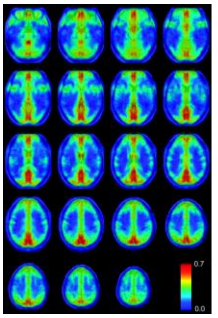
During the acute phase, hippocampal T2/FLAIR hyperintensities on routine MRI were seen in the majority of patients (21/27 patients (77.7%); unilateral in 8/27 patients (29.6%); bilateral in 13/27 patients (48.1%)), while in 6 patients (22.3%) no hippocampal abnormalities were present (table 1). At the 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 mm³ vs 1.191×106±0.29×106 mm³, p=0.697) *and total grey matter volume* (0.567×106±0.01×106 mm³ vs 0.591×106±0.01×106 mm³, 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.



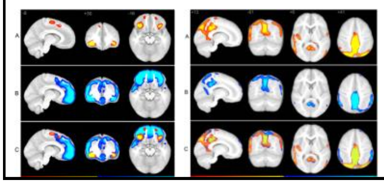
Interhemispheric correlation averaged over 39 control subjects. Scale bar shows Fisher-transformed correlation (Z-score).

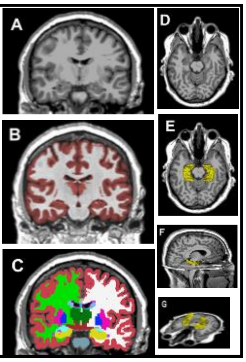
scMRI Reveals Large-Scale Brain Network Abnormalities in Autism

Brandon A. Zielinski, Jeffrey S. Anderson, Alyson L. Froehlich, Molly B. D. Prigge, Jared A. Nielsen, Jason R. Cooperrider, Annahir N. Cariello, P. Thomas Fletcher, Andrew L. Alexander, Nicholas Lange, Erin D. Bigler, Janet E. Lainhart

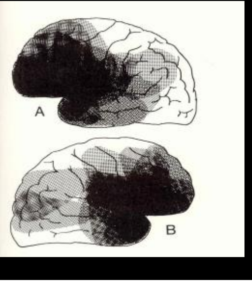
Seed ROIs were selected within right frontoinsular cortex and right posterior cingulate cortex [63]. These regions anchor the salience and default mode networks, respectively.

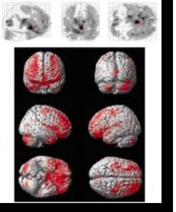
Salience Network — Default Mode Network





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.





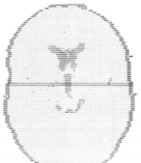
Bigler. 2005

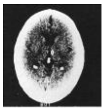
Alcohol, Vol. 1, pp. 133–140, 1984. © Ankho International Inc. Printed in the U.S.A.

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

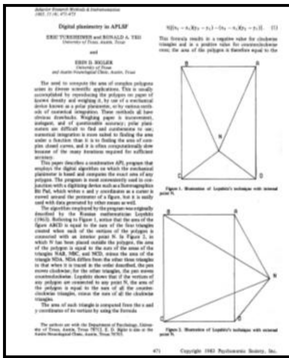
CAROL A. GEBHARDT,*[a] MARGARET A. NAESER† AND NELSON BUTTERS‡

*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.



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.

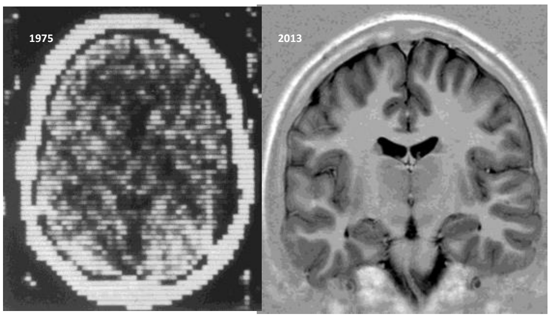
Fig *Computer drawn representation of slice from CT scan of a brain with significant cortical atrophy.*

1984

Nuclear Magnetic Resonance Imaging/Magnetic Resonance Imaging

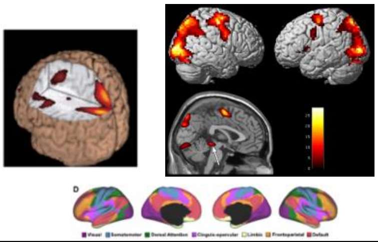
Mallard, J.R. (1984). **The Wellcome Foundation lecture, 1984. Nuclear magnetic resonance imaging in medicine: medical and biological applications and problems,** *Proc R Soc Lond B Biol Sci.* 226(1245), 391 – 4

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 Neuropsychologic 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.].

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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

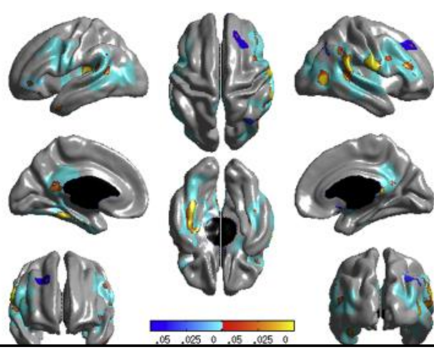


Table 2 – Cognitive test score correlations with N in parentheses.

	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)

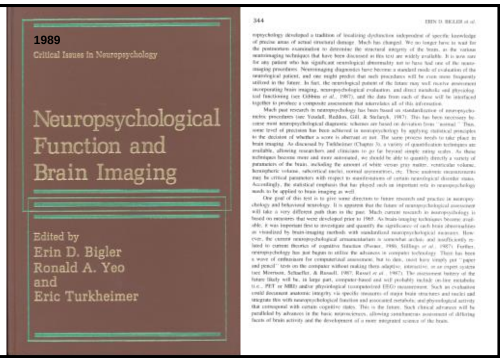
TMT-B = Trail Making Test Part B; *$p < .001$; **$p < .005$.

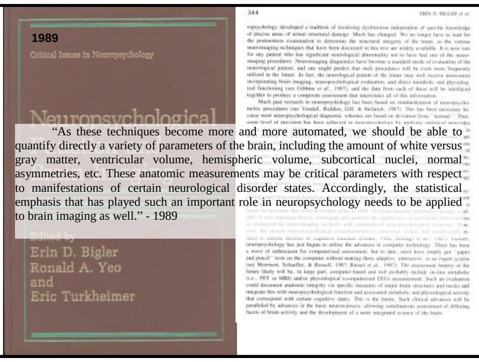
Table 3 – The results obtained from linear regression models examining the relationship between brain volumetry measures and TMT-B completion time with and without simple and complex processing speed.

	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





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

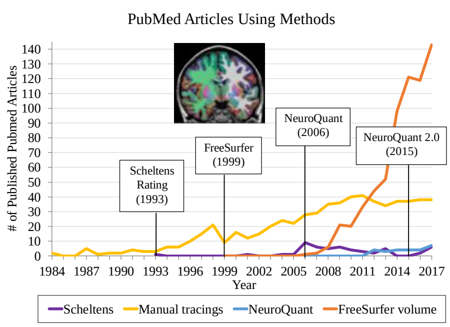
Automated Image Analysis and Supercomputing Game Changers!!

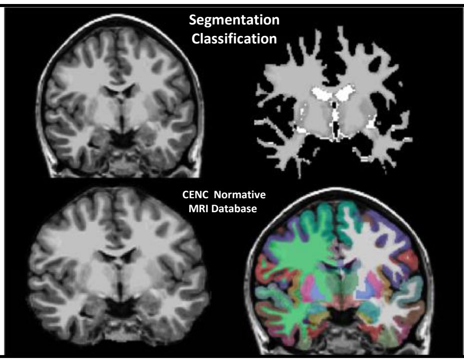
FreeSurfer* as an automated platform introduced in 2003 and BYU's Super Computer comes online in 2006

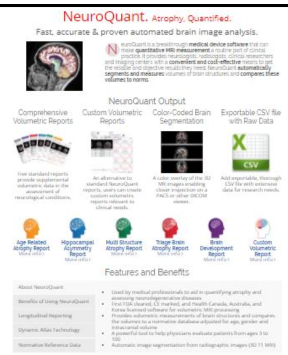
2008 Use to Date: 320 scans used 21,370 hours or 890 days or 2.45 years of processor "time" based on standard single computer time to calculate the FreeSurfer analysis.

