NEUROIMAGING AND CONNECTOME ANALYSIS OF TLE: FROM HIPPOCAMPAL SUBFIELDS TO LARGE-SCALE NETWORKS

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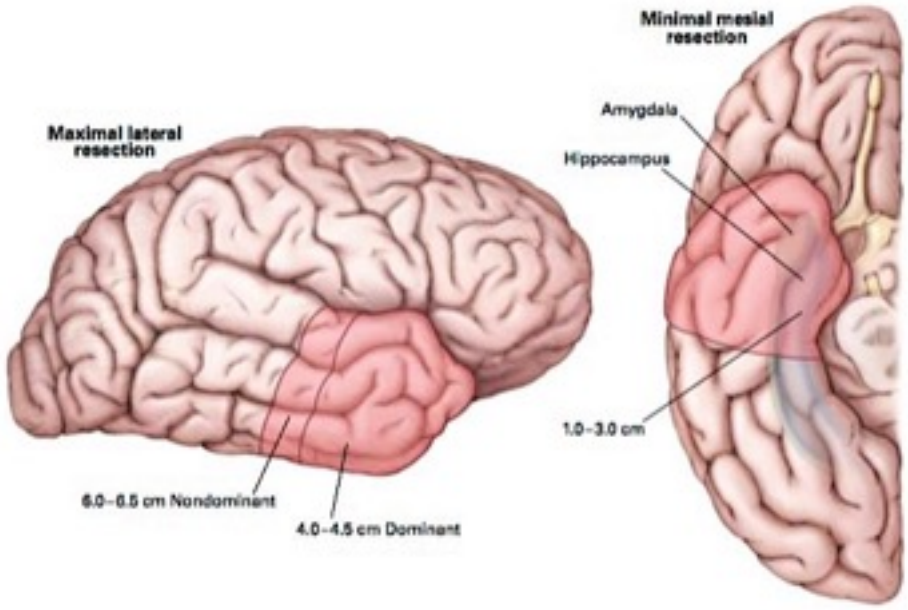
TEMPORAL LOBE EPILEPSY

ONE OF THE MOST COMMON DRUG-RESISTANT EPILEPSIES IN ADULTS

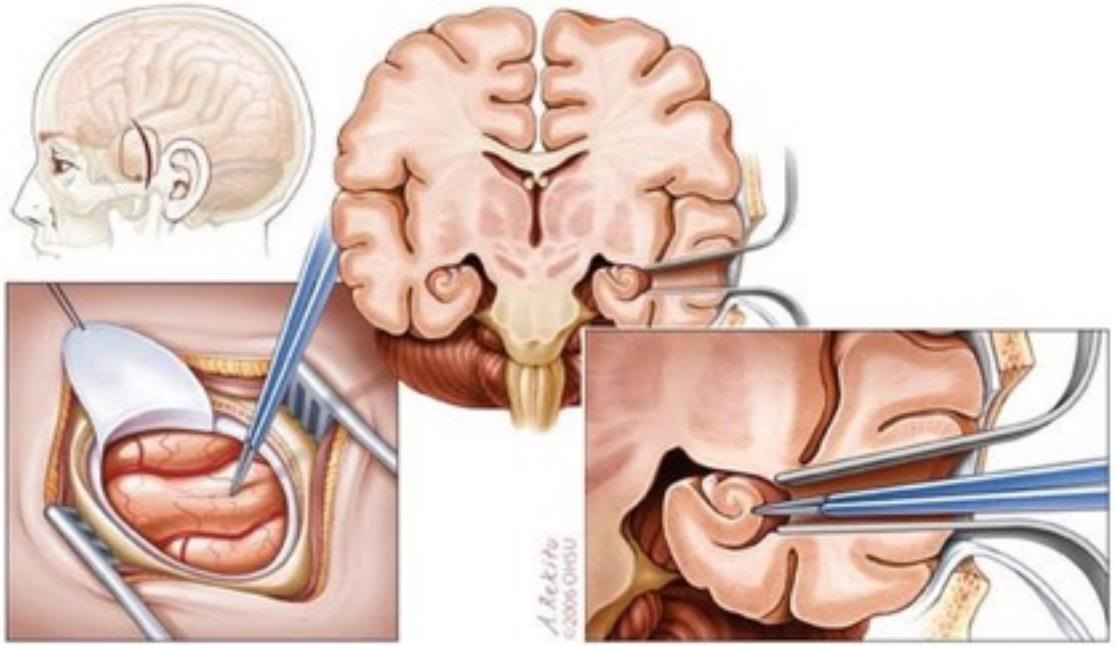
SEIZURES ARISING FROM TL

SURGERY MOST EFFECTIVE TREATMENT

ASSOCIATED WITH HIPPOCAMPAL SCLEROSIS (HS)



Wiebe et al. (2001) NEJM

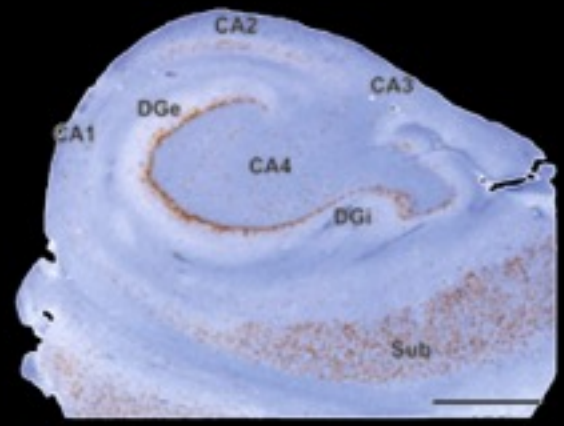


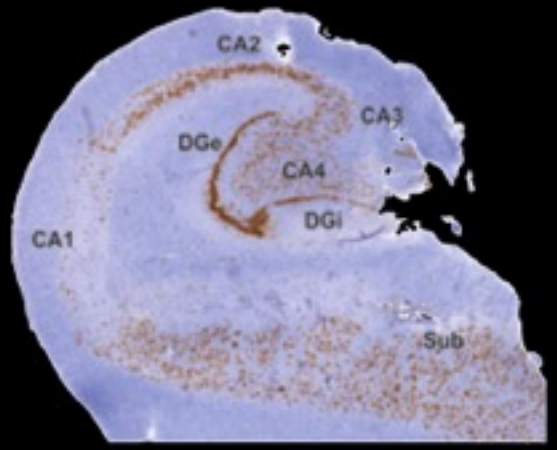
Spencer & Burchiel (2012) Epilepsy Research and Treatment

