



Seizure Semiology

Mohamad Z. Koubeissi, MD
Professor of Neurology
Director, Epilepsy Center
The George Washington University



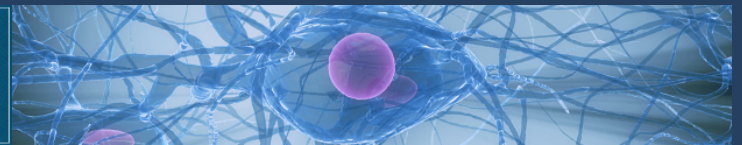
2023 **GW**
Epilepsy Board Review
& Best Practices

DISCLOSURES

- **Disclosure of Financial Relationships:
None related to the current talk**

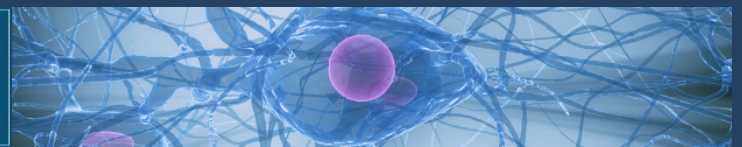
The Importance of Semiology

- **Planning invasive monitoring**
 - Non-lesional
 - Lesional:
 - Dual
 - Extensive (e.g. Catenoix et al. 2013)
- **Planning post-processing of imaging studies**
 - (e.g. Bernasconi et al. ; Bien et al. 2009)



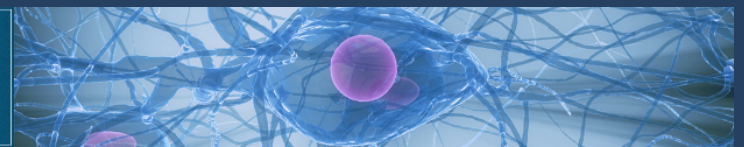
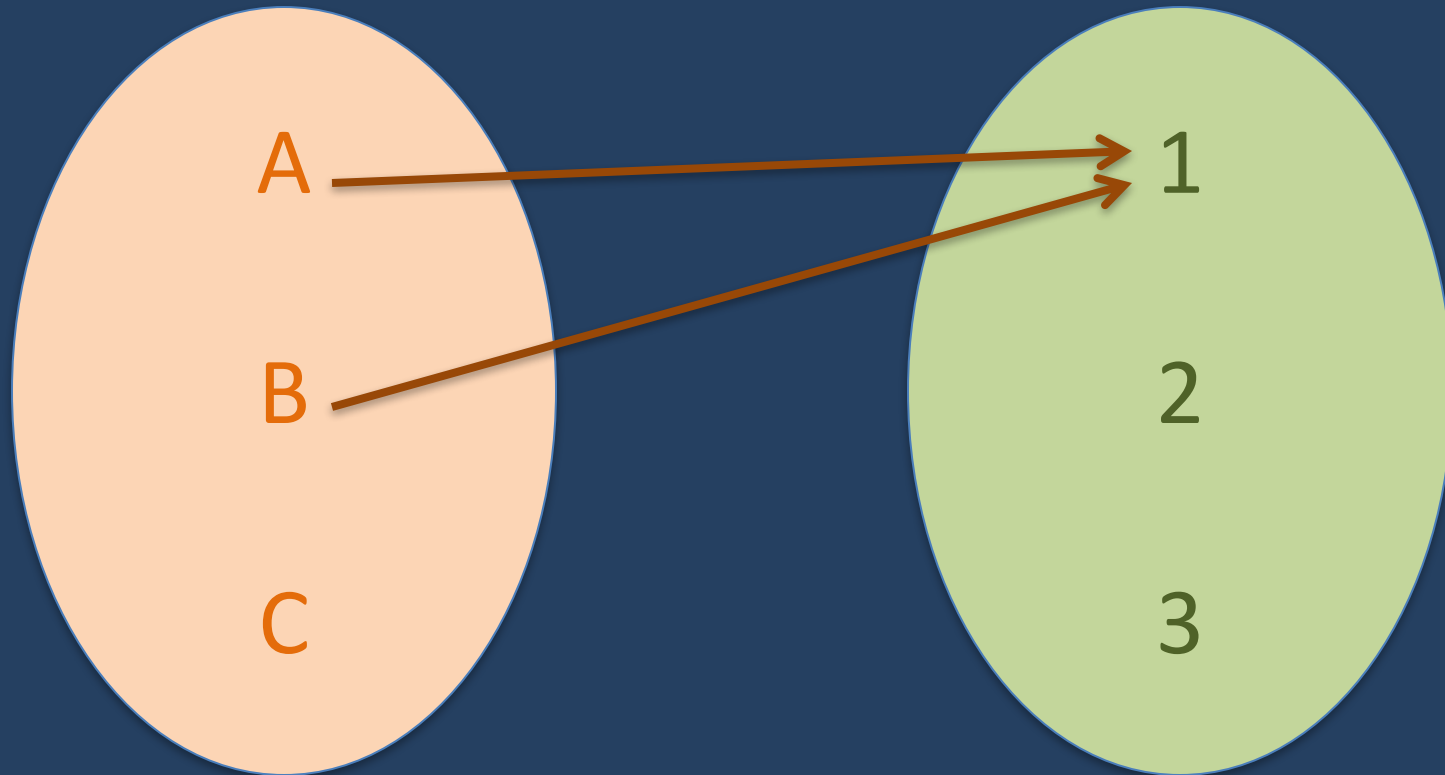
How to study semiology?

- **Surgical outcome**
 - Seizure freedom means seizure focus was responsible for earliest seizure sign?
 - Duration of follow-up
 - Seizure recurrence: same or new semiology?
- **Anatomo-clinical correlations**
 - No need for resective surgery
 - Electrode sampling
 - Specificity of a region? – “The Network” concept
 - Childhood onset seizures: Different “Wiring”?