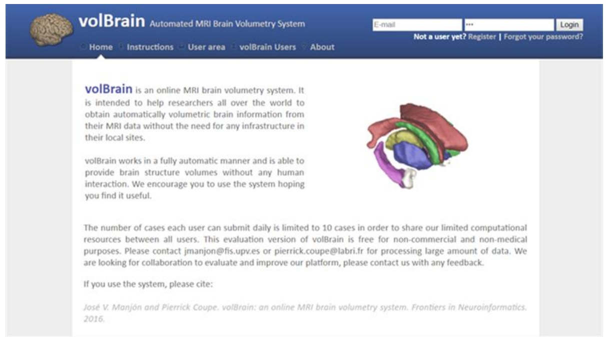
The supercomputer did it in roughly a week's time!

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

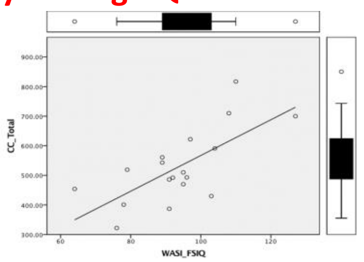




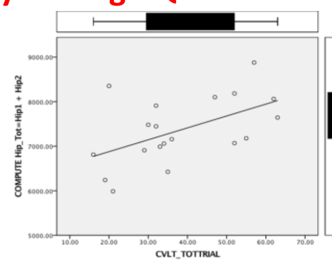




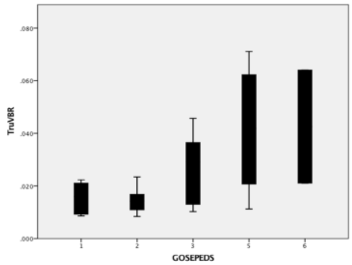
Why is image Quantification Important?



Why is image Quantification Important?



Why is image Quantification Important?



adapt

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

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

Check for updates

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

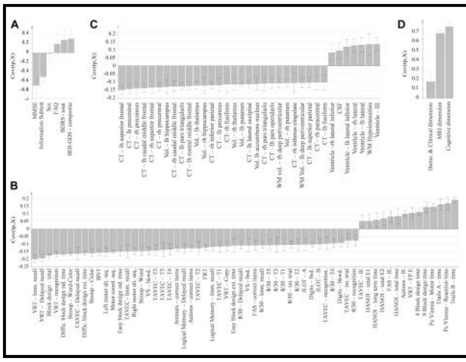
Why is image Quantification Important?

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-value ANOVA/ Mann-Whitney
Age, y	460	58.4 (11.4)	35–84	294	54.8 (10.6)	35–79	166	66.2 (10.9)	40–84	<0.001
Sex, female	460	251	54.6%	294	158	53.7%	166	93	56%	0.637
WAIS-III information	462	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?

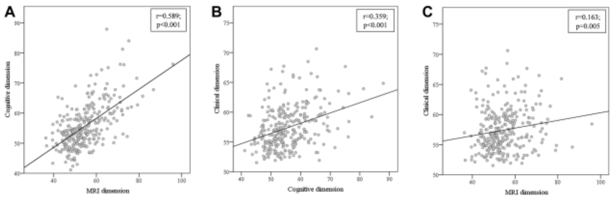
Table 3. Potential effect of sex and the WAIS-III Information subtest on the cognitive and MRI OPLS models

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.

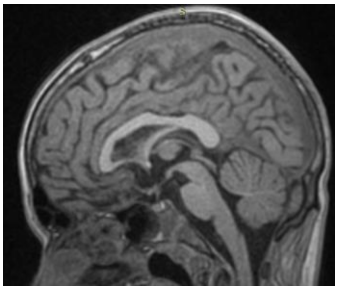
Why is image Quantification Important?



What You Can Do Now!!

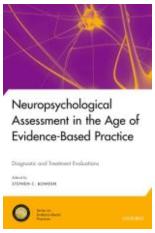
A Semiquantitative Approach

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)

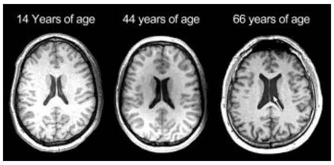
National Academy of Neuropsychology: Series on Evidence-Based Practices



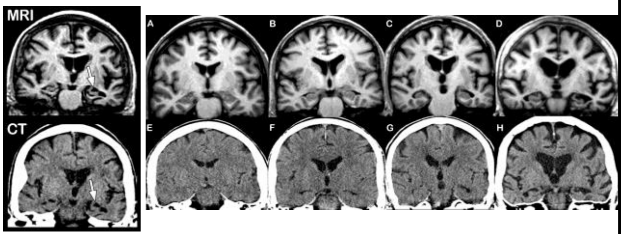
2017

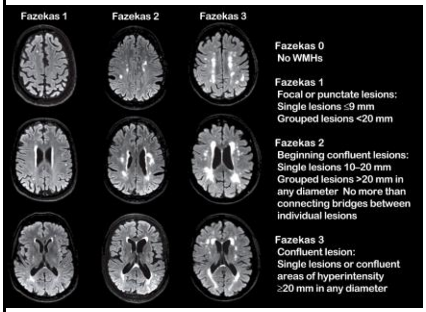
Chapter 8: ***Evidence-Based Integration of Clinical Neuroimaging Findings in Neuropsychology***.
Erin D. Bigler

Clinical Ratings

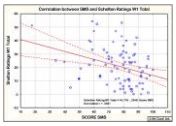


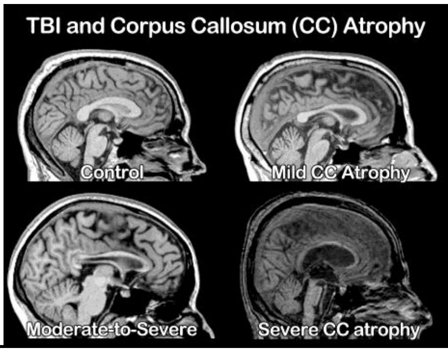
Bigler 2017: Evidence-Based Integration of Clinical Neuroimaging Findings in Neuropsychology





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

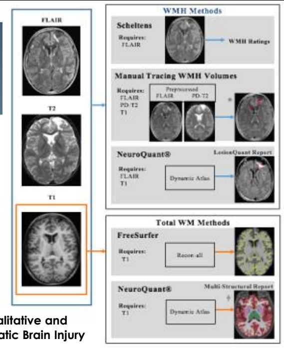




Bigler 2017: *Evidence-Based Integration of Clinical Neuroimaging Findings in Neuropsychology*

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

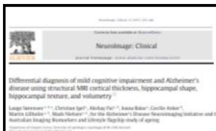
Jean-Michel Saury[a] and Ingrid Emanuelson[b]

[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

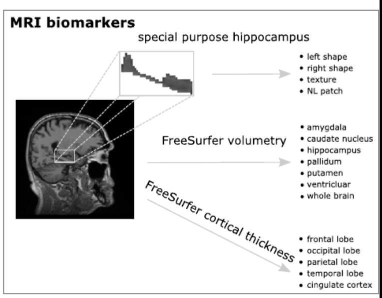
ABSTRACT

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.

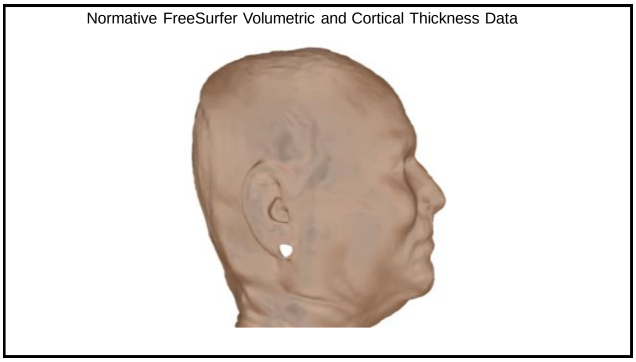
KEYWORDS
Diagnosis; RAVLT; tests

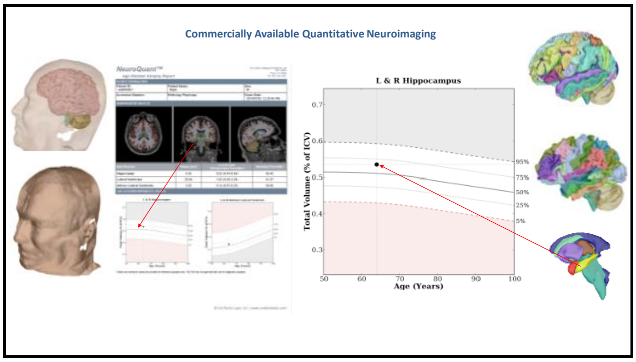


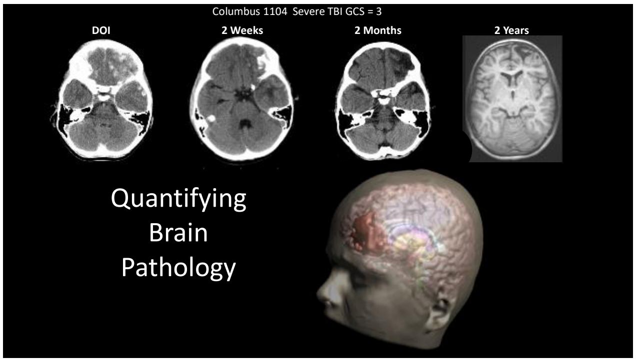
The hippocampus is affected early and severely in the AD pathological process (Braak and Braak, 1991; West et al., 1994), and the volume of this brain structure is the most widely applied (Jack et al., 2011b) and only qualified (Hill et al., 2014) MRI imaging biomarker in AD (p.480)."