TEMPORAL LOBE EPILEPSY

HS IS THE TLE HALLMARK BUT NOT A SINGLE ENTITY

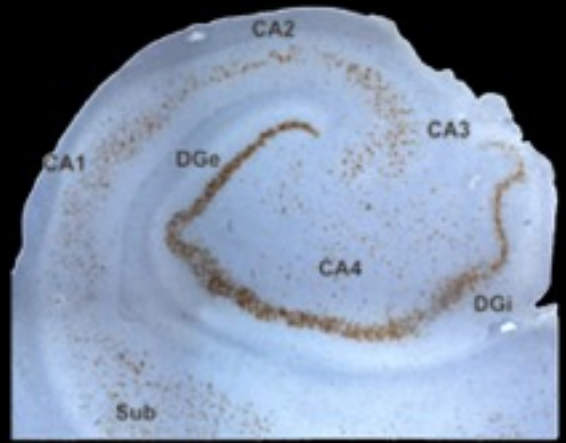
CA1+CA4
cell loss
+
gliosis

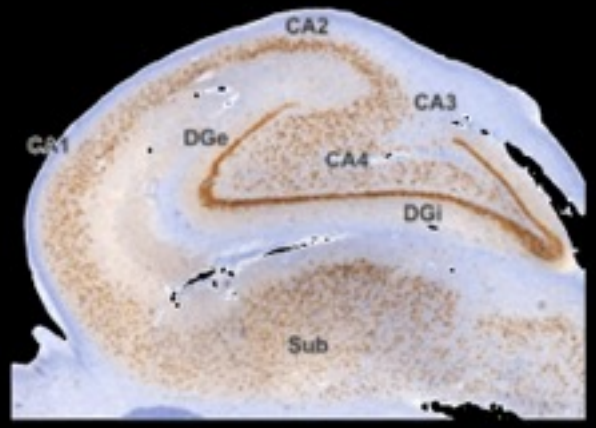




CA1
cell loss
+
gliosis

CA4
cell loss
+
gliosis

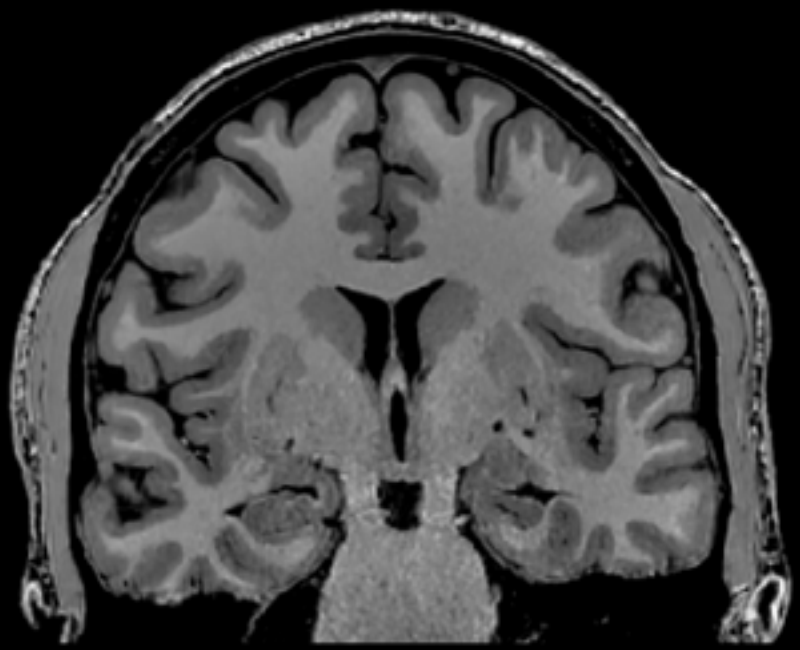




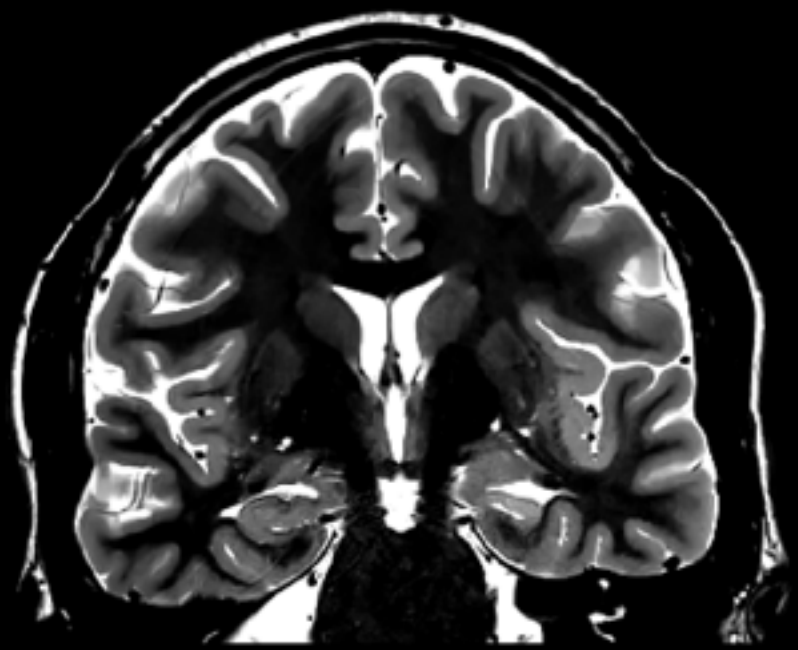
gliosis
only

Blümcke et al (2013) Epilepsia

THE CONTRIBUTIONS OF NEUROIMAGING TO TLE EVALUATION AND DIAGNOSIS OF HS



T1-weighted

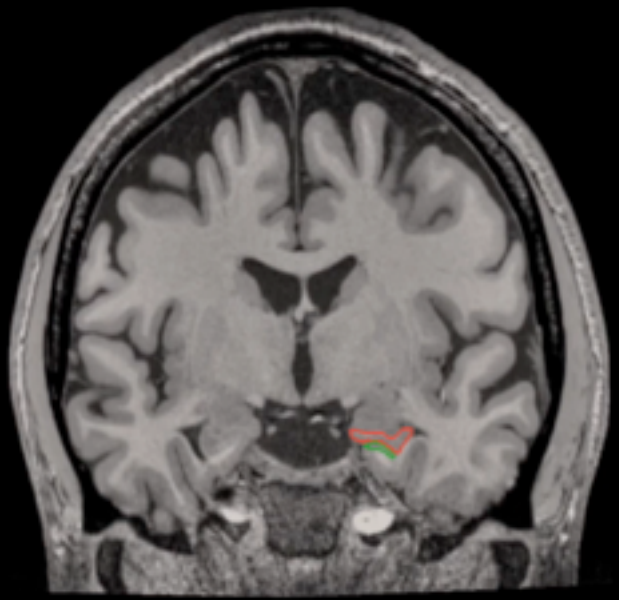


T2-weighted

Cascino (1991) Ann Neur; Cendes (1993) Neurology; Jackson (1990) Ann Neur; Kuznieckiy (1997) Neurology; Bernasconi (2003) Brain

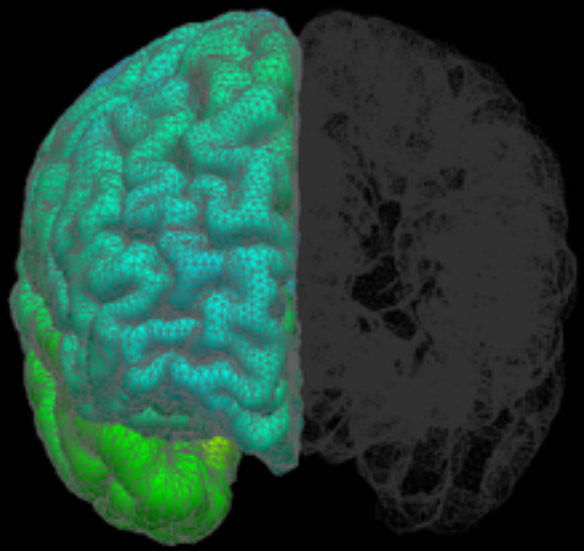
THE POWER OF NEUROIMAGING TO CHARACTERIZE HUMAN BRAIN ORGANIZATION

REGIONAL



Courtesy of Jessie Kulaga-Yoskovitz

WHOLE-BRAIN

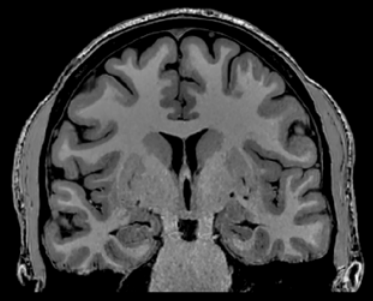


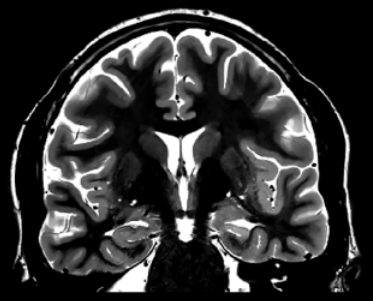
CONNECTOME

Courtesy of Alfred Anwander

CAN WE DESCRIBE THE PATHOLOGICAL SPECTRUM OF TLE IN-VIVO?
DO STRUCTURAL CHANEGES RELATE TO FUNCTIONAL NETWORK ALTERATIONS?

STUDY DESIGN





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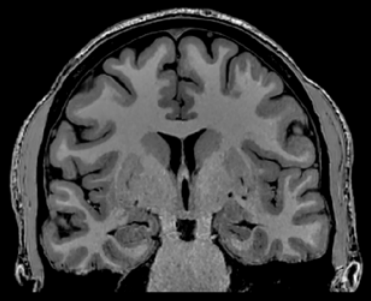
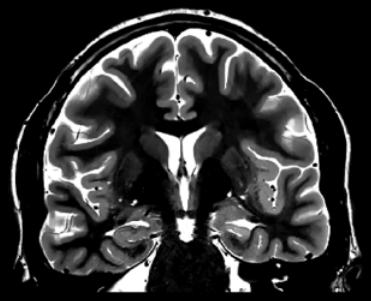
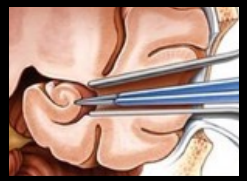
3T MRI DATA

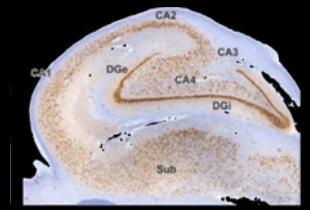
SURGERY

HS









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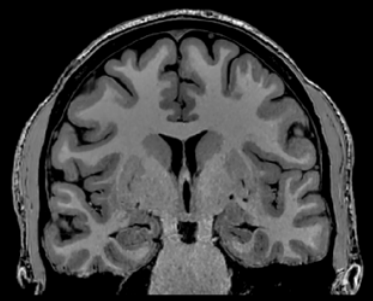
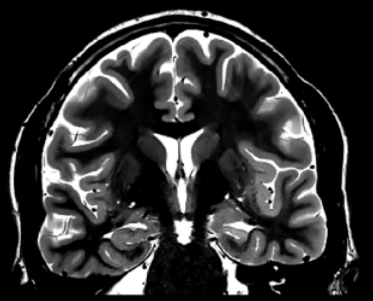
3T MRI DATA

SURGERY

GLIOSIS





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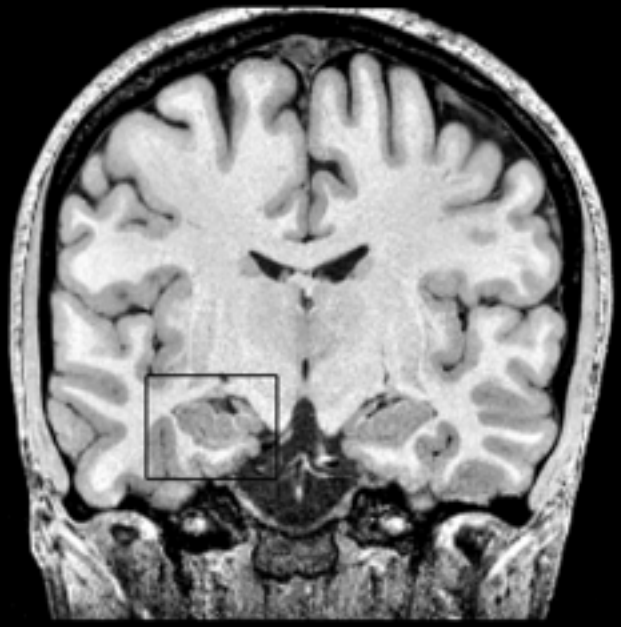
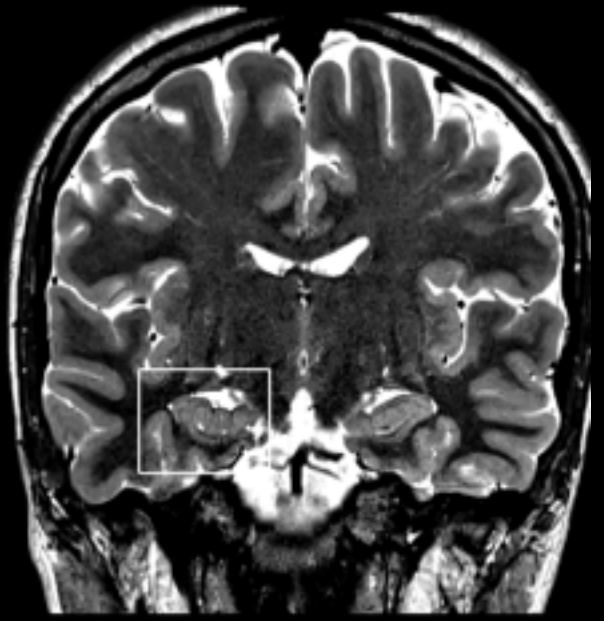
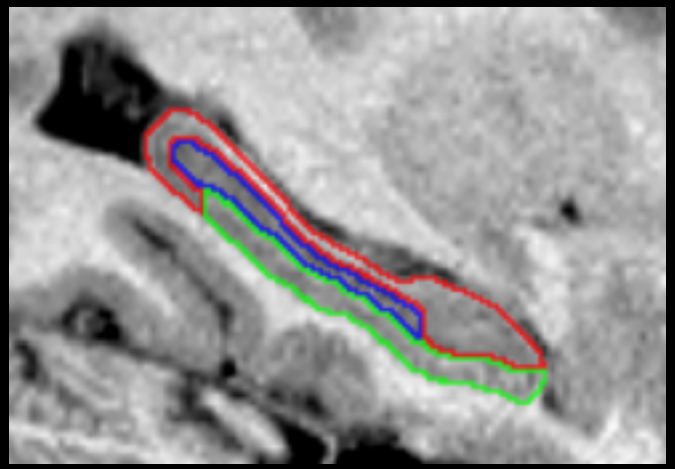
3T MRI DATA