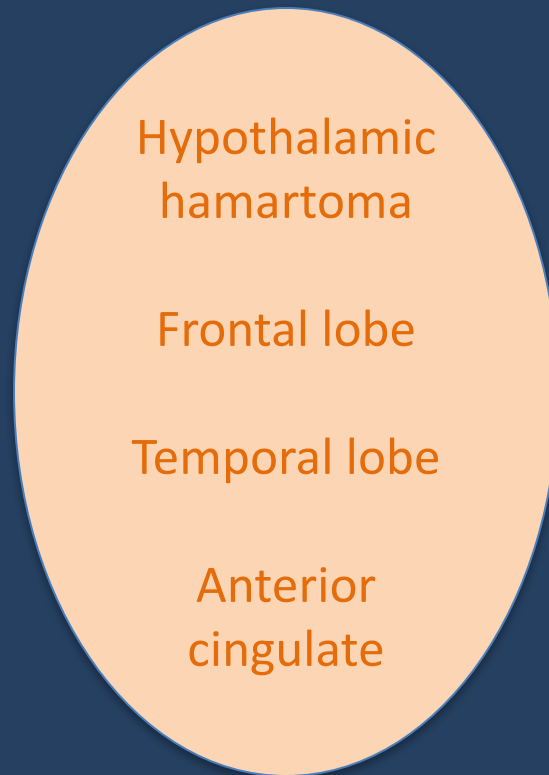


Epileptogenic Zone

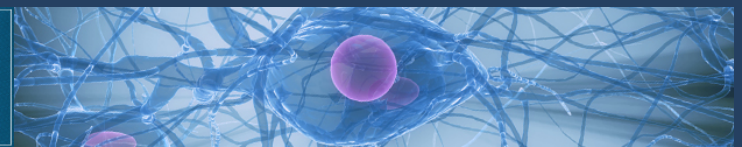
Symptomatogenic Zone

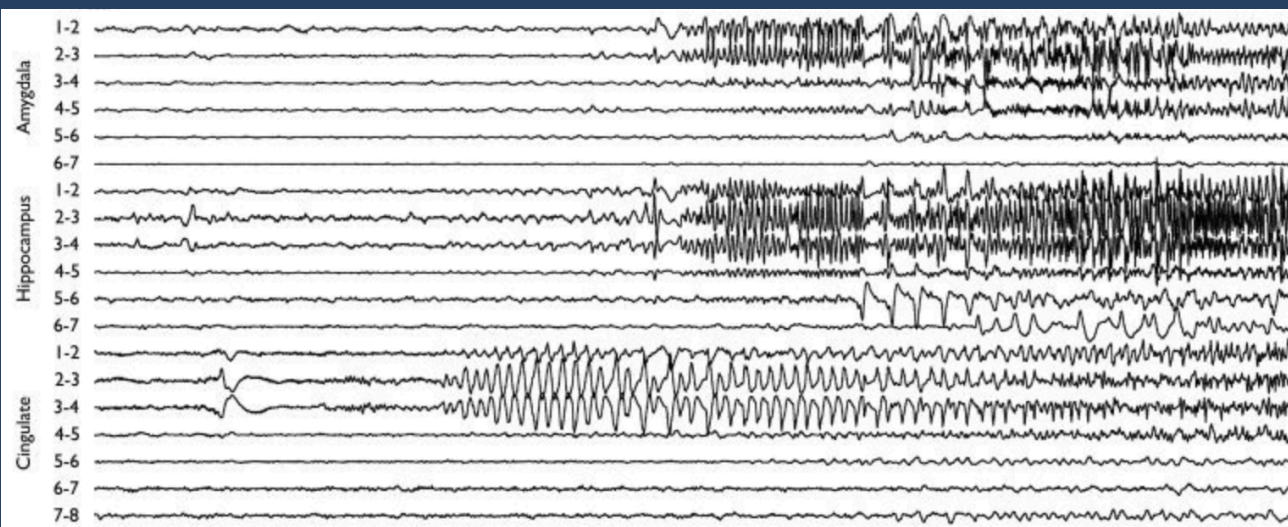
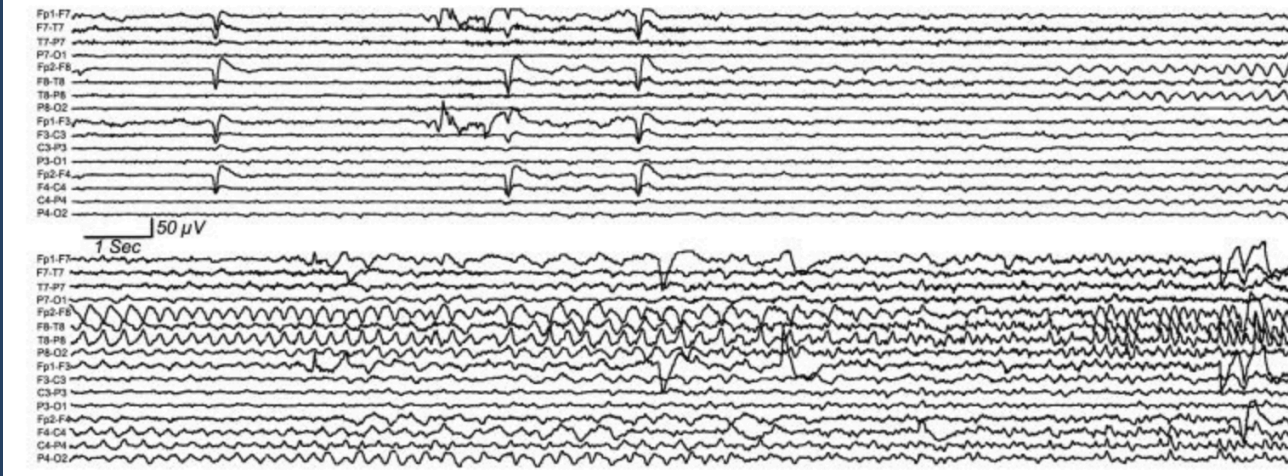
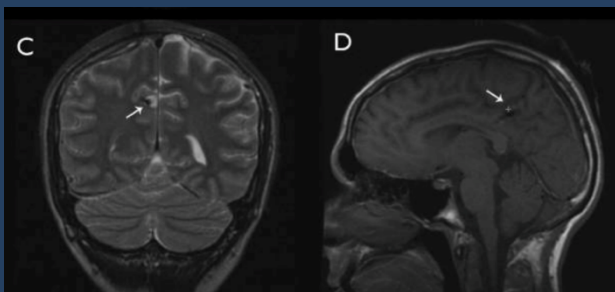
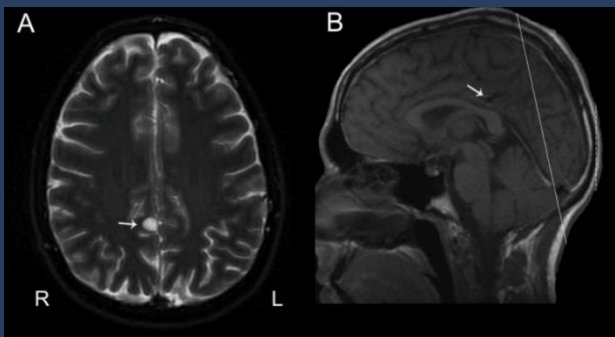


Epileptogenic Zone

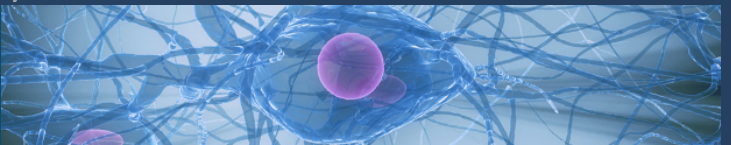


Symptomatogenic Zone



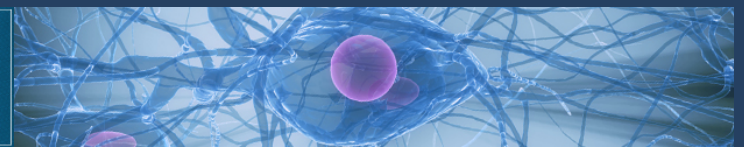
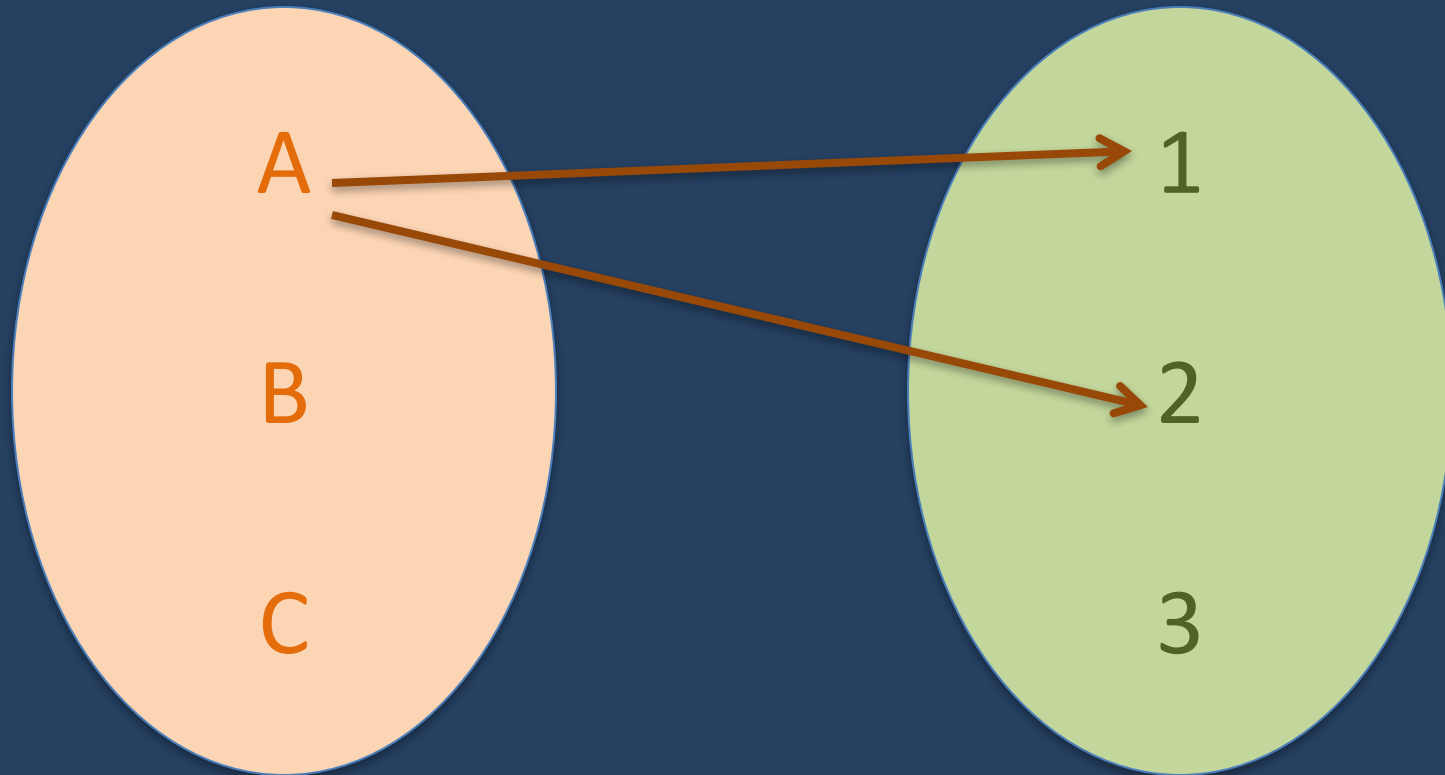


(Koubeissi et al. 2009)