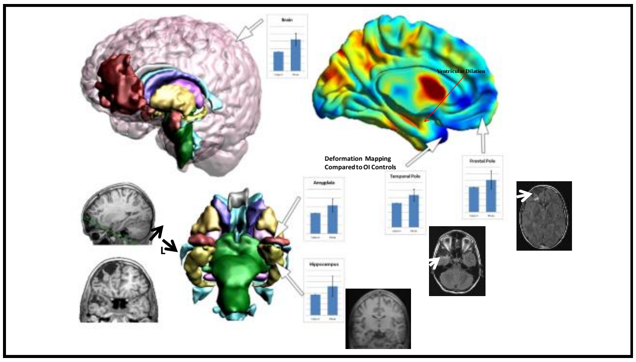


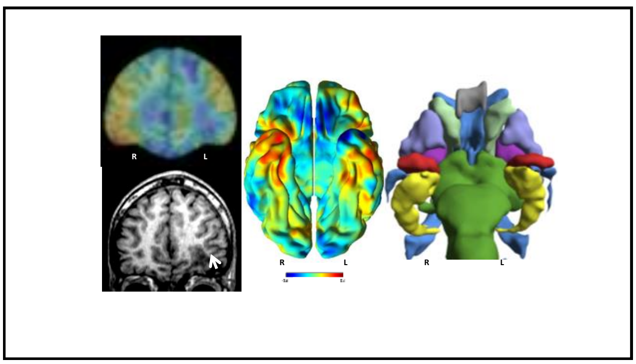
A Truly Quantitative Approach

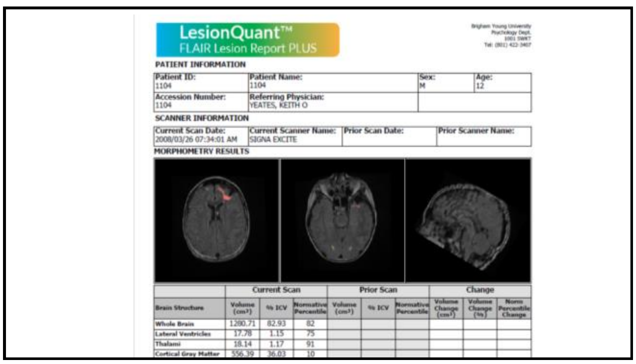











LesionQuant™
FLAIR Lesion Report PLUS

PATIENT INFORMATION

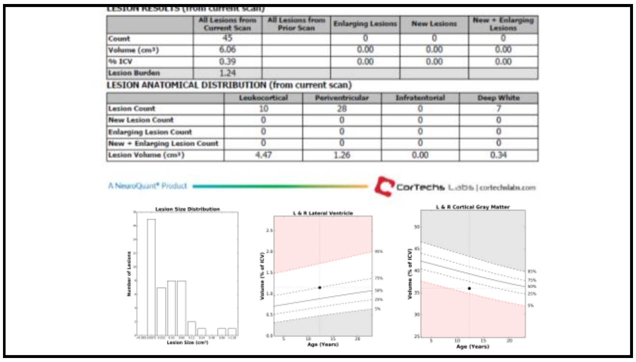
Patient ID: 1104	Patient Name: 1104	Sex: M	Age: 12
Accession Number: 1104	Referring Physician: YEATES, KEITH O		

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 (cm³)	% ICV	Normative Percentile	Volume (cm³)	% ICV	Normative Percentile	Volume Change (cm³)	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						

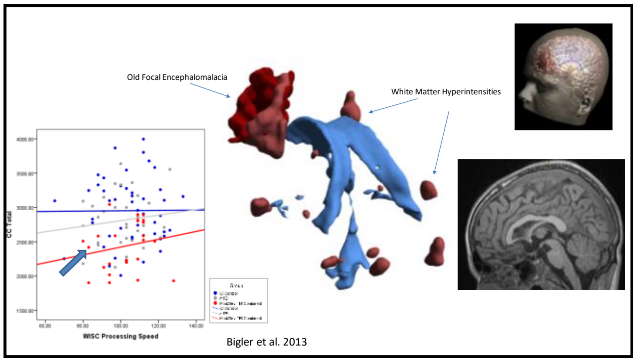


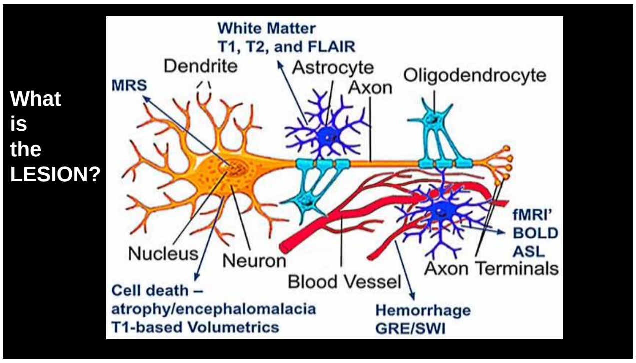
LESION RESULTS (from current scan)

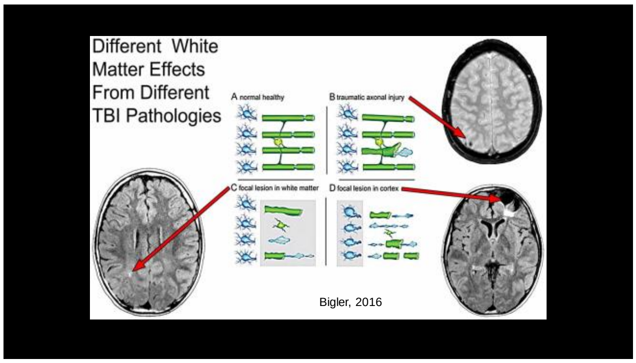
	All Lesions from Current Scan	All Lesions from Prior Scan	Enlarging Lesions	New Lesions	New + Enlarging Lesions
Count	45		0	0	0
Volume (cm³)	6.06		0.00	0.00	0.00
% ICV	0.39		0.00	0.00	0.00
Lesion Burden	1.24				

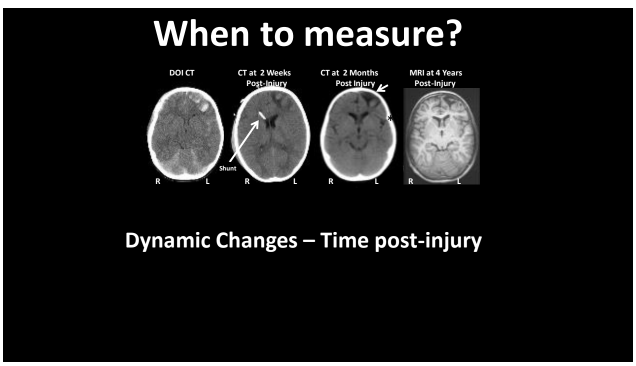
LESION ANATOMICAL DISTRIBUTION (from current scan)

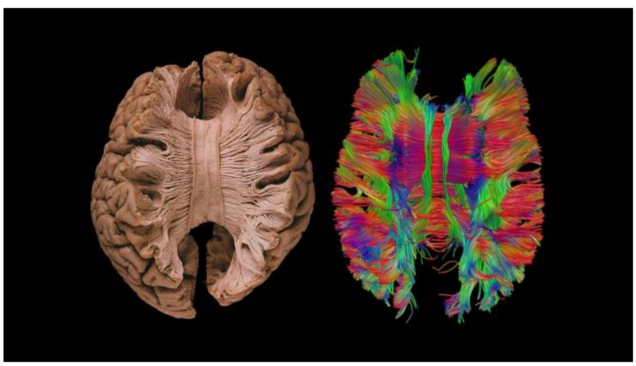
	Leukocortical	Periventricular	Infratentorial	Deep White
Lesion Count	10	28	0	7
New Lesion Count	0	0	0	0
Enlarging Lesion Count	0	0	0	0
New + Enlarging Lesion Count	0	0	0	0
Lesion Volume (cm³)	4.47	1.26	0.00	0.34