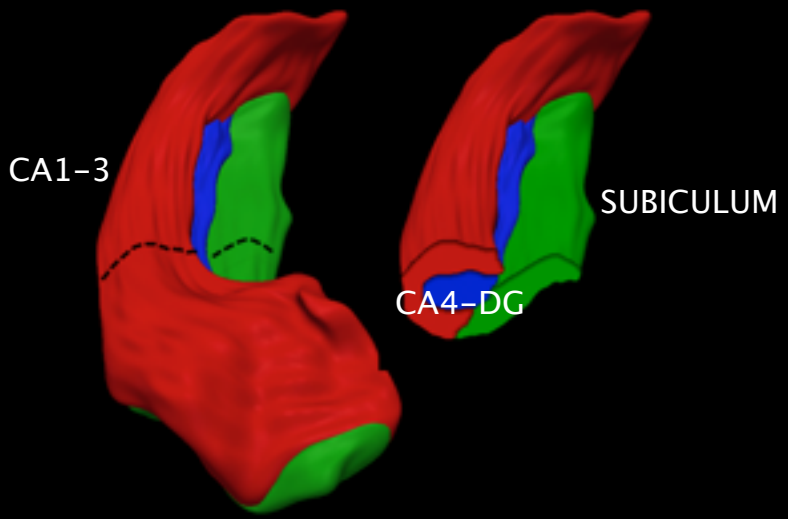
CONTROLS





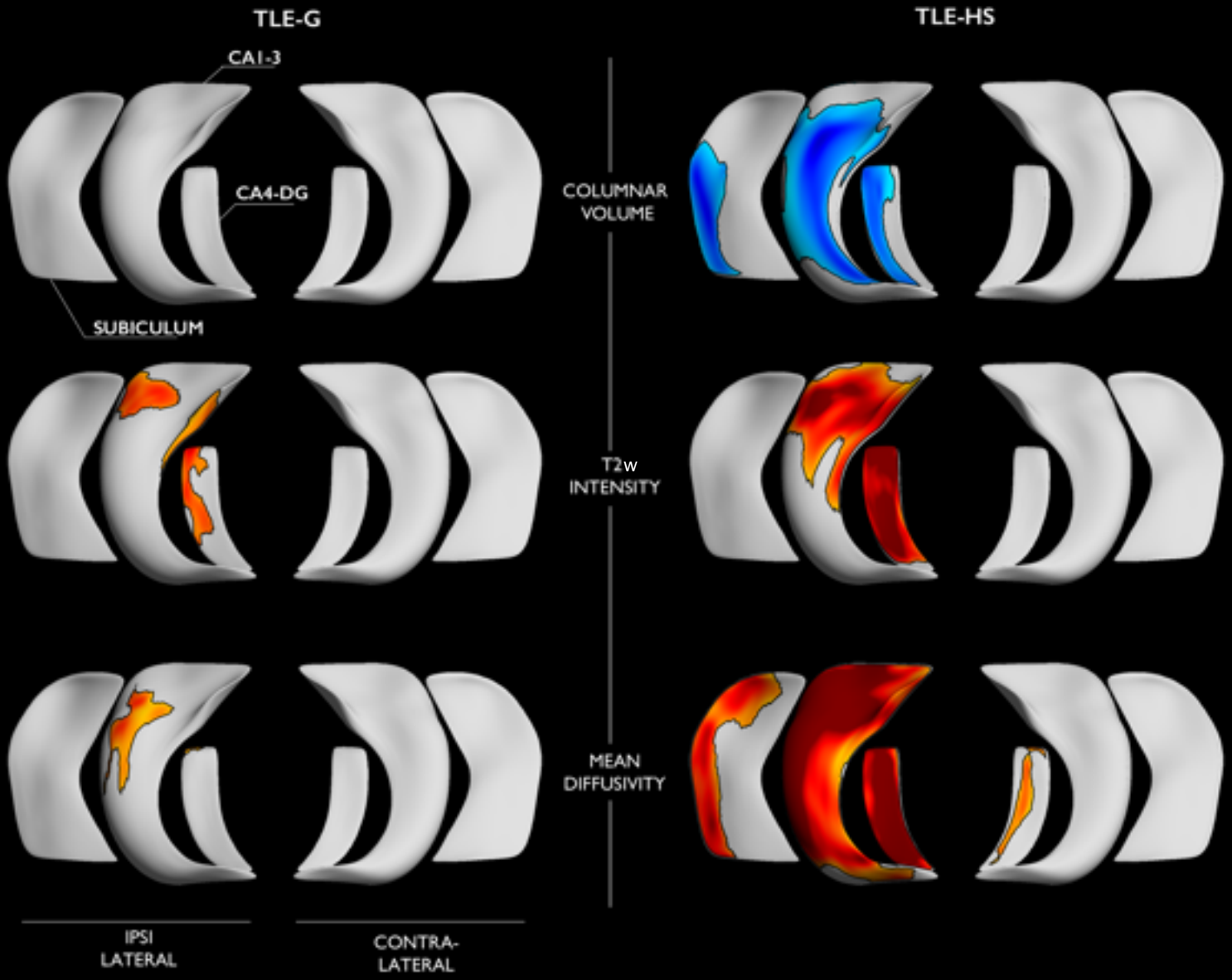
https://www.nitrc.org/projects/mni-hisub25/





Scientific Data, 2015

FEATURE-SPECIFIC COMPARISON TO CONTROLS



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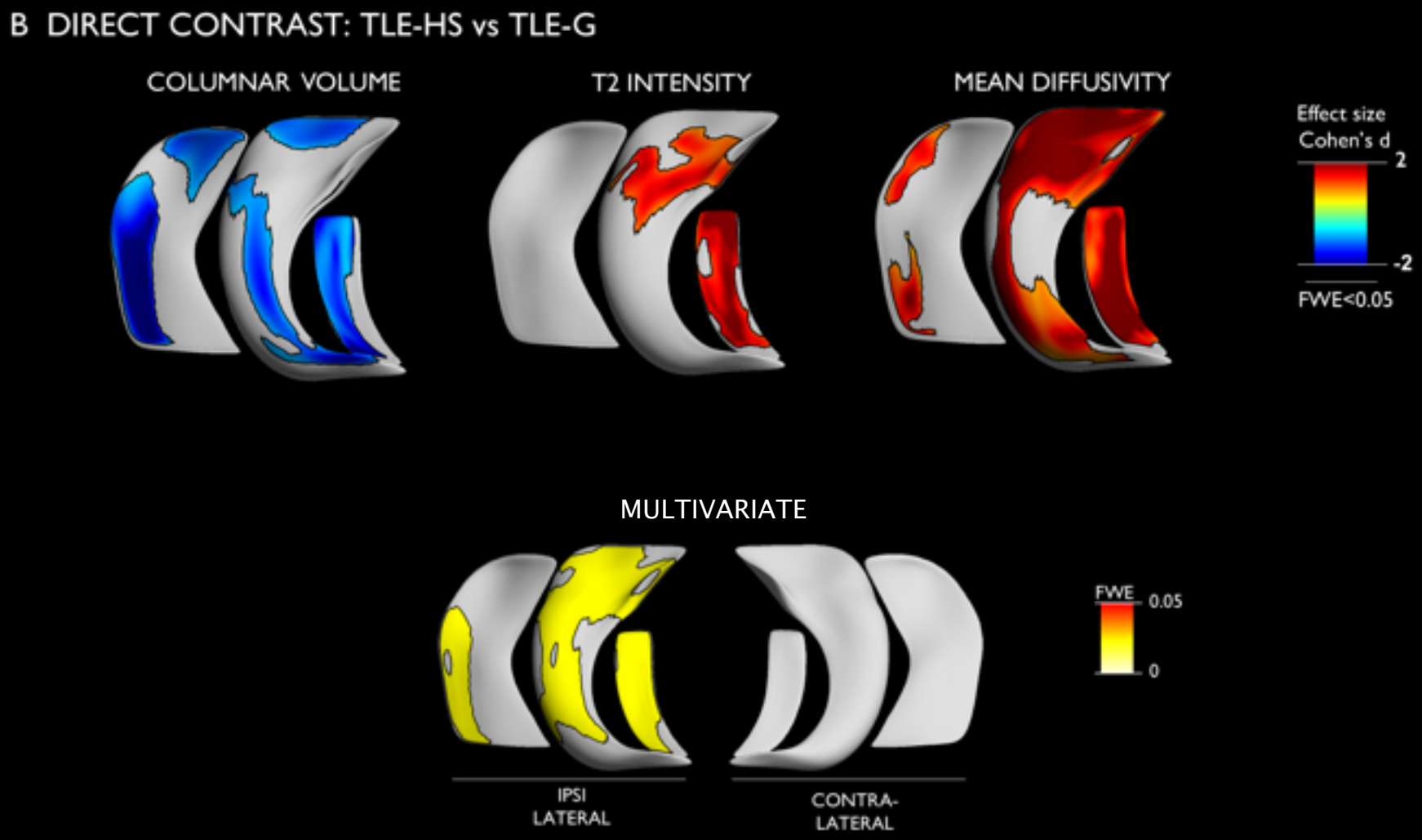
DIRECT CONTRASTS