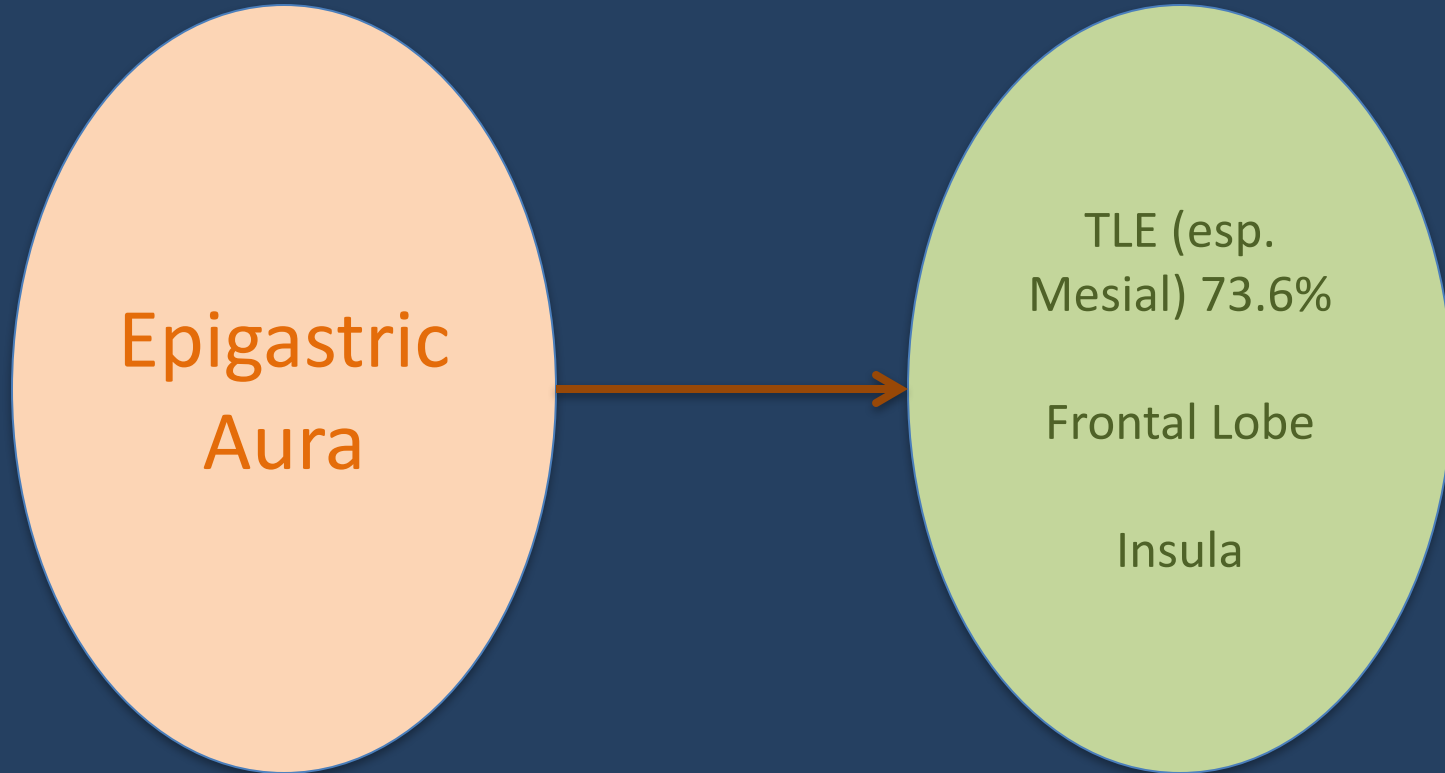
Epileptogenic Zone

Symptomatogenic Zone

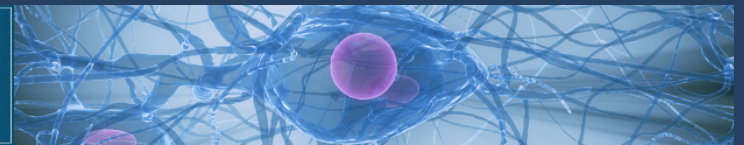


Epileptogenic Zone

Symptomatogenic Zone



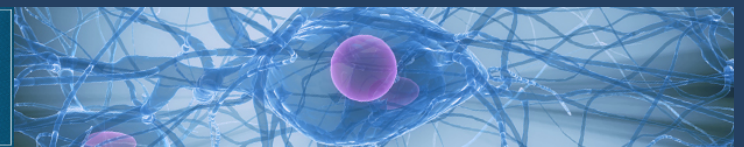
Beniczky et al. (2022) Epileptic_Disord



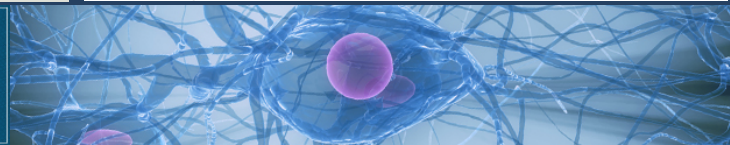
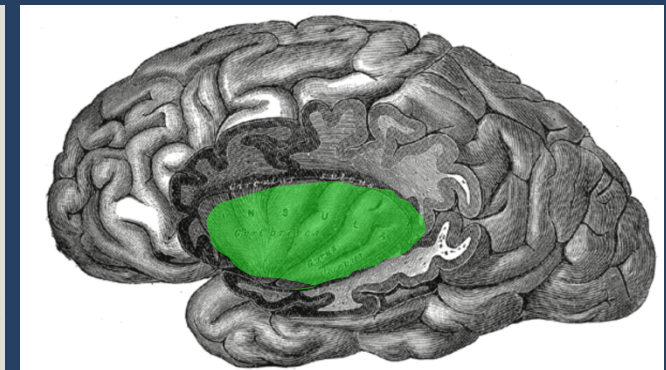
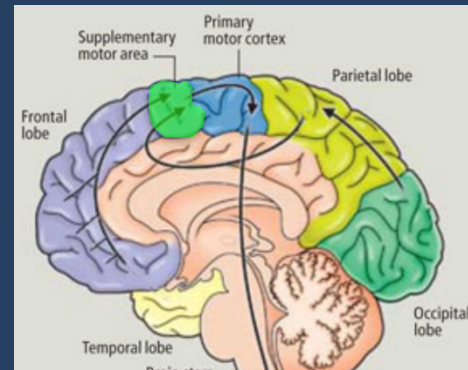
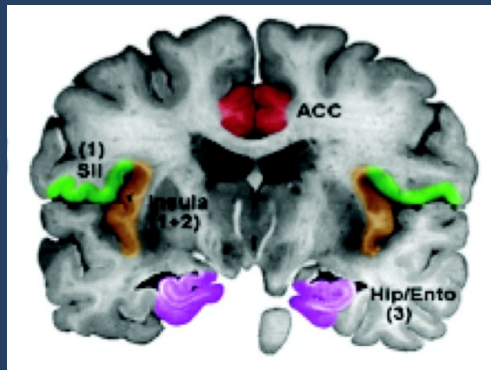
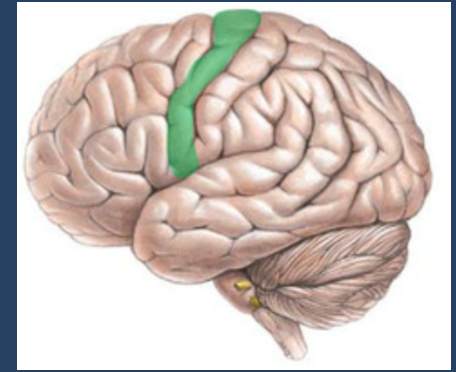
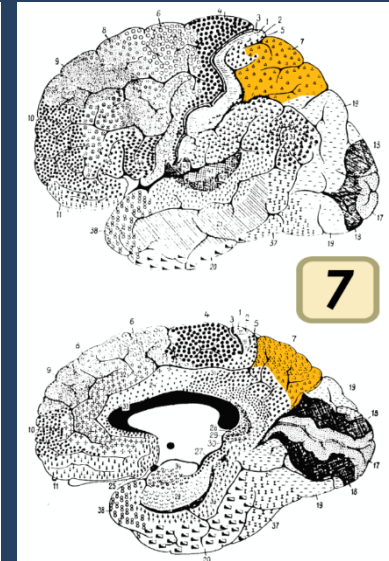
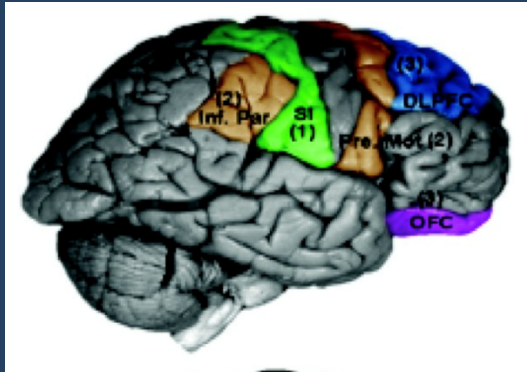
Semiology: General Considerations

- **Primary cortex: elemental hallucinations**
 - Auditory: Engine-like
 - Visual: flashes of light
 - Sensory: tingling, numbness
- **Association cortex**
 - Less direct relation with the peripheral nervous system
 - Widely distributed networks → alteration of awareness
- **Synchronization**
 - Decorrelation → “release” phenomena
 - Increased synchronization → Déjà vu
- **Discharge frequency**
 - Fast, gamma discharge tends to deactivate normal function
 - Slower theta discharge may mimic physiological function

(Chauvel and McGonigal 2014)

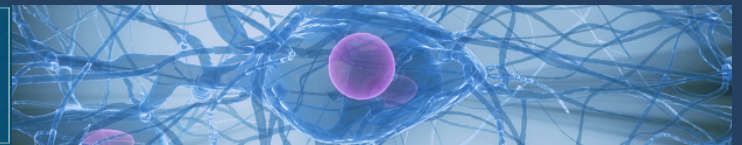


Somatosensory



Vision

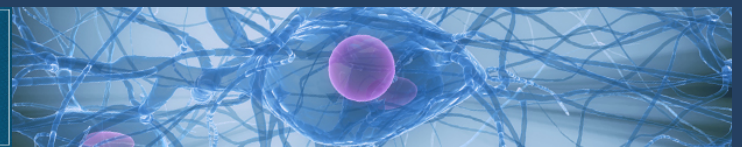
- **Elementary**
 - Colored circles
 - Twinkling stars
 - Moving flies
- **Complex**
 - Dyschromatopsia
 - Metamorphopsia