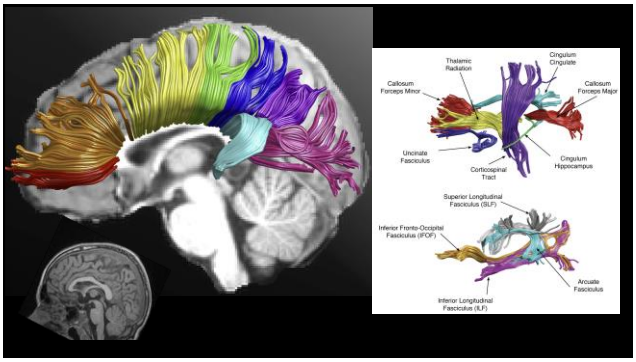


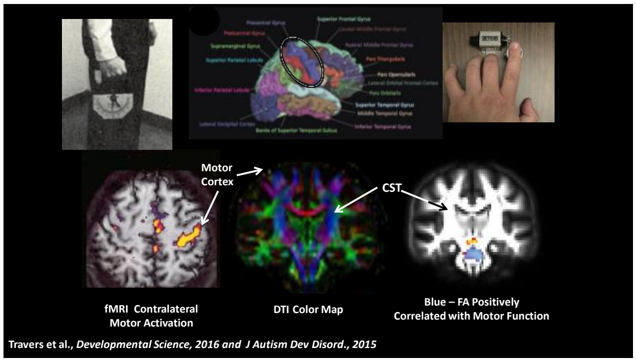


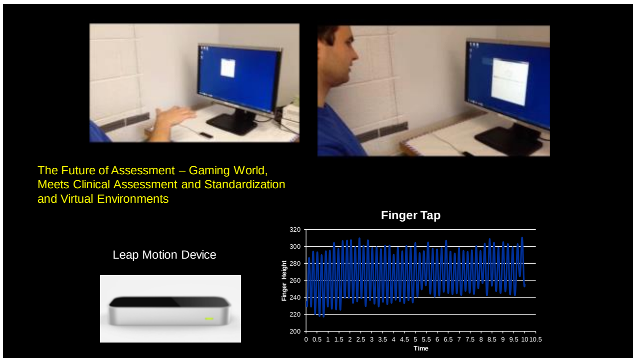


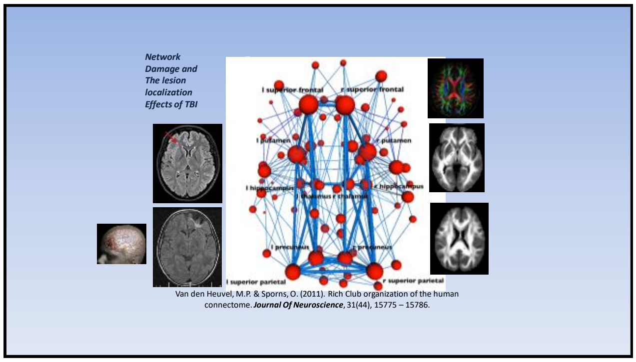












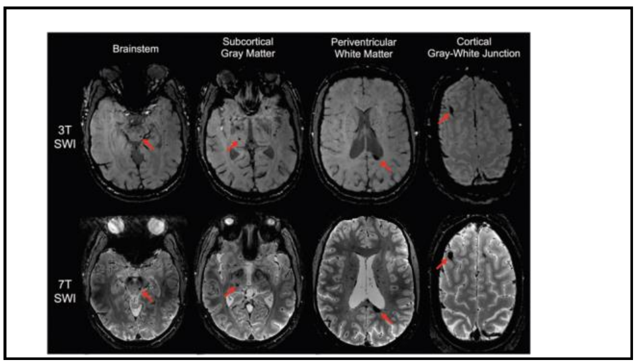
Brain Connectivity, VOL. 8, NO. 5 | normal

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

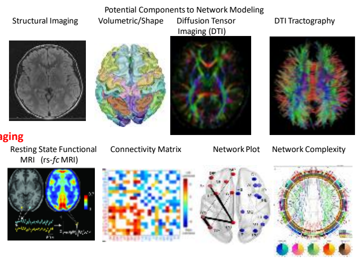
Seul Lee, Jonathan R. Polimeni, Collin M. Price, Brian L. Edlow, and Jennifer A. McNab

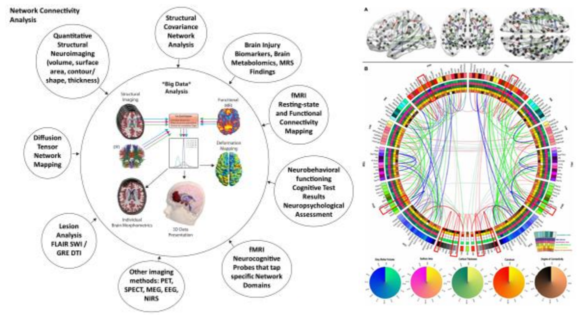
Published Online: 1 Jun 2018 | https://doi.org/10.1089/brain.2017.0499

Ever Changing, Improved Technology



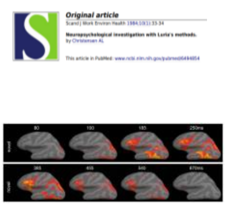
21st Century Neuroimaging Methods





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

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



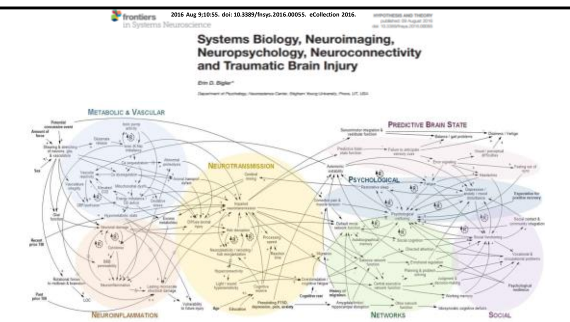
"Functional Systems" : These systems are organized so that each cortical zone contributes in a specific way in accordance with its position within the cortical hierarchy and in accordance with the rules of innervation and inhibition. Therefore, for a complex behavioral act to be performed in a precise 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?

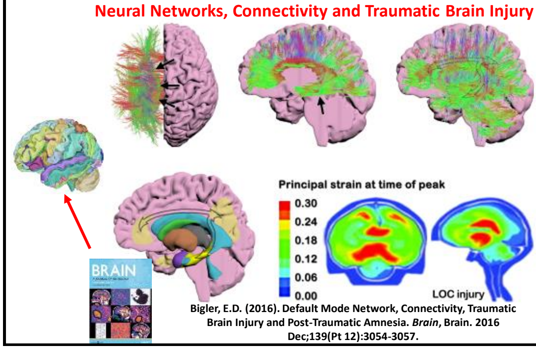

frontiers in Systems Neuroscience 2016 Aug 9;10:55. doi: 10.3389/fnsys.2016.00055. eCollection 2016.

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

Erin D. Bigler

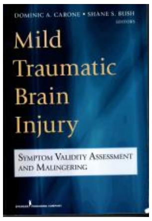
Kenzie, E. et al. Concussion as a multi-scale complex system, *Frontiers of Neurology*, 2017, Front Neurol. 2017 Sep 28;8:513. doi: 10.3389/fneur.2017.00513
Kenzie, E. et al. The Dynamics of Concussion: Mapping Pathophysiology, Persistence, and Recovery With Causal-Loop Diagramming. Front Neurol. 2018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

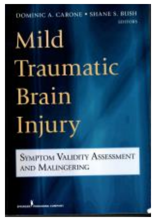


Foreword

"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

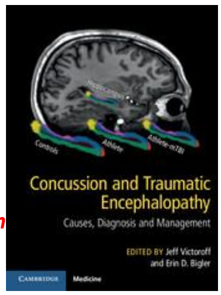
Could this possibly be an accurate statement?