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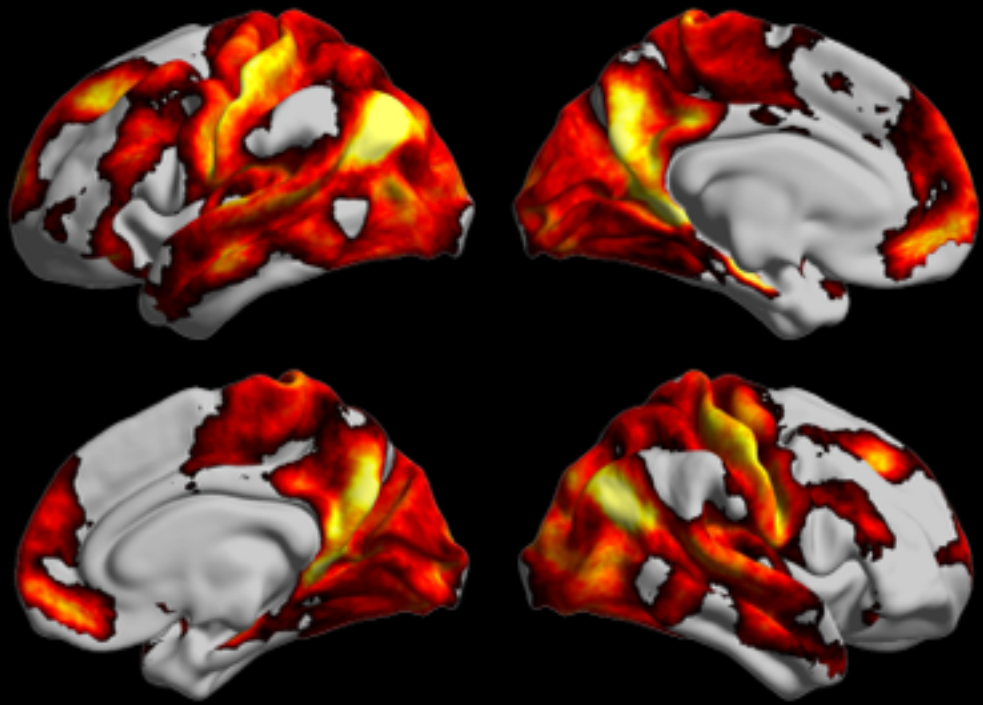
FUNCTION

rs-FMRI ANALYSIS OF
INTRINSIC FUNCTIONAL NETWORKS

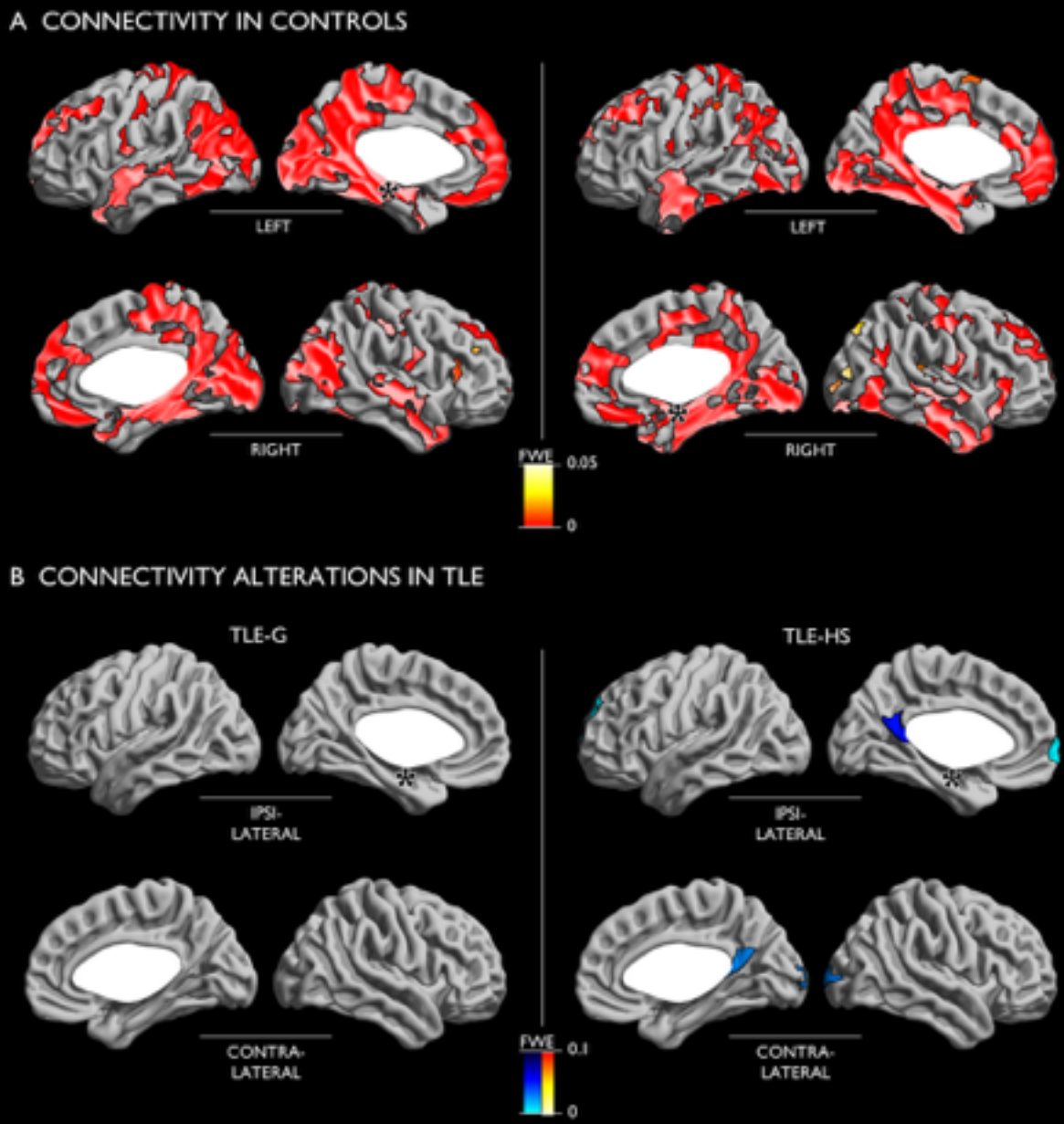
HIPPOCAMPUS HIGHLY INTEGRATED
WITH DMN

TLE-HS vs TLE-G:
DISEASE MODEL TO PROBE
STRUCTURE-FUNCTION RELATIONS



HCP hippocampal connectivity

FUNCTIONAL ANOMALIES IN TLE



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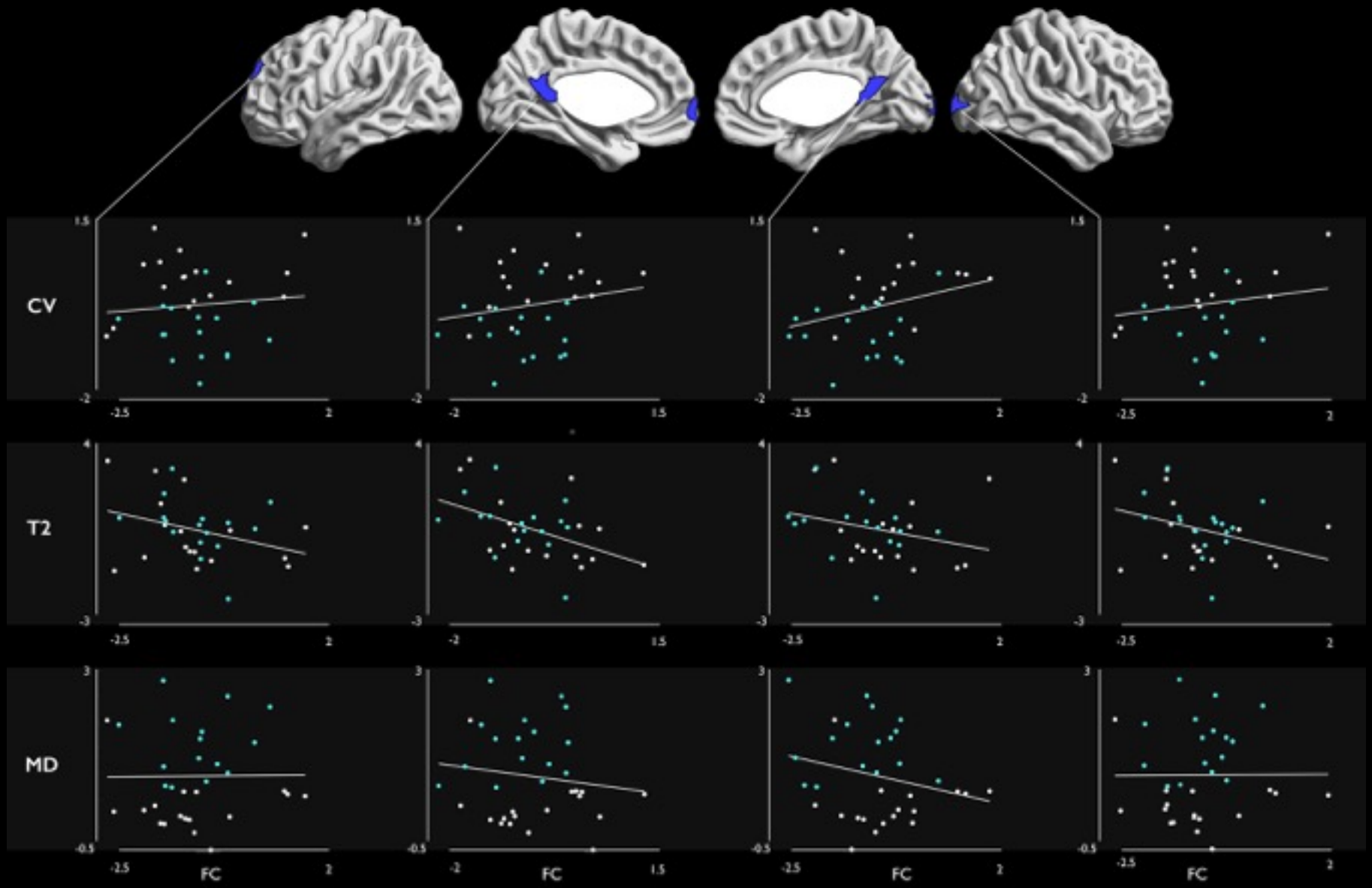
STRUCTURE–FUNCTION RELATIONSHIPS IN TLE