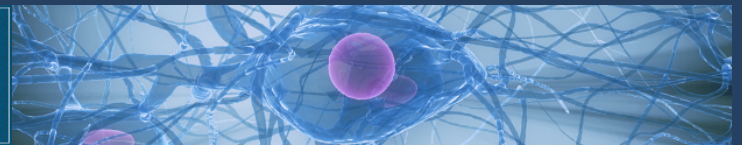


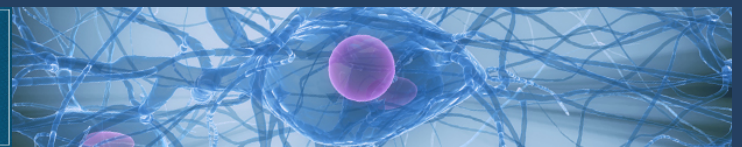
Simple Motor Seizures: Tonic

- Sustained contractions for several seconds
- Proximal muscle
- Uni- or bilateral
- Mostly asymmetric
- SMA seizures may be bilateral with preserved consciousness
- in frontal lobe epilepsy (62.2%) [32% bilateral]
- In temporal lobe epilepsy (1.7%) [only unilateral]
- If unilateral, then lateralizing

(Tufenkjian and Lüders 2013)

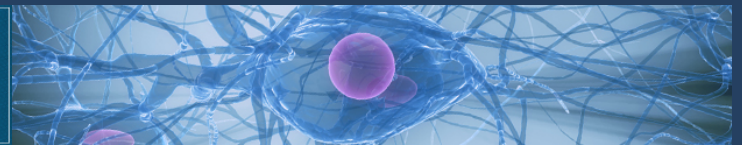






Secondarily generalized seizures

- **Sequence of motor manifestations:**
 - Version
 - Contralateral tonic face contraction
 - M2e position
 - sign of four
- **Lateralizing, but not localizing**

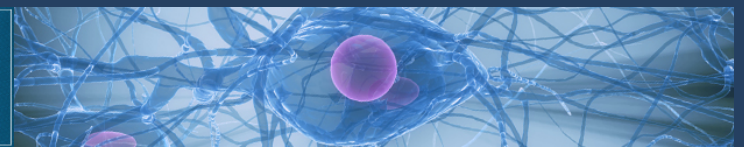


Article abstract—We studied 61 spontaneous seizures in 27 epileptic patients with simultaneous EEG and video recording. Each seizure had an initial forced turning (versive) head and eye movement contralateral to the EEG location of seizure onset. Twelve of the 27 secondarily generalized versive seizures also had ipsilateral head and eye version at the end of the generalized convulsion. Initial contraversion and late ipsiversion both appeared to result from ictal activation of frontal contraversive areas in the hemisphere that, at the time, was predominantly involved in the seizure discharge. During initial contraversion, ictal activation was predominant in the hemisphere of seizure onset; during late ipsiversion, in the hemisphere involved by secondary generalization. Late version, unlike initial version, is frequently ipsilateral and cannot be assumed to indicate seizure onset in the contralateral hemisphere.

NEUROLOGY 1986;36:1212-1217

Ipsilateral forced head and eye turning at the end of the generalized tonic-clonic phase of versive seizures

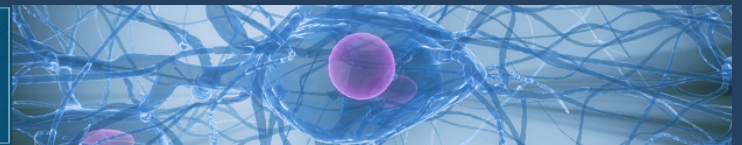
Elaine Wyllie, MD; Hans Lüders, MD, PhD; Harold H. Morris, MD; Ronald P. Lesser, MD;
Dudley S. Dinner, MD; and Lawrence Goldstick, MD

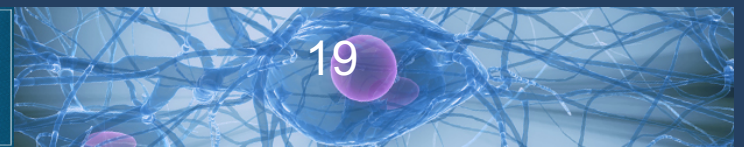


Clonic Seizures

- Regular contractions at 0.2-5 per second
- The symptomatogenic zone is M1
- The epileptogenic zone is close to M1 if no alteration of awareness
- In TLE, the face, frontal eye field, and hand areas are affected earlier than legs
- Unilateral clonic seizures are highly lateralizing
- End of seizure ipsilateral clonus

(Tufenkjian and Lüders 2013)





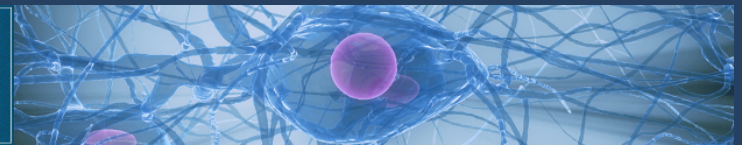
Clinical Seizure Lateralization in Frontal Lobe Epilepsy

Silvia Beatrice Bonelli, Stefanie Lurger, Fritz Zimprich, Elisabeth Stogmann, Eva Assem-Hilger,
and Christoph Baumgartner

Department of Neurology, Medical University of Vienna, Vienna, Austria

Asymmetric ending of secondarily generalized seizures

Asymmetric ending of the clonic phase at the end of a GTC seizure, with the last clonic jerk ipsilateral to the hemisphere of seizure onset (Leutmezer et al., 2002; Trinka et al., 2002).

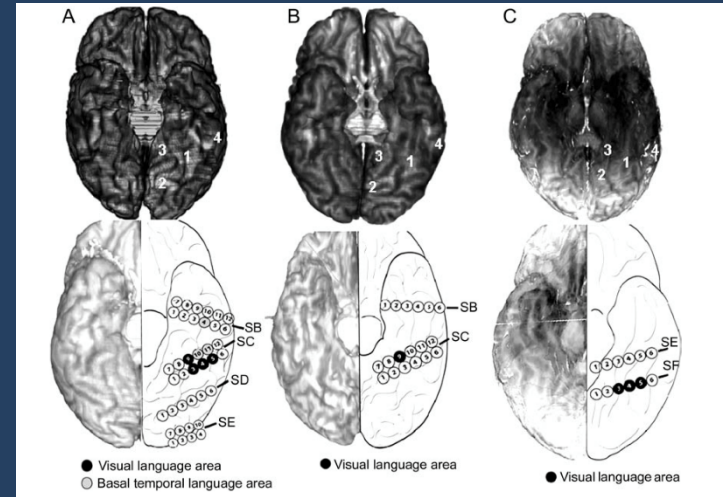




J. Mani, MD, DM
 B. Diehl, MD
 Z. Piao, MS
 S.S. Schuele, MD, MPH
 E. LaPresto, MS
 P. Liu, MS
 D.R. Nair, MD
 D.S. Dinner, MD
 H.O. Lüders, MD, PhD

Evidence for a basal temporal visual language center

Cortical stimulation producing pure alexia

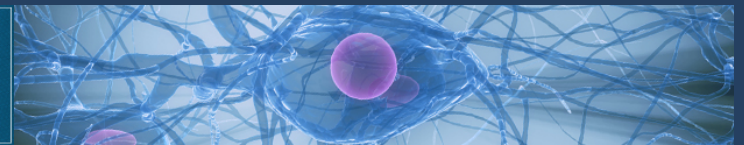


Epilepsia, 41(4):457-462, 2000
 Lippincott Williams & Wilkins, Inc., Philadelphia
 © International League Against Epilepsy

Clinical Research

Lateralizing Value of Asymmetric Tonic Limb Posturing Observed in Secondarily Generalized Tonic-Clonic Seizures

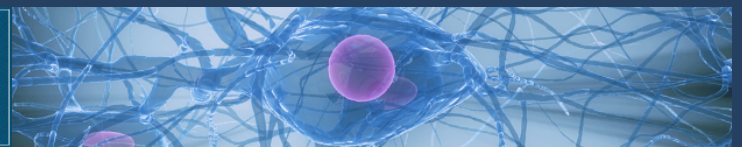
Prakash Kotagal, *Andrew Bleasel, *Eric Geller, Pongkiat Kankirawatana, Bhagwan I. Moorjani, and †Lisa Rybicki