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

PLOS ONE

RESEARCH ARTICLE

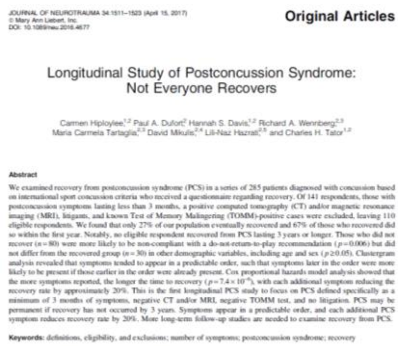
Mild Traumatic Brain Injury (mTBI) and chronic cognitive impairment: A scoping review



"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)
© Mary Ann Liebert, Inc.
DOI: 10.1089/neu.2016.4677

Original Articles

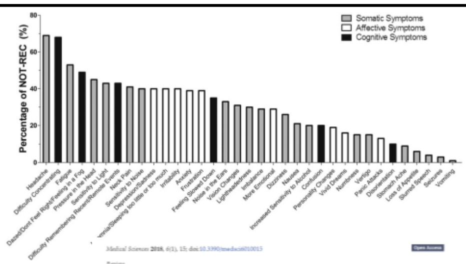
Longitudinal Study of Postconcussion Syndrome: Not Everyone Recovers

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 ($p = 7.4 \times 10^{-6}$), 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

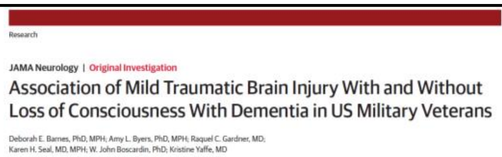
Open Access

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

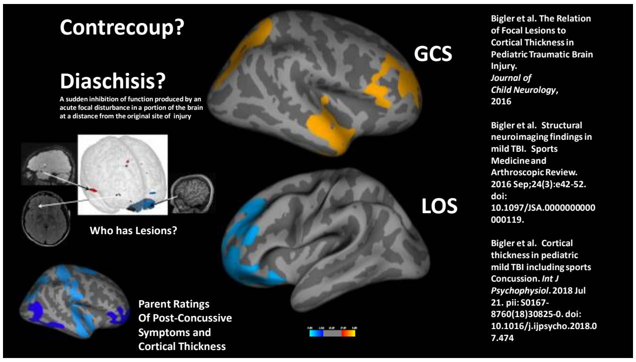
JAMA Neurology | Original Investigation

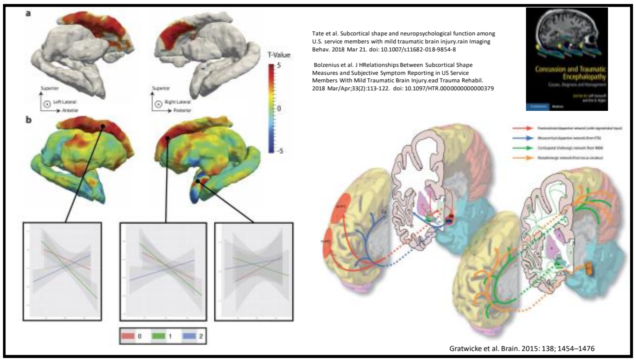
Association of Mild Traumatic Brain Injury With and Without Loss of Consciousness With Dementia in US Military Veterans

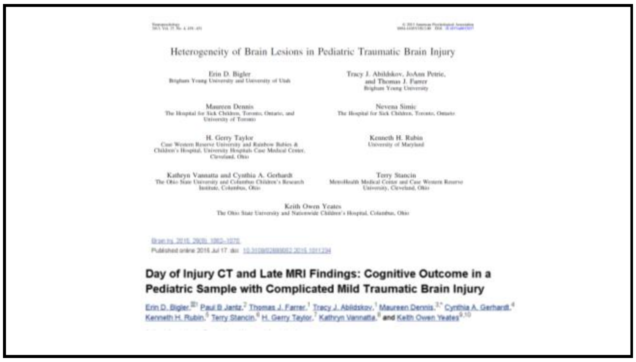
Deborah E. Barnes, PhD, MPH; Amy L. Byers, PhD, MPH; Raquel C. Gardner, MD; Karen H. Seal, MD, MPH; W. John Boscardin, PhD; Kristine Yaffe, MD

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.






Heterogeneity of Brain Lesions in Pediatric Traumatic Brain Injury

Erin D. Bigler
Brigham Young University and University of Utah

Tracy J. Abildskov, JoAnn Petrie, and Thomas J. Farrer
Brigham Young University

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

Nevena Simic
The Hospital for Sick Children, Toronto, Ontario

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

Kenneth H. Rubin
University of Maryland

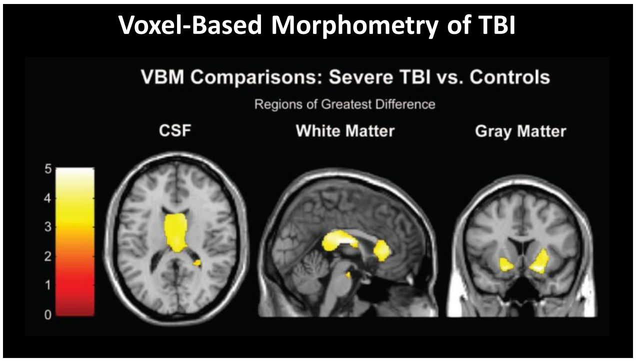
Kathryn Vannatta and Cynthia A. Gerhardt
The Ohio State University and Columbus Children's Research Institute, Columbus, Ohio

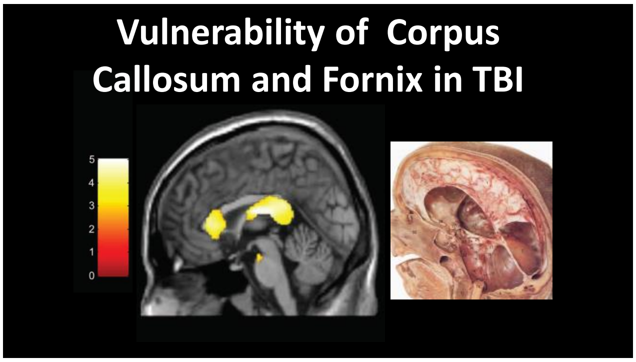
Terry Stancin
MetroHealth Medical Center and Case Western Reserve University, Cleveland, Ohio

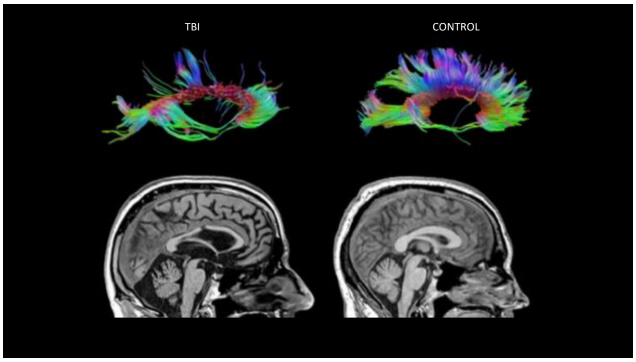
Keith Owen Yeates
The Ohio State University and Nationwide Children's Hospital, Columbus, Ohio

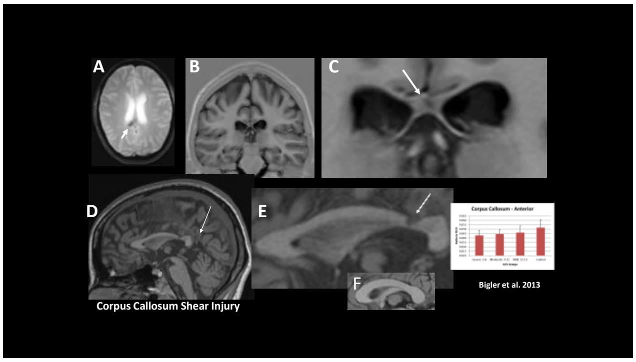
Day of Injury CT and Late MRI Findings: Cognitive Outcome in a Pediatric Sample with Complicated Mild Traumatic Brain Injury

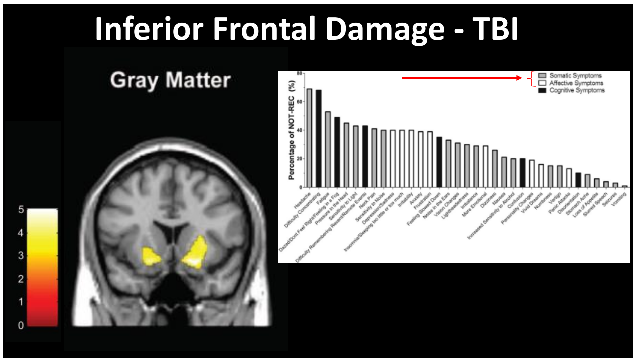
Erin D. Bigler, Paul B Jantz, Thomas J. Farrer, Tracy J. Abildskov, Maureen Dennis, Cynthia A. Gerhardt, Kenneth H. Rubin, Terry Stancin, H. Gerry Taylor, Kathryn Vannatta, and Keith Owen Yeates