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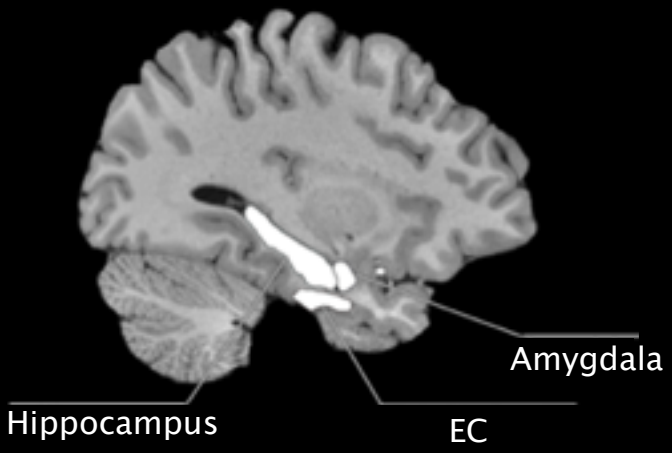
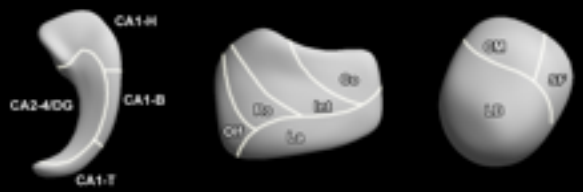
IN THE CONTEXT OF SURGICAL OUTCOME PREDICTION:
IS TLE ADEQUATELY CAPTURED BY THE HIPPOCAMPUS ALONE?