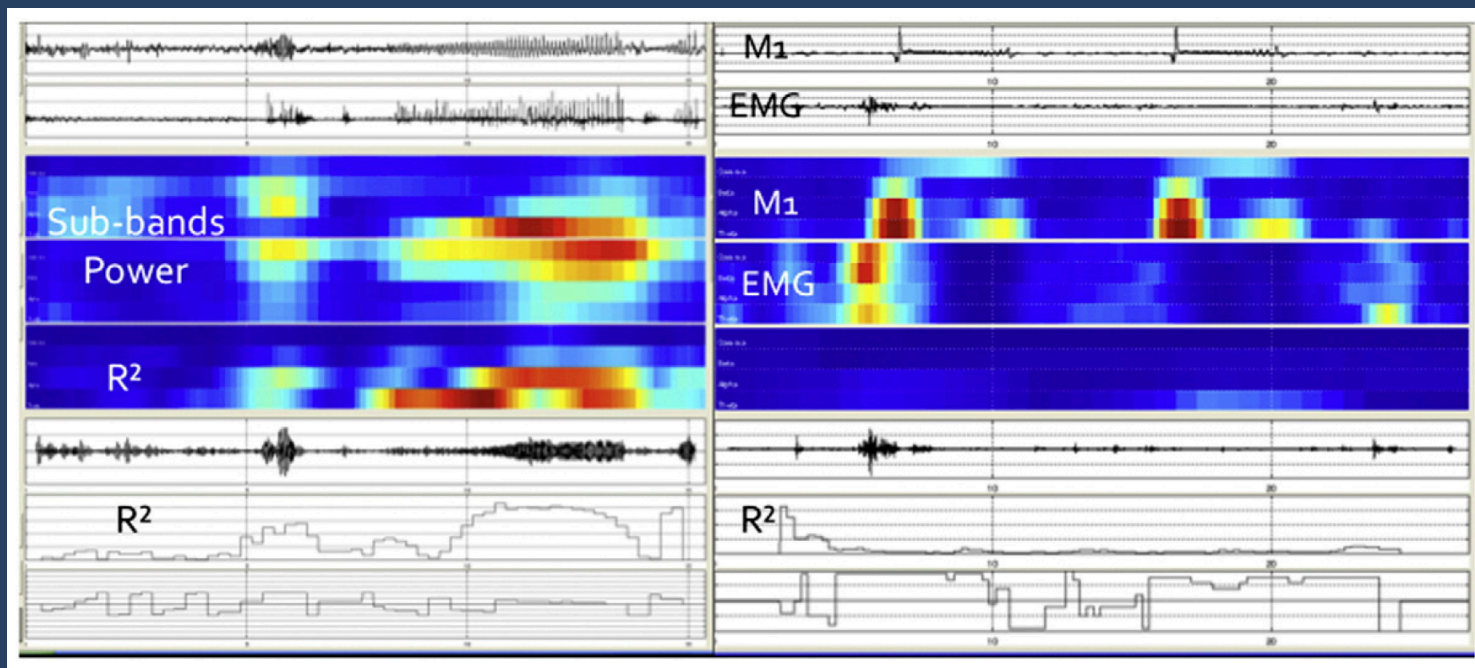
Complex Motor Seizures

- The topologic character is less marked
- Complexity is greater
- Inhibitory, namely negative components
- Pre-SMA seizures:
 - Speech arrest
 - Quavering vocalization
 - Arrest of movement or subtle leg repositioning
 - Negative motor areas

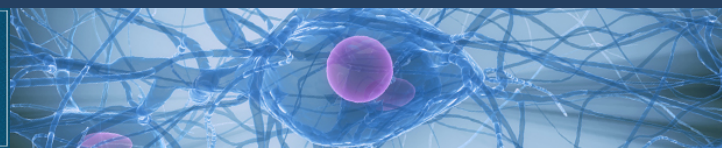
(Chauvel and McGonigal 2014)



Central Epilepsy: Correlations between SEEG and EMG



(Chauvel and McGonigal 2014)

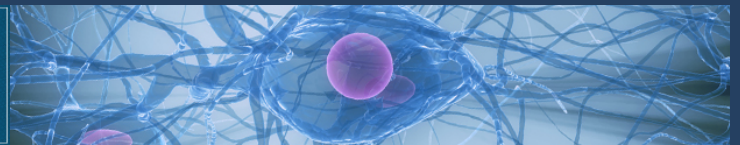




GW

SCHOOL OF MEDICINE
AND HEALTH SCIENCES

The Department of Neurology



Dystonic posturing in complex partial seizures of temporal lobe onset: A new lateralizing sign

P. Kotagal, MD; H. Lüders, MD, PhD; H.H. Morris, MD; D.S. Dinner, MD; E. Wyllie, MD;
J. Godoy, MD; and A.D. Rothner, MD

Article abstract—We observed unilateral dystonic posturing of an arm or leg in 41 complex partial seizures (CPS) from 18 patients. In all cases this was contralateral to the ictal discharge. Unilateral automatisms occurred in 39 of 41 seizures on the side opposite the dystonic limb. Version occurred in 11 of the 41 CPS to the same side as the dystonic posturing and always followed the posturing. Subdural recordings of seven seizures showed ictal onset from the mesial basal temporal lobe. At the onset of dystonic posturing, maximum ictal activity was in the basal temporal lobe with minimal involvement of the cerebral convexity. Unilateral dystonic posturing occurs frequently in CPS of temporal lobe onset and is a lateralizing sign with a high degree of specificity. It probably reflects spread of the ictal discharge to basal ganglia structures.

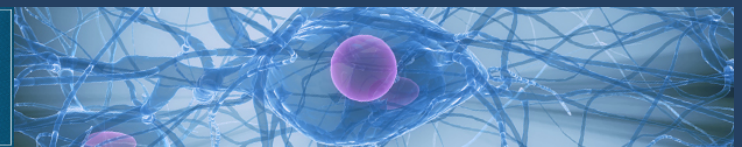
NEUROLOGY 1989;39:196-201

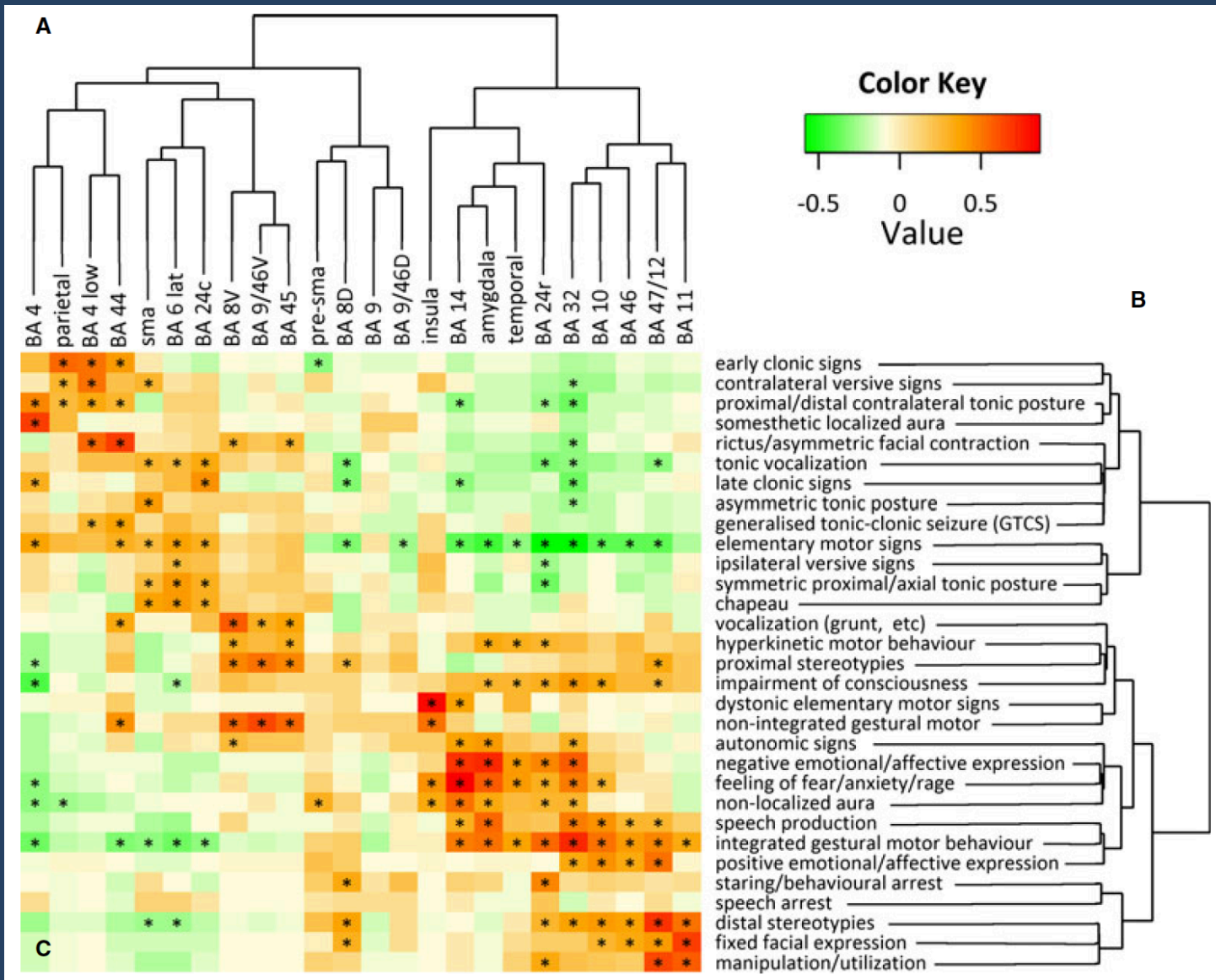
Frontal lobe seizures: From clinical semiology to localization

*†¹Francesca Bonini, *†‡¹Aileen McGonigal, *†‡Agnès Trébuchon, *†‡Martine Gavaret,
*†‡Fabrice Bartolomei, *†§Bernard Giusiano, and *†‡Patrick Chauvel

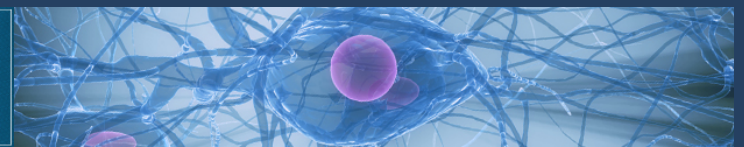
Epilepsia, 55(2):264–277, 2014
doi: 10.1111/epi.12490