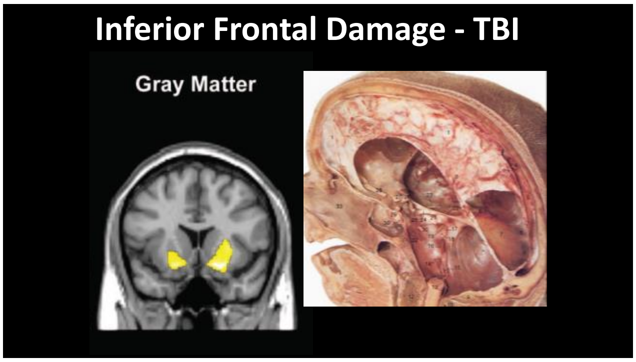


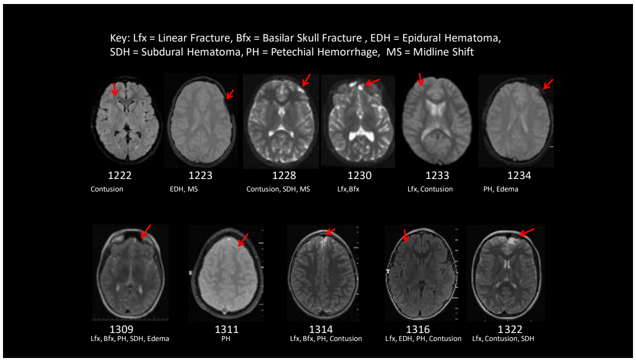



TBI
CONTROL


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


Inferior Frontal Damage - TBI
Gray Matter
5
4
3
2
1
0
Percentage of NOT-REC (%)
Somatic Symptoms
Affective Symptoms
Cognitive Symptoms


Inferior Frontal Damage - TBI
Gray Matter


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
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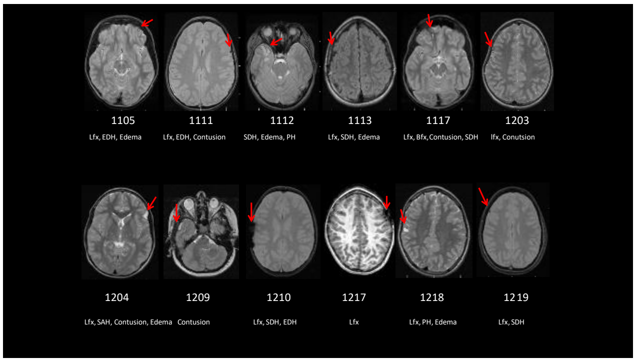
1322
Lfx, Contusion, SDH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Lfx, EDH, Edema
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Lfx, PH, Edema
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Lfx, SDH

Original Article

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

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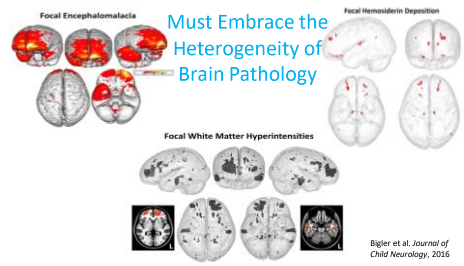
The Relation of Focal Lesions to Cortical Thickness in Pediatric Traumatic Brain Injury

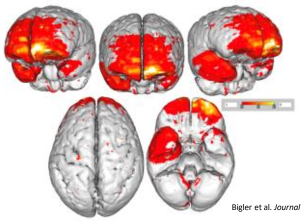
Erin D. Bigler, PhD[1,2], Brandon A. Zielinski, MD, PhD[3],
Naomi Goodrich-Hunsaker, PhD[4], Garrett M. Black, BS[4], B. S. Trevor Huff, BS[4],
Zachary Christiansen, BS[4], Dawn-Marie Wood, MS[4], Tracy J. Abildskov[4],
Maureen Dennis, PhD[5,6], H. Gerry Taylor, PhD[7], Kenneth Rubin, PhD[8],
Kathryn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



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

Heterogeneity in TBI

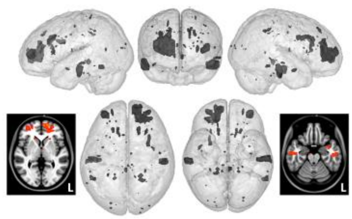
Focal Encephalomalacia



Bigler et al. *Journal of Child Neurology*2016

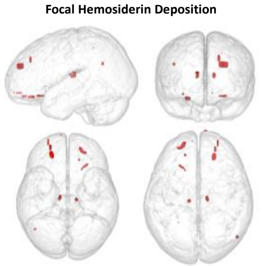
Heterogeneity in TBI

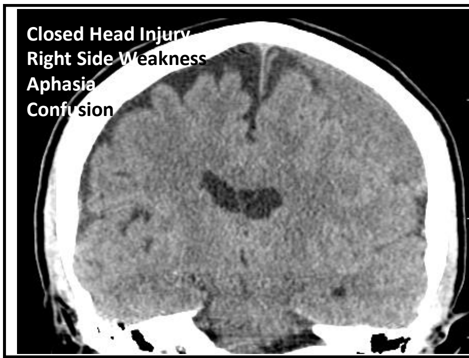
Focal White Matter Hyperintensities

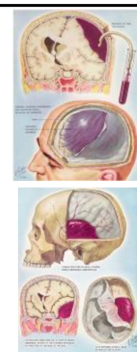


Heterogeneity in TBI

Focal Hemosiderin Deposition



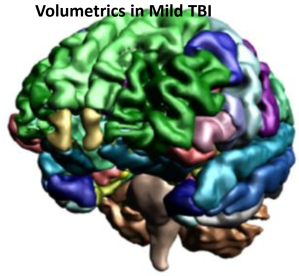


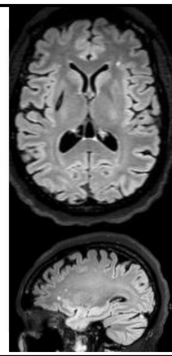


The Integration of Neuropathological with the Neuroimaging and Neuropsychological Outcome

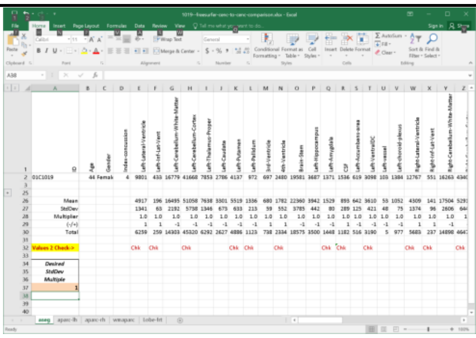
How nice would it be?

White Matter Hyperintensity and Volumetrics in Mild TBI

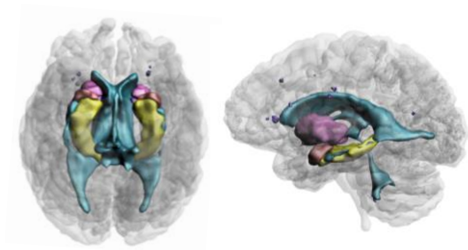




CENC Study



Where Volumetric Differences Reside in CENC Case



Neurobiology of Aging 72 (2018) 14–22

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

Check for updates

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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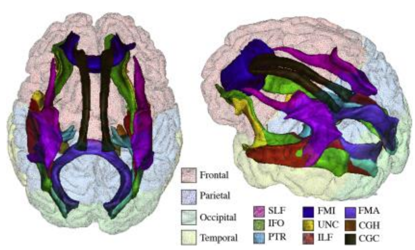
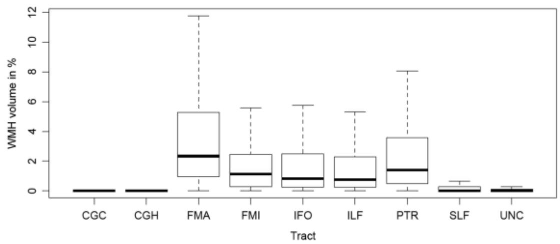
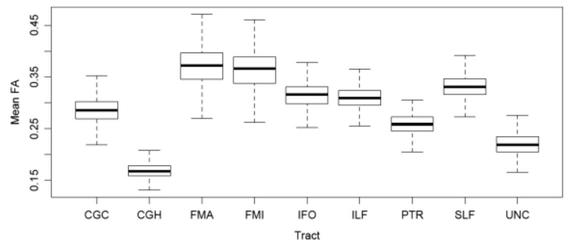
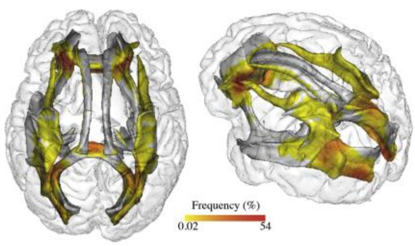
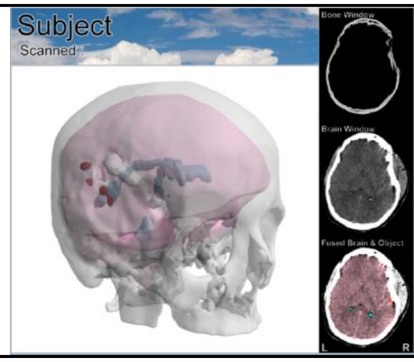
[e] Department of Neurology, Boston University School of Medicine, Boston, MA, USA
[f] Department of Biostatistics, Boston University School of Public Health, Boston, MA, USA