MRI PROFILING AND SUBTYPING

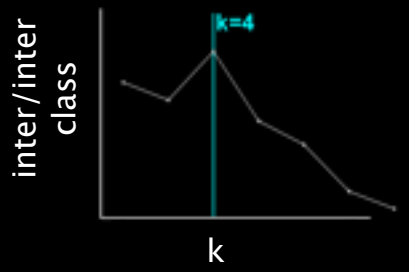
MESIOTEMPORAL PROFILING

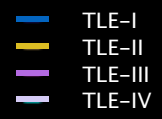
n=114

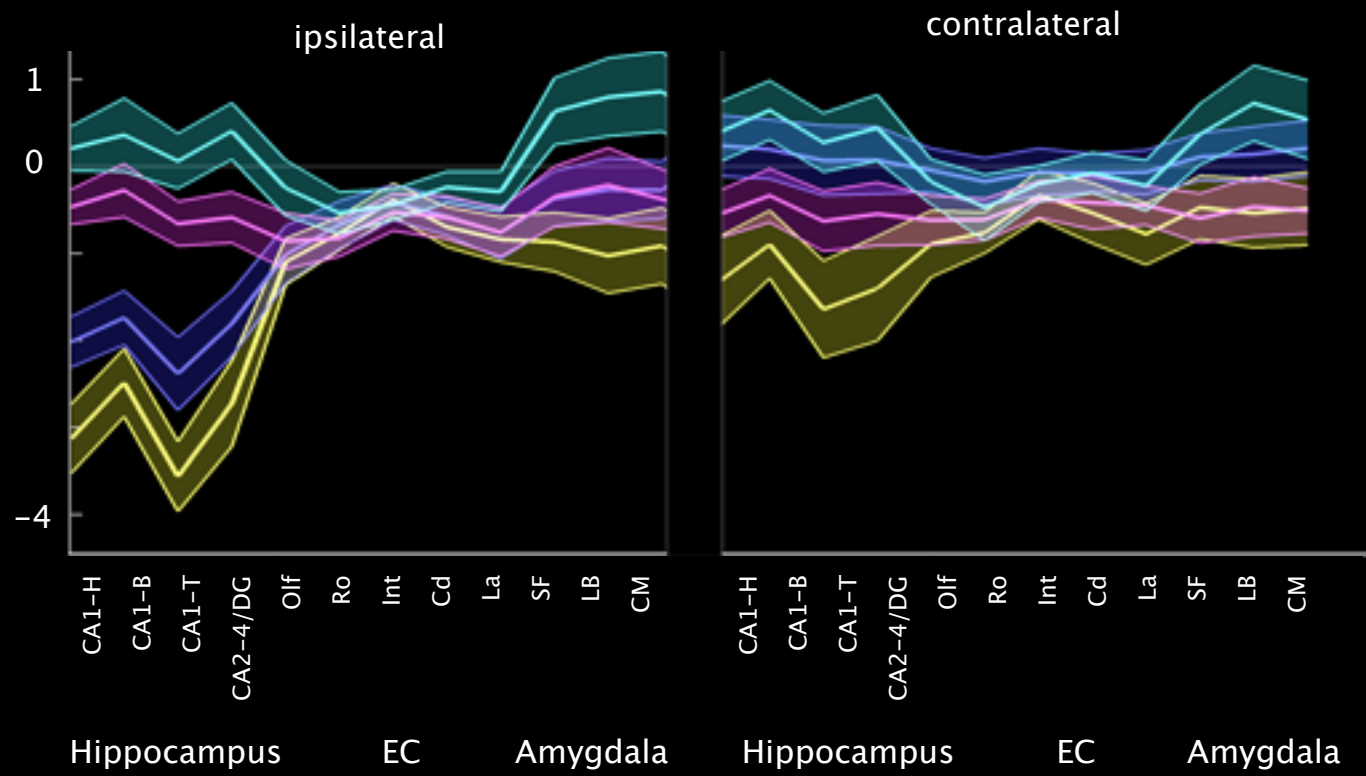




CLUSTERING PATIENT SPECTRUM BASED ON MRI MORPHOMETRY

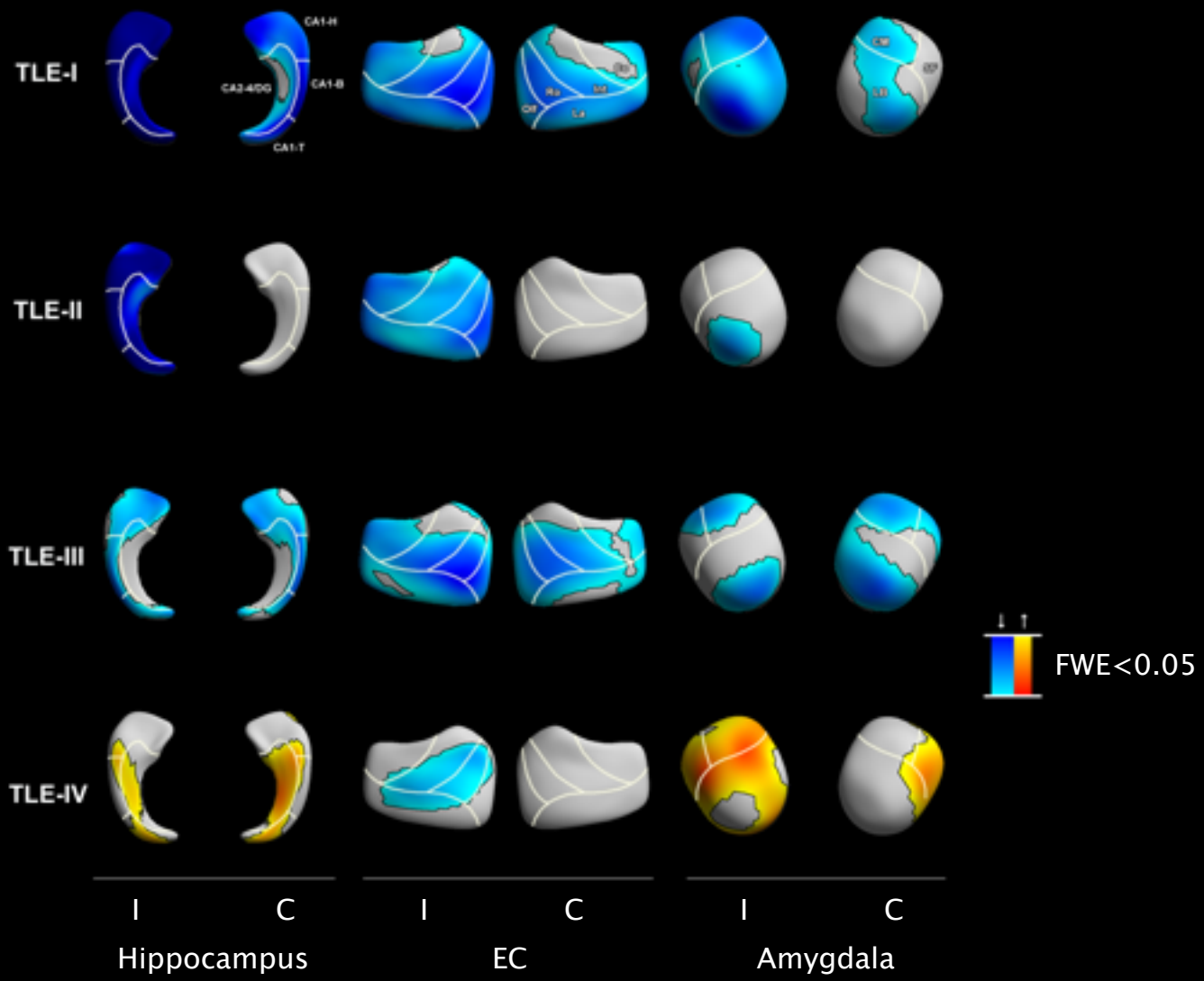






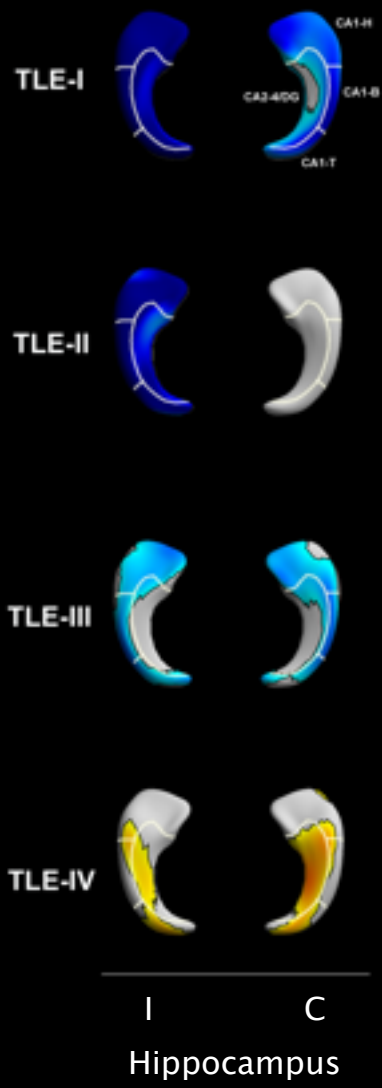
Annals of Neurology 2015

DATA-DRIVEN SUBCLASSES



Annals of Neurology 2015

RELATION TO IMAGING-INDEPENDENT CRITERIA



	HS/Gliosis	Engel-I
TLE-I	71/29%	68%
TLE-II	72/28%	89%
TLE-III	43/57%	65%
TLE-IV	17/83%	44%

LDA outcome prediction:

class + surface data: **92%**

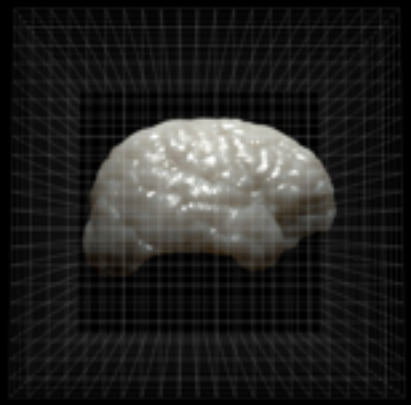
surface-measures only: **81%**

volumetry: **71%**

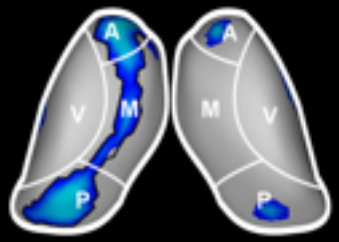
Annals of Neurology 2015

DO ANOMALIES EXTEND BEYOND THE MESIOTEMPORAL LOBE?