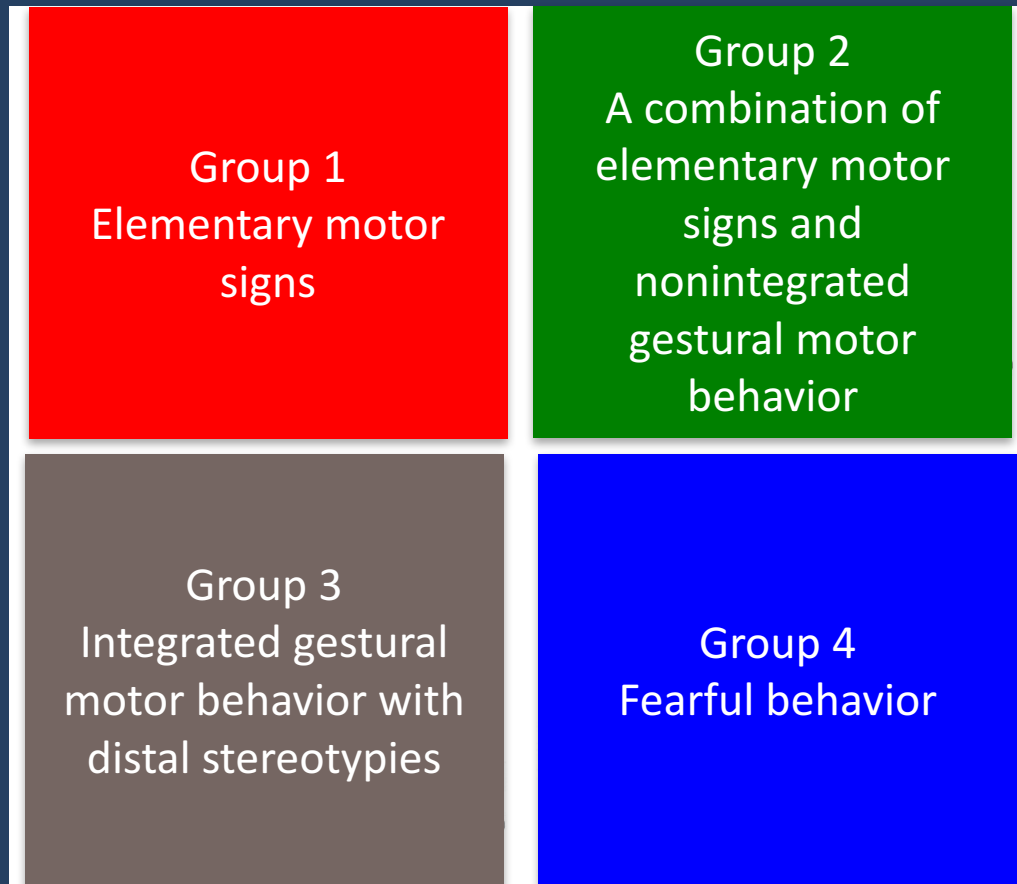
(Bonini et al 2014)



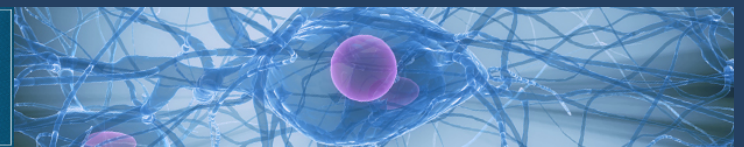


(Bonini et al 2014)



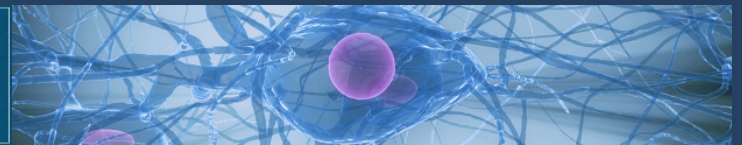


(Bonini et al 2014)



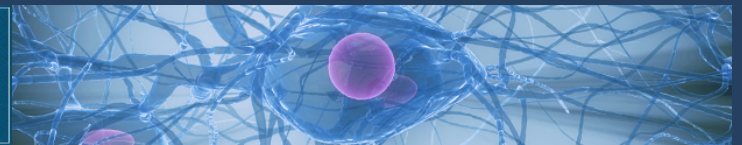
Consciousness

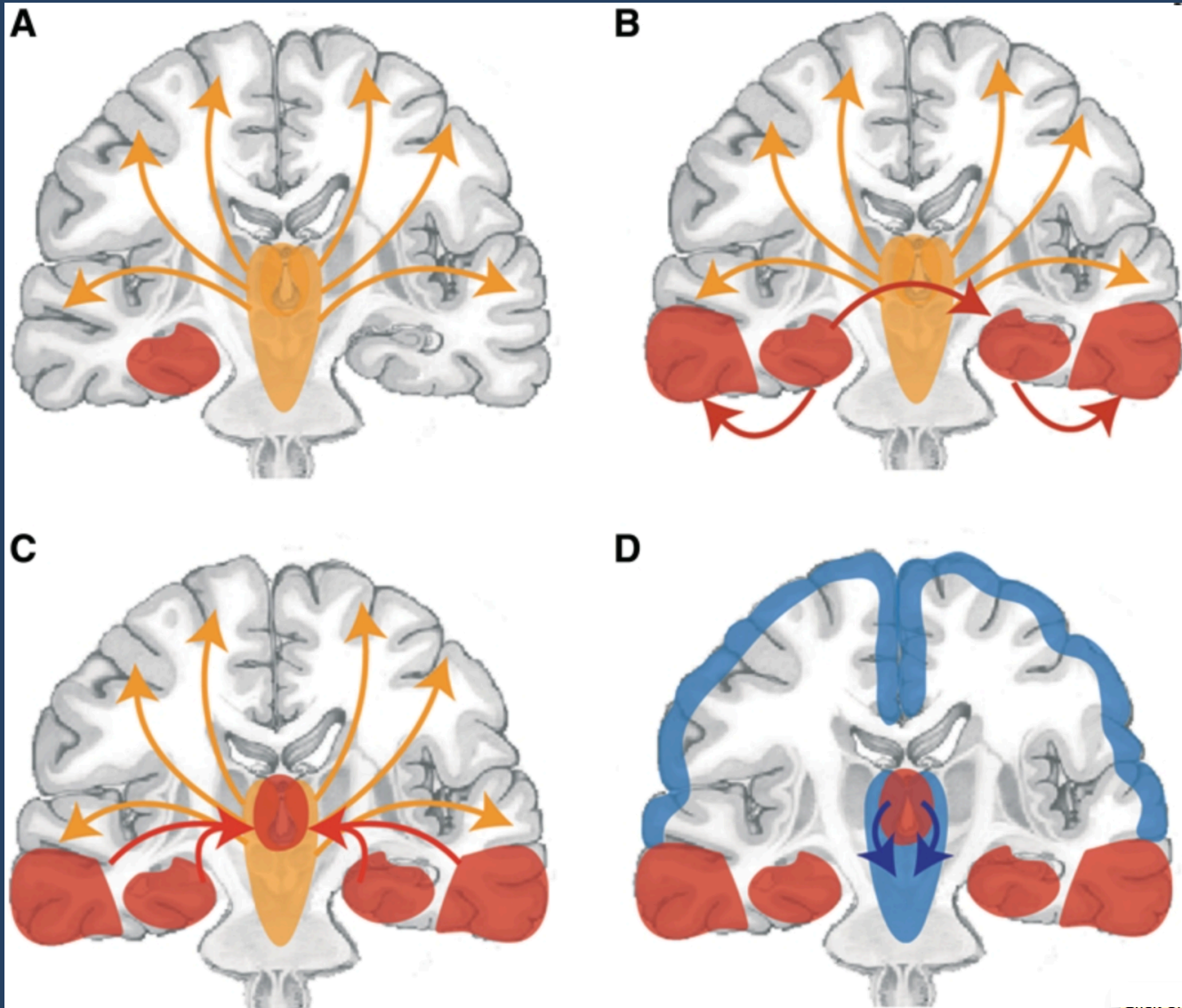
- Network inhibition hypothesis
- Consciousness access hypothesis
- Claustrum/Piriform Cortex



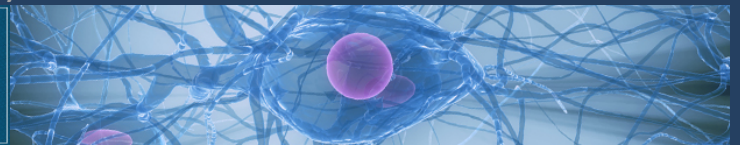
Consciousness

- Network inhibition hypothesis
- Consciousness access hypothesis
- Claustrum/Piriform Cortex