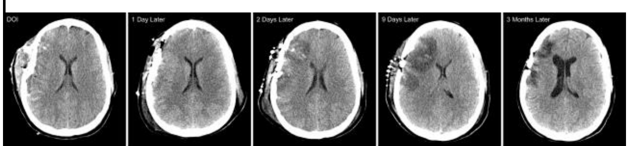


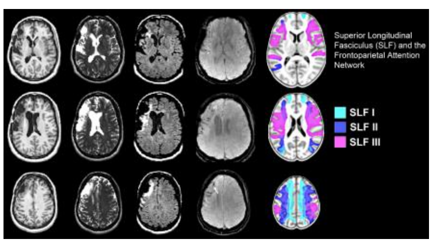


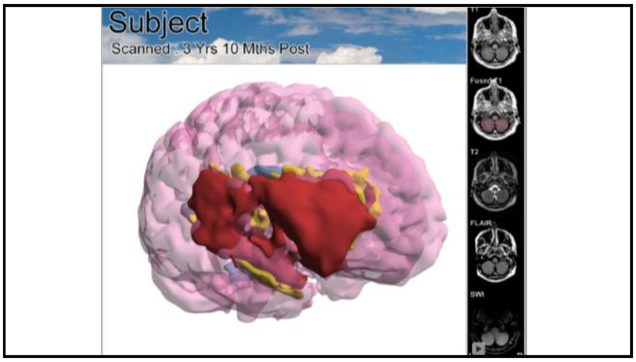




What Should We Measure and When?



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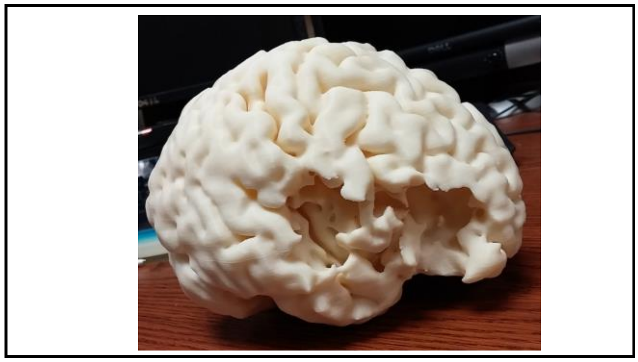
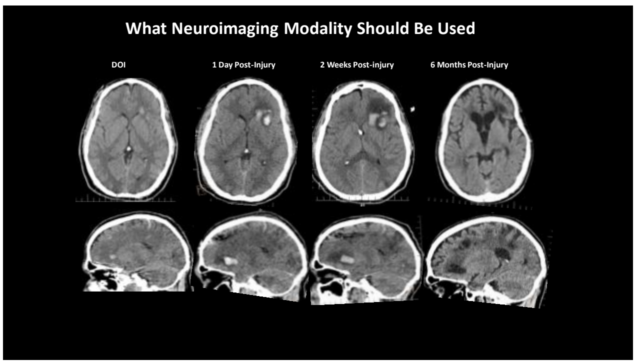
FLAIR
SWI




What Neuroimaging Modality Should Be Used
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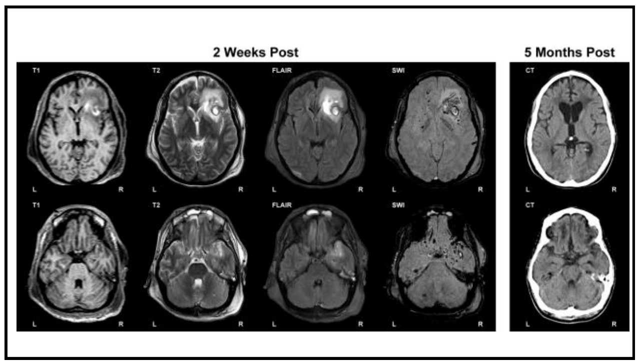
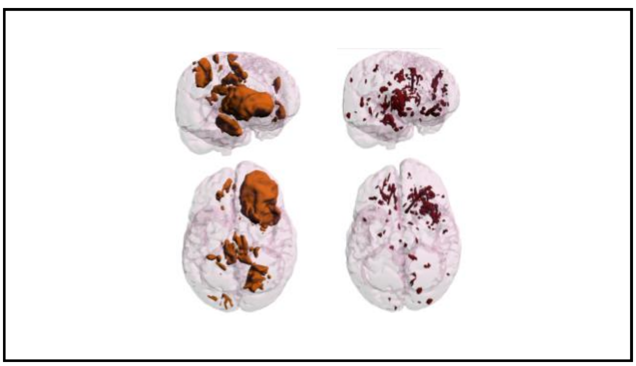
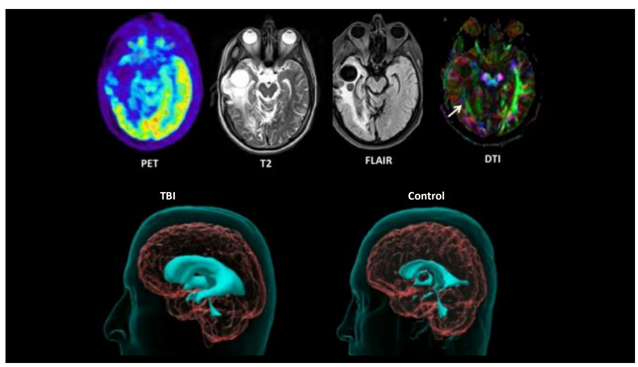
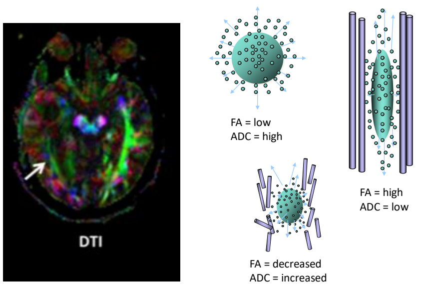
1 Day Post-Injury
2 Weeks Post-injury
6 Months Post-Injury