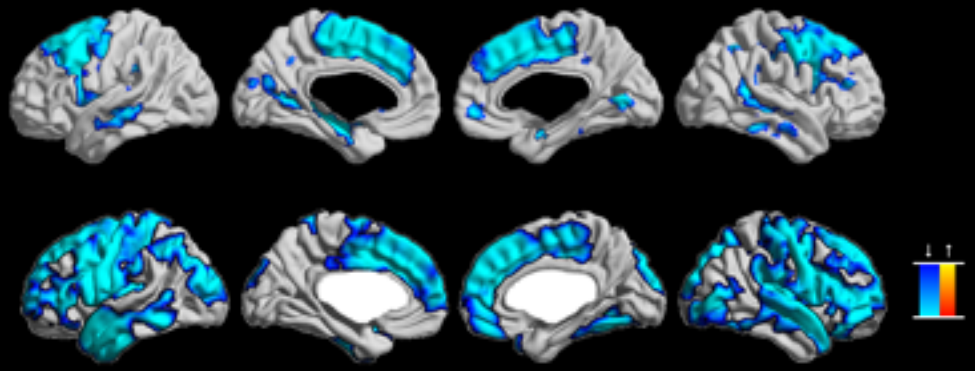
WHOLE-BRAIN GREY MATTER



Keller 2002 JNNP, Bonilha 2004/06 NIMG, Bernasconi 2004 NIMG

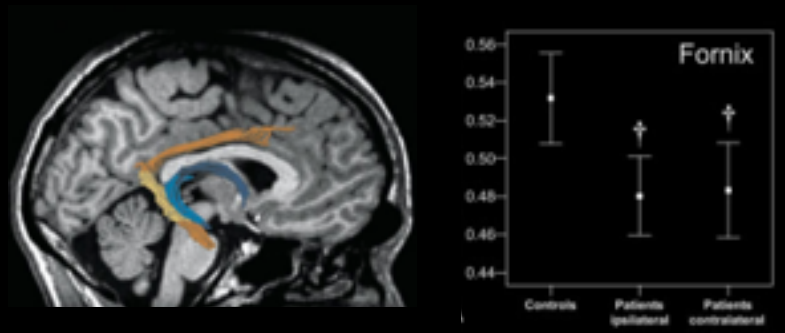


Neurology 2012

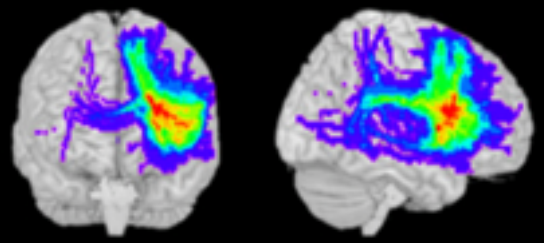


Lin 2007 CerCor, McDonald 2008 Epilepsy, Bernhardt 2008 NIMG

WHOLE-BRAIN WHITE MATTER

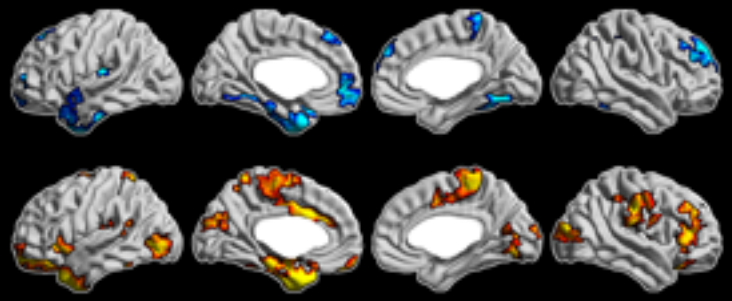


Concha et al 2005 Ann Neu



Powell et al 2006 NIMG

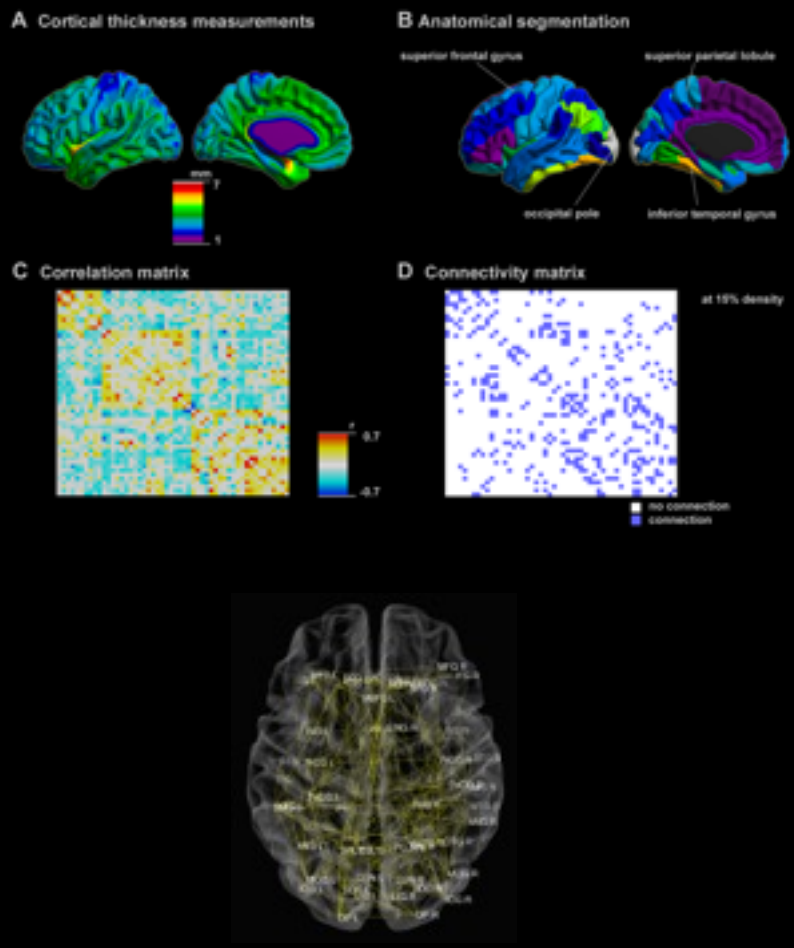
35%



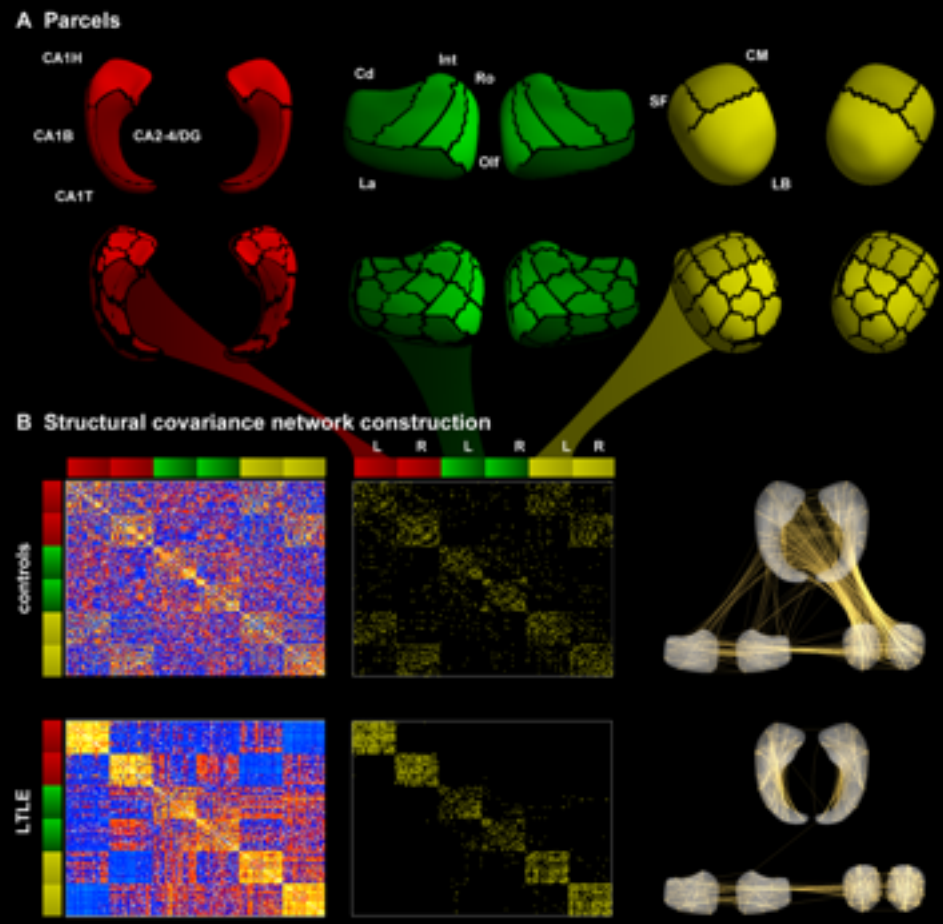
Liu 2016 Brain

MACROLEVEL STRUCTURAL NETWORK GENERATION

NEOCORTEX



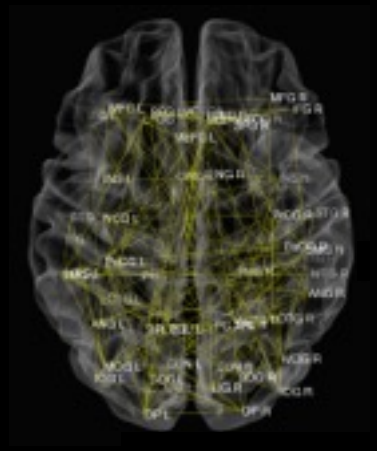
MESIOTEMPORAL LOBE



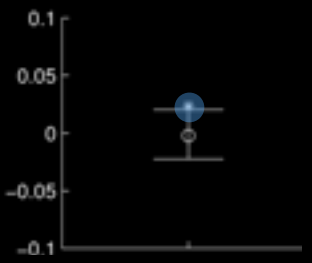
MACROLEVEL STRUCTURAL NETWORK ALTERATIONS

NEOCORTEX

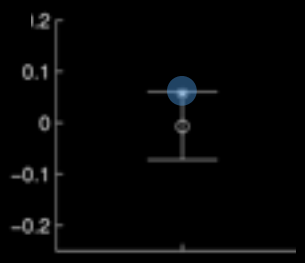
CONTROLS



TLE



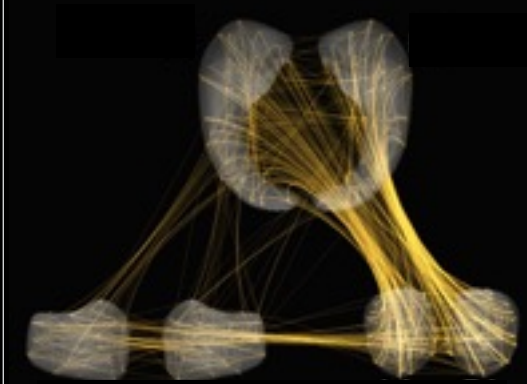
CLUSTERING



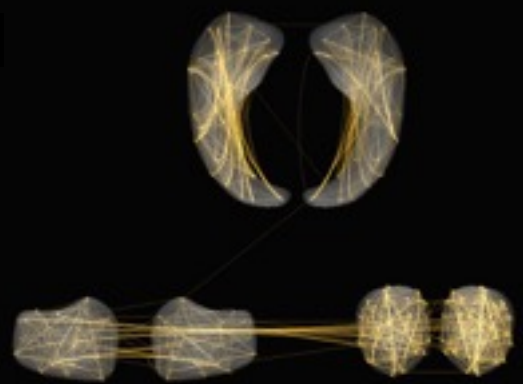
PATH LENGTH

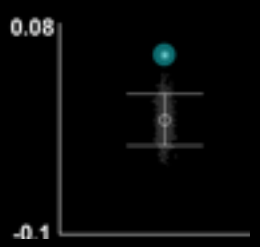
MESIOTEMPORAL LOBE

CONTROLS



TLE





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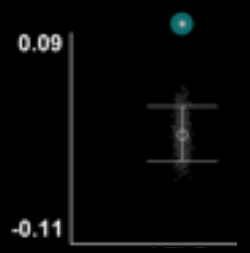

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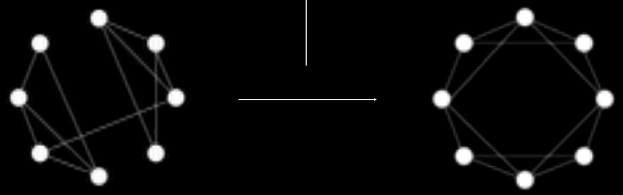
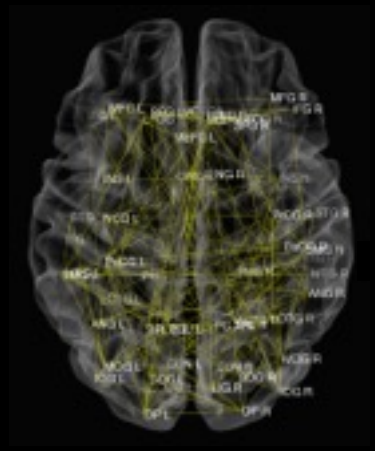


Cerebral Cortex 2011, 2016

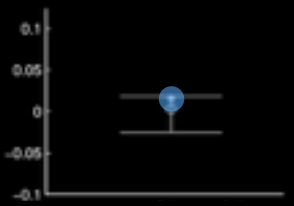
RELATIONSHIP TO OUTCOME

NEOCORTEX

CONTROLS



TLE



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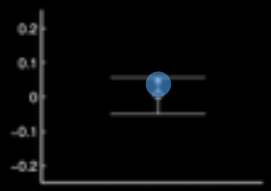
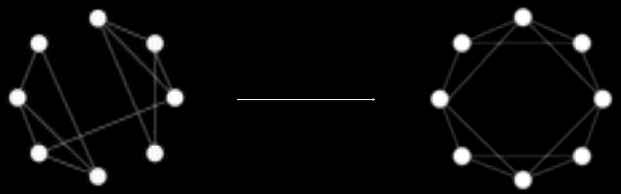


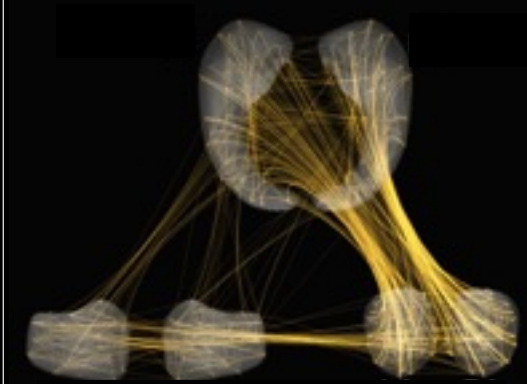
PATH LENGTH



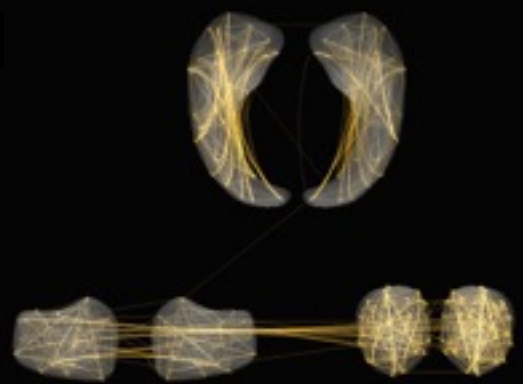
worse outcome

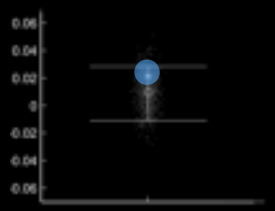
MESIOTEMPORAL LOBE

CONTROLS

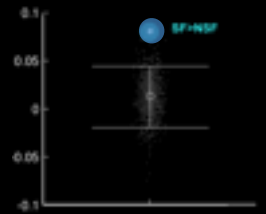


TLE





CLUSTERING



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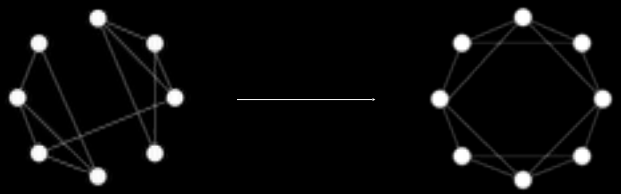
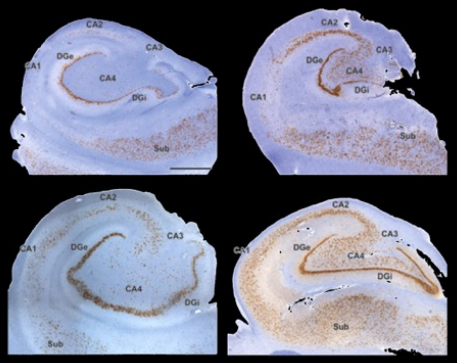
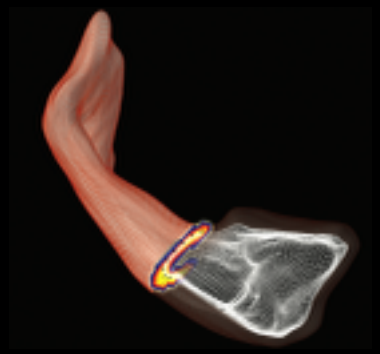


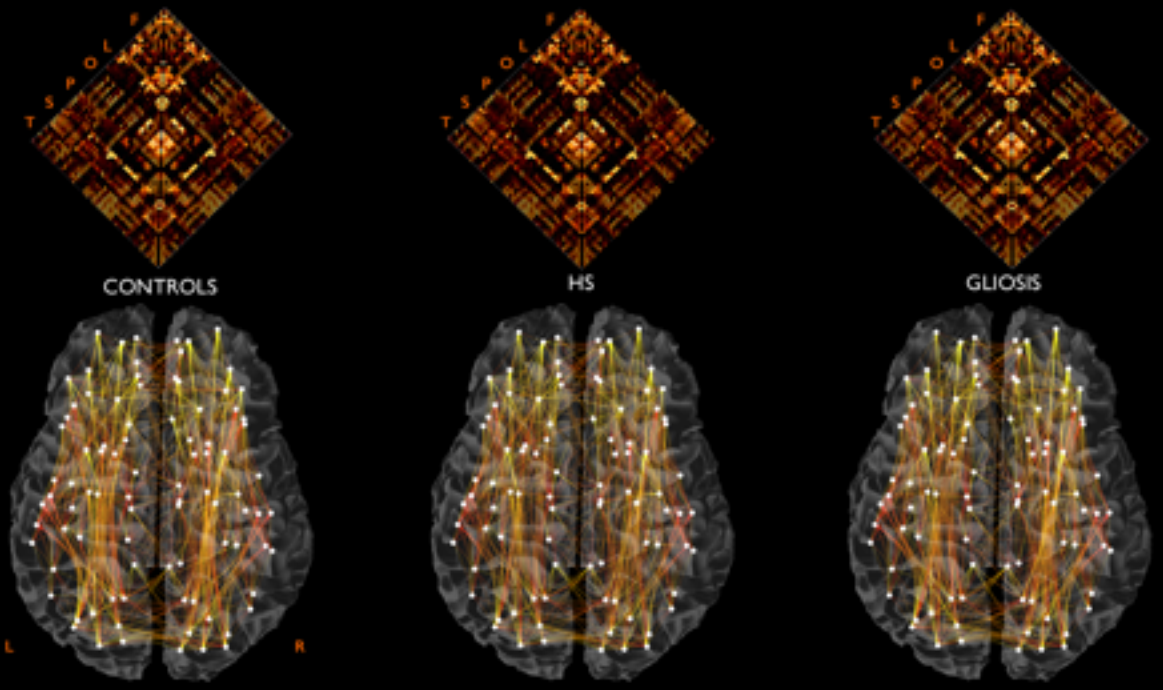
better outcome

IS THERE A RELATION BETWEEN
HS AND MACROSCALE NETWORK ANOMALIES?

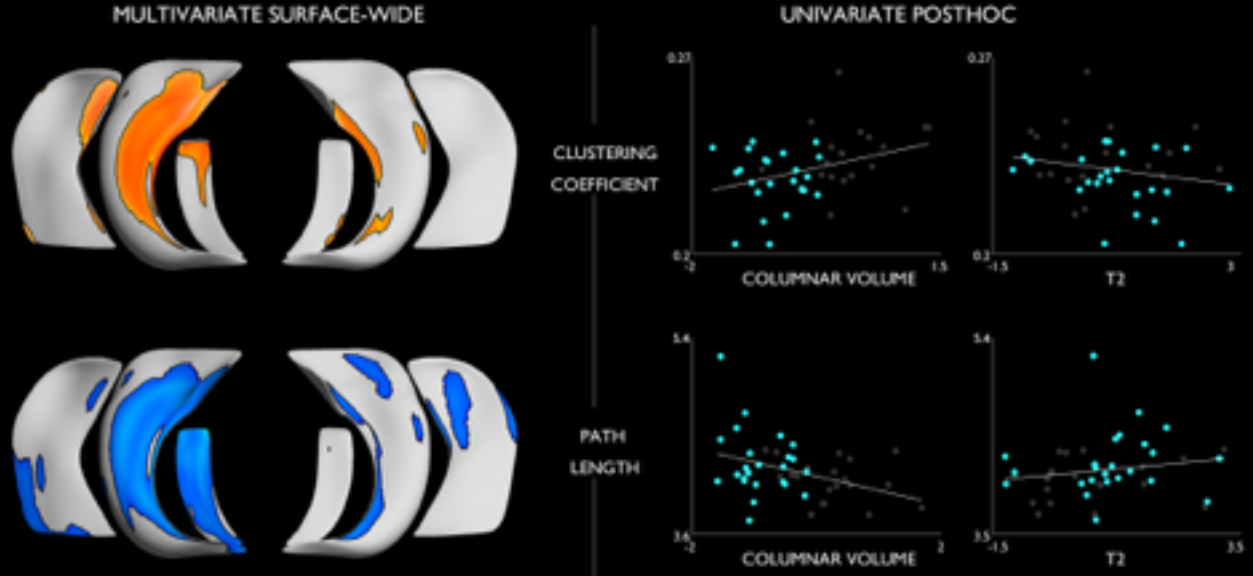




A STRUCTURAL CONNECTOMES



RELATION BETWEEN NETWORK MARKERS AND HIPPOCAMPAL SUBFIELD FEATURES



in preparation

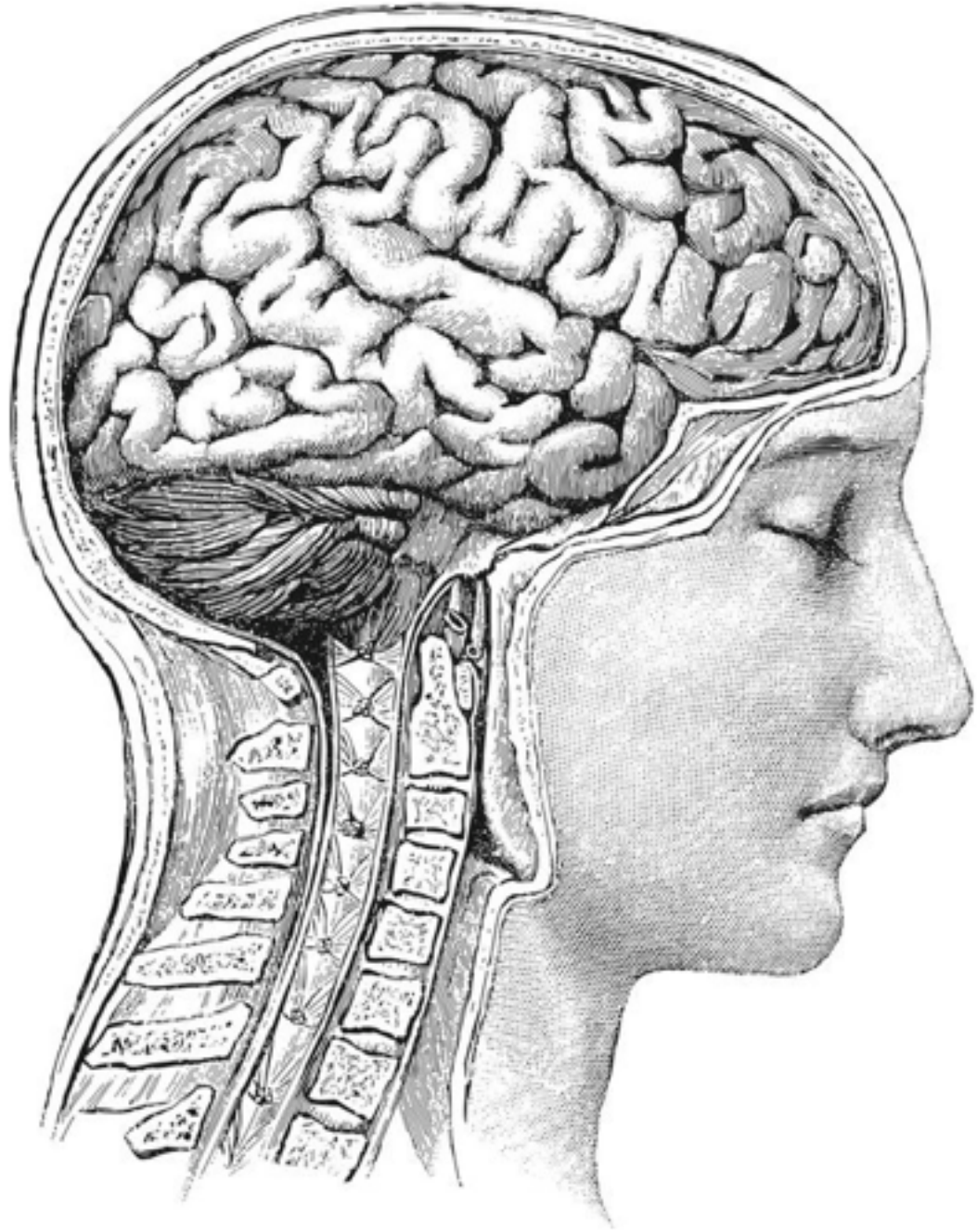
SUMMARY | CONCLUSIONS

MULTIPARAMETER MRI:
IN-VIVO DESCRIPTION OF HS IN TLE

WHOLE-BRAIN STUDIES INDICATE
MARCOLEVEL ANOMALIES BEYOND MTL

HS GRADES NEVERTHELESS CLOSELY
RELATE TO CONNECTOME PHENOTYPES

NEUROIMAGING AND CONNFCTOMICS
PROMISE TO PROVIDE PROGNOSTIC MARKERS
OF PATHOLOGY AND OUTCOMES



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CIHR IRSC

NSERC CRSNG

Canadian League Against Epilepsy