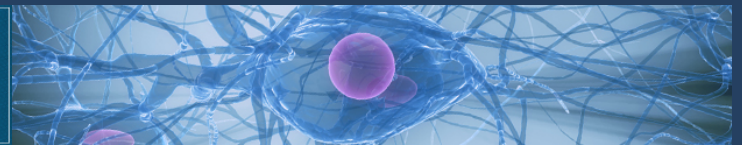


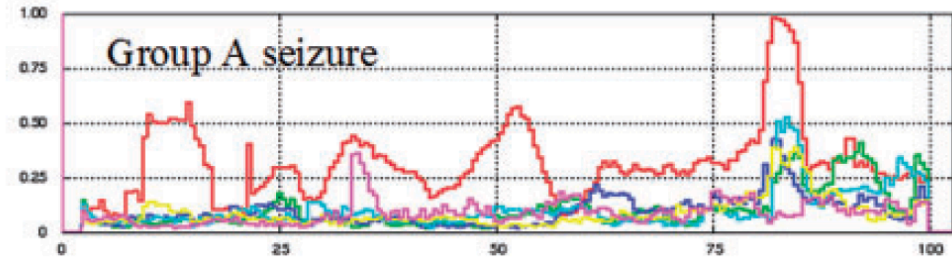
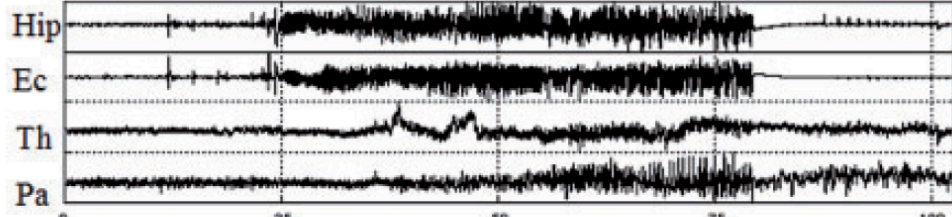
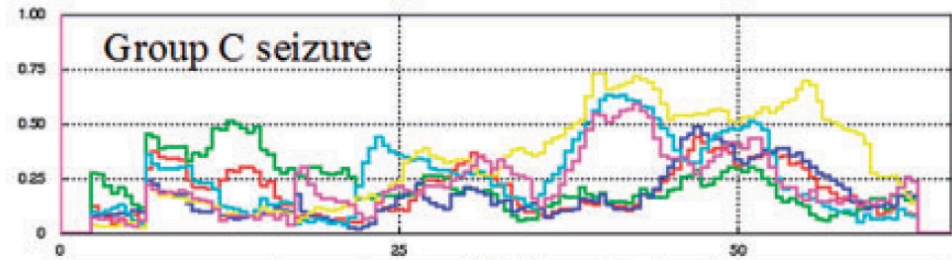
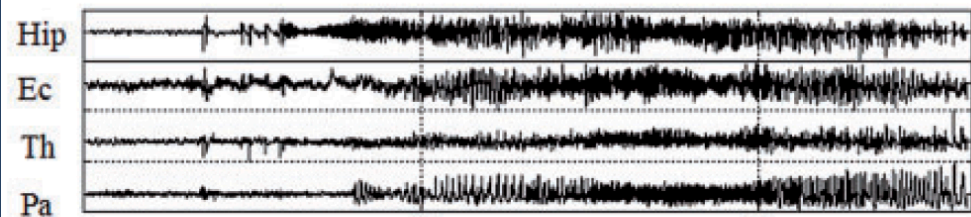
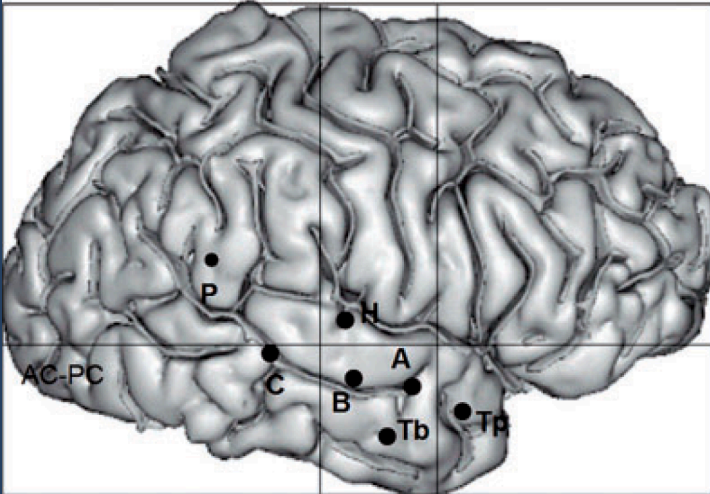
(Englot et al. 2010)



Consciousness

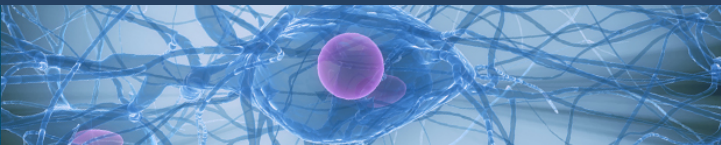
- Network inhibition hypothesis
- Consciousness access hypothesis
- Claustrum/Piriform Cortex





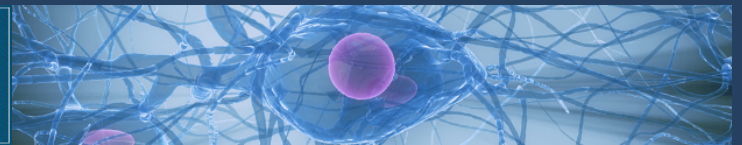
- Hip-Ec
- Hip-Th
- Hip-Pa
- Ec-Th
- EC-Pa
- Th-Pa

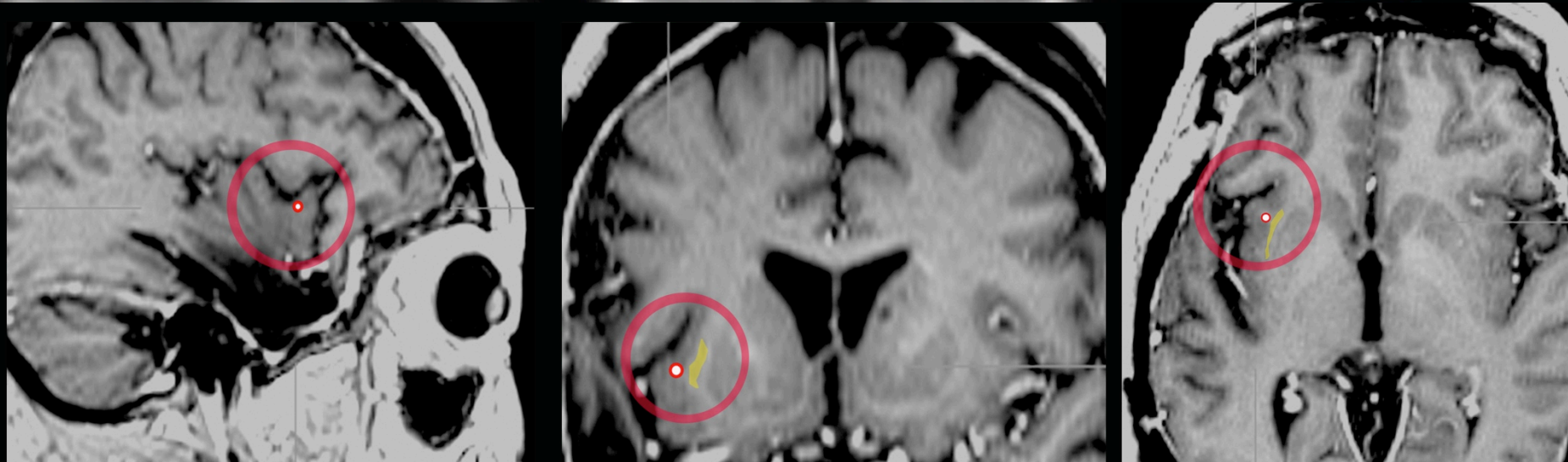
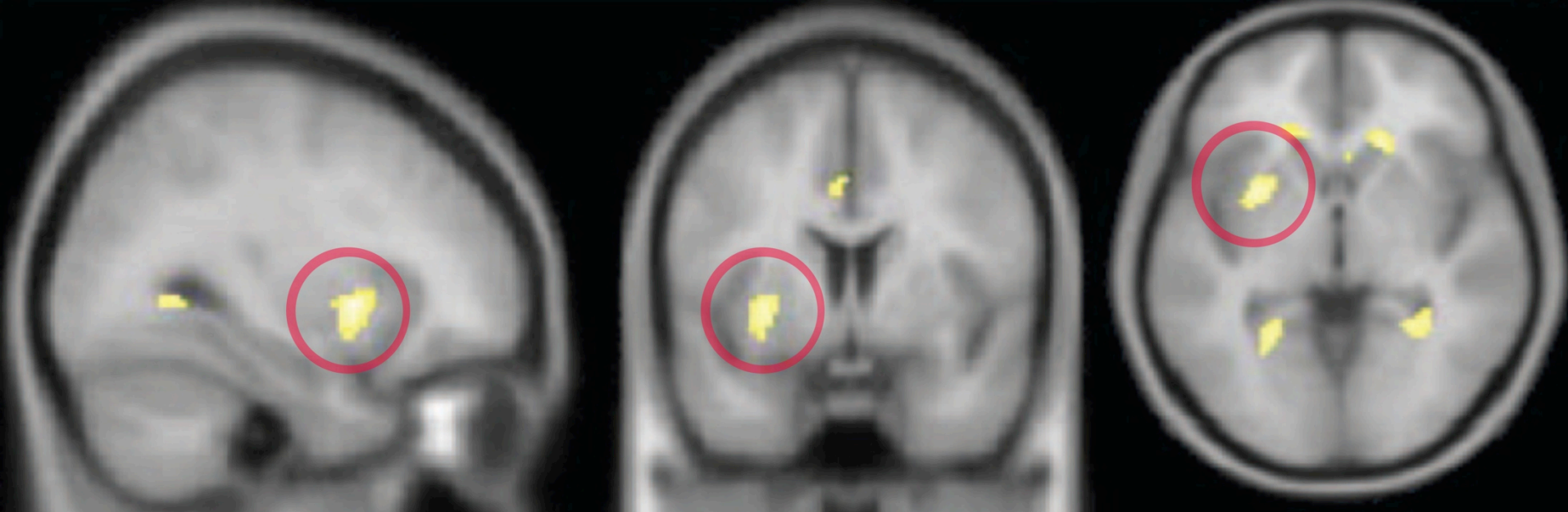
(Arthuis et al. 2009)



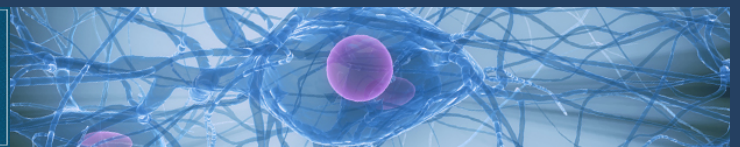
Consciousness

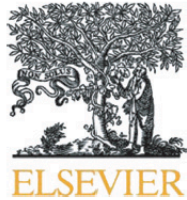
- Network inhibition hypothesis
- Consciousness access hypothesis
- **Clastrum/Piriform Cortex**





(Laufs et al 2011; Koubeissi et al *in print*)

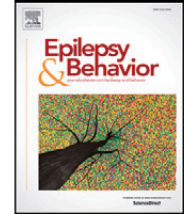




Contents lists available at ScienceDirect

Epilepsy & Behavior

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



Brief Communication

Yawning induced by focal electrical stimulation in the human brain

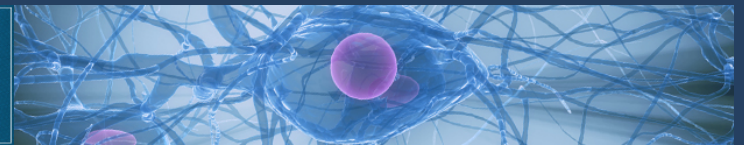
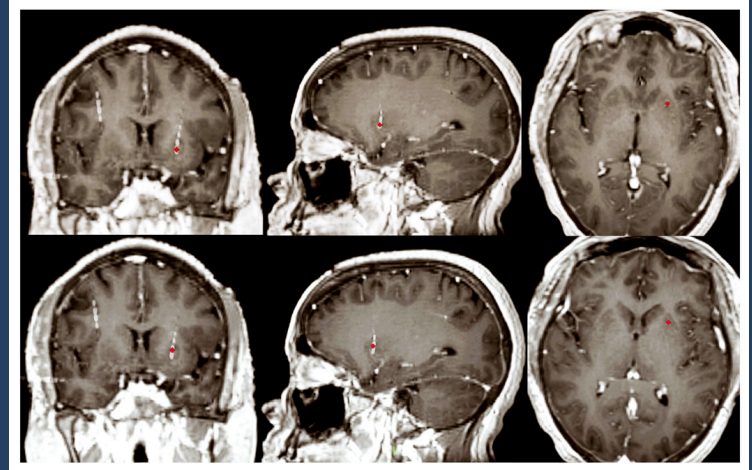


Sweta Joshi^a, Arezou Bayat^a, Linda Gagnon^a, Donald C. Shields^b, Mohamad Z. Koubeissi^{a,*}

^a Department of Neurology, George Washington University, 2150 Pennsylvania Avenue, 9th Floor, Washington, D.C. 20037, USA

^b Department of Neurological Surgery, George Washington University, 2150 Pennsylvania Avenue, Suite 7-420, Washington, D.C. 20037, USA

- A 46-year-old woman with epilepsy underwent SEEG
- The first two contacts of a depth electrode that was intended to sample the left insula were in contact with the putamen
- Stimulation of these contacts at 6 mA and 8 mA consistently elicited yawning on two separate days
- Engagement in arithmetic and motor tasks during stimulation did not result in yawning

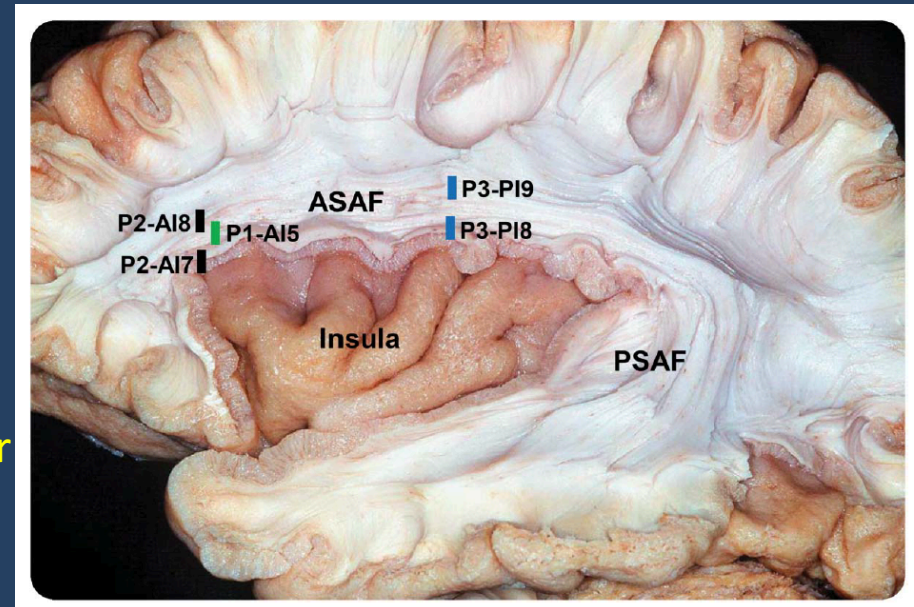


Mohamad Z. Koubeissi, MD
Guadalupe Fernandez-Baca Vaca, MD
Robert Maciunas, MD†
Caspar Stephani, MD

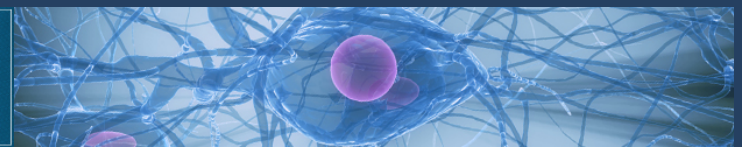
A white matter tract mediating awareness of speech

Neurology® 2016;86:1-3

- SEEG in 3 patients sampling suprainular white matter of the left hemisphere
- Stimulation resulted in speech disturbance and speech arrest. In addition stimulation **reproducibly induced complex verbal auditory phenomena including (1) hearing one's own voice in the absence of overt speech, and (2) lack of perception of arrest or alteration in ongoing repetition of words**



The anterior part of the arcuate fasciculus is part of a network that is important in the mediation of speech planning and awareness likely by linking the language areas of the inferior parietal and posterior inferior frontal cortices



Association Between Semiology and Anatomo-functional Localization in Patients With Cingulate Epilepsy

A Cohort Study

Veronica Pelliccia, MD, Pietro Avanzini, PhD, Michele Rizzi, MD, Fausto Caruana, PhD, Laura Tassi, MD, Stefano Francione, MD, Francesca Gozzo, MD, Valeria Mariani, MD, PhD, Piergiorgio d'Orio, MD, Laura Castana, MD, Roberto Mai, MD, Michele Terzaghi, MD, Lino Nobili, MD, PhD, and Ivana Sartori, MD

Neurology[®] 2022;98:e2211-e2223. doi:10.1212/WNL.0000000000200145

Correspondence

Dr. Pelliccia
veronica.pelliccia@
ospedaleniguarda.it

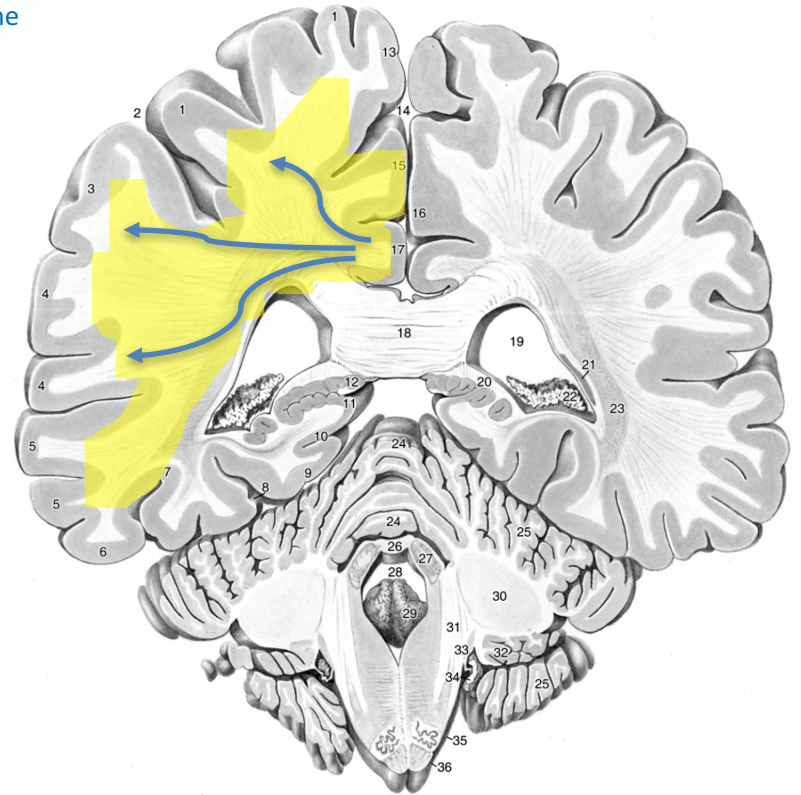