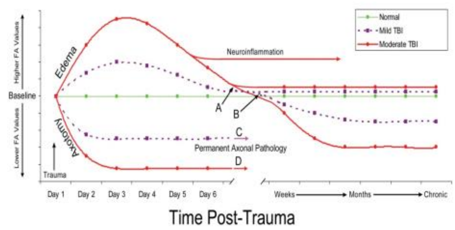

2 Weeks Post
5 Months Post
T1
T2
FLAIR
SWI
CT

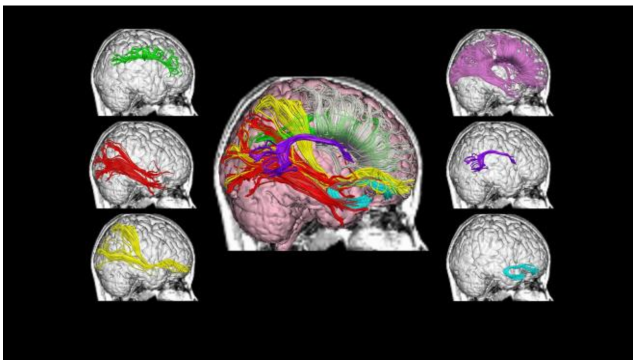


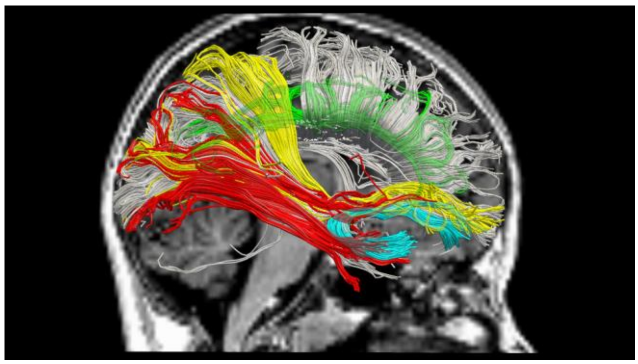

PET
T2
FLAIR
DTI
TBI
Control

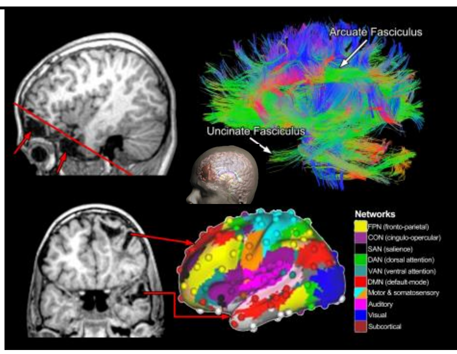
Diffusion Tensor Imaging



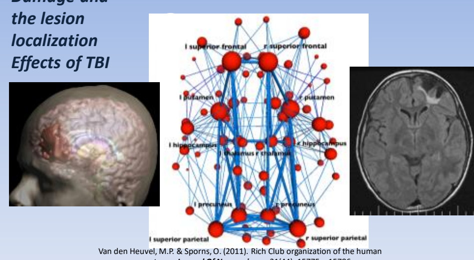




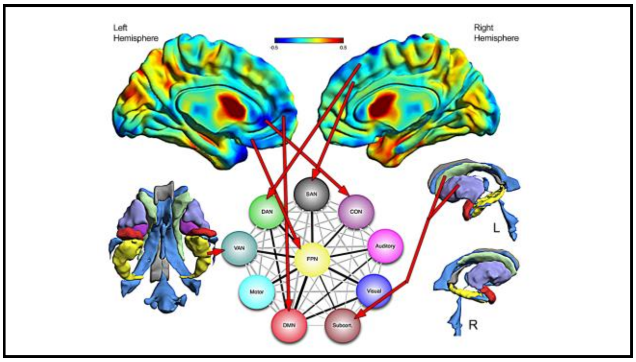


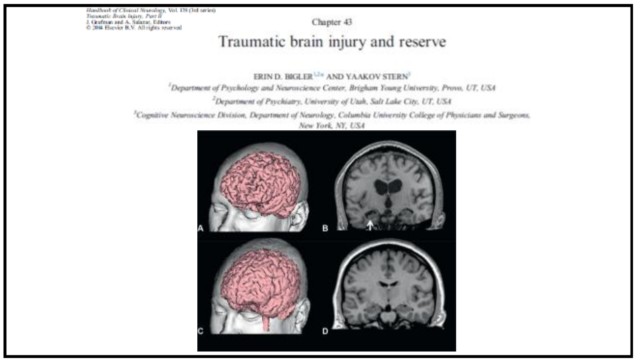


Network Damage and the lesion localization Effects of TBI



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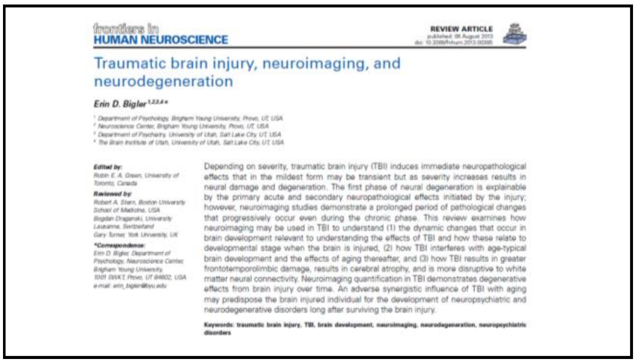
[3]Cognitive Neuroscience Division, Department of Neurology, Columbia University College of Physicians and Surgeons, New York, NY, USA



frontiers in HUMAN NEUROSCIENCE

REVIEW ARTICLE
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Traumatic brain injury, neuroimaging, and neurodegeneration

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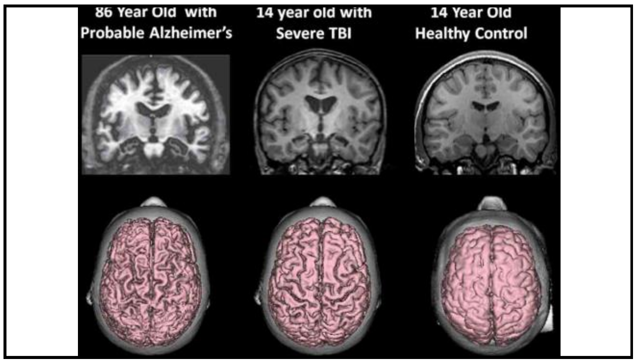
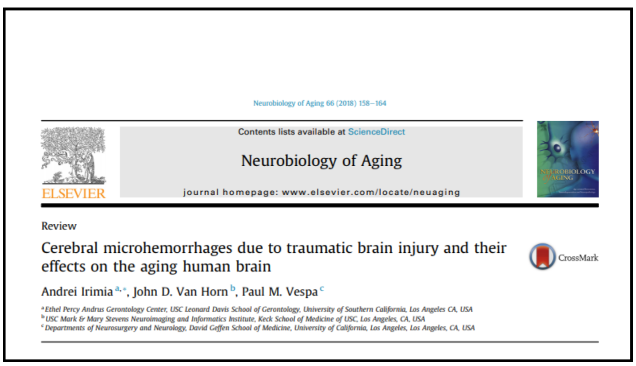
Depending on severity, traumatic brain injury (TBI) induces immediate neuropathological effects that in the mildest form may be transient but as severity increases results in neural damage and degeneration. The first phase of neural degeneration is explainable by the primary acute and secondary neuropathological 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





Neurobiology of Aging 66 (2018) 158–164

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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]

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[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, CA, USA

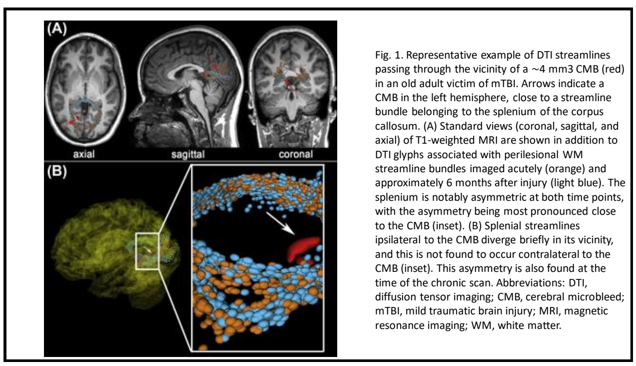
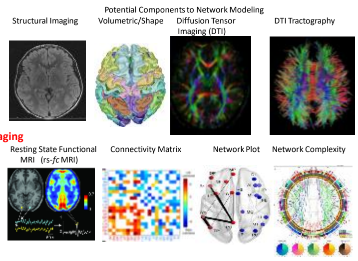
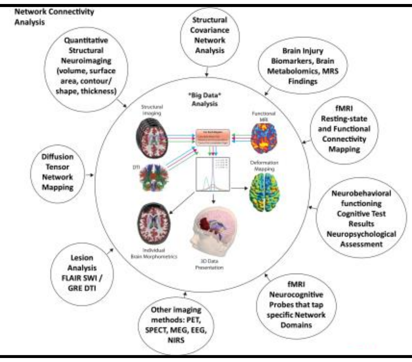
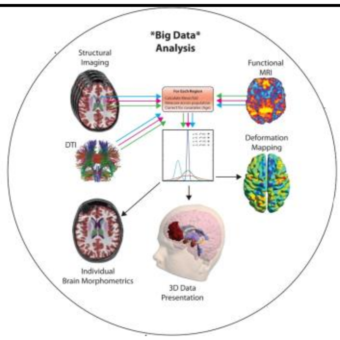


Fig. 1. Representative example of DTI streamlines passing through the vicinity of a ~4 mm3 CMB (red) in an old adult victim of mTBI. Arrows indicate a CMB in the left hemisphere, close to a streamline bundle belonging to the splenium of the corpus callosum. (A) Standard views (coronal, sagittal, and 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







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

Traumatic Brain Injury as a Disorder of Brain Connectivity

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[4]Department of Psychology, Brigham Young University, Provo, Utah
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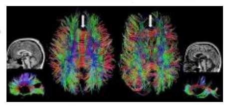
[6]Department of Psychiatry, University of Utah, Salt Lake City, Utah
[7]Memory Disorders Research Center, VA Boston Healthcare System, Boston, Massachusetts

(Received April 3, 2015; Final Revision August 6, 2015; Accepted August 11, 2015)

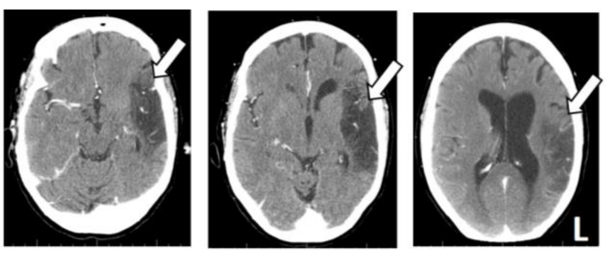


Abstract

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.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TEDx
0:07 / 15:24


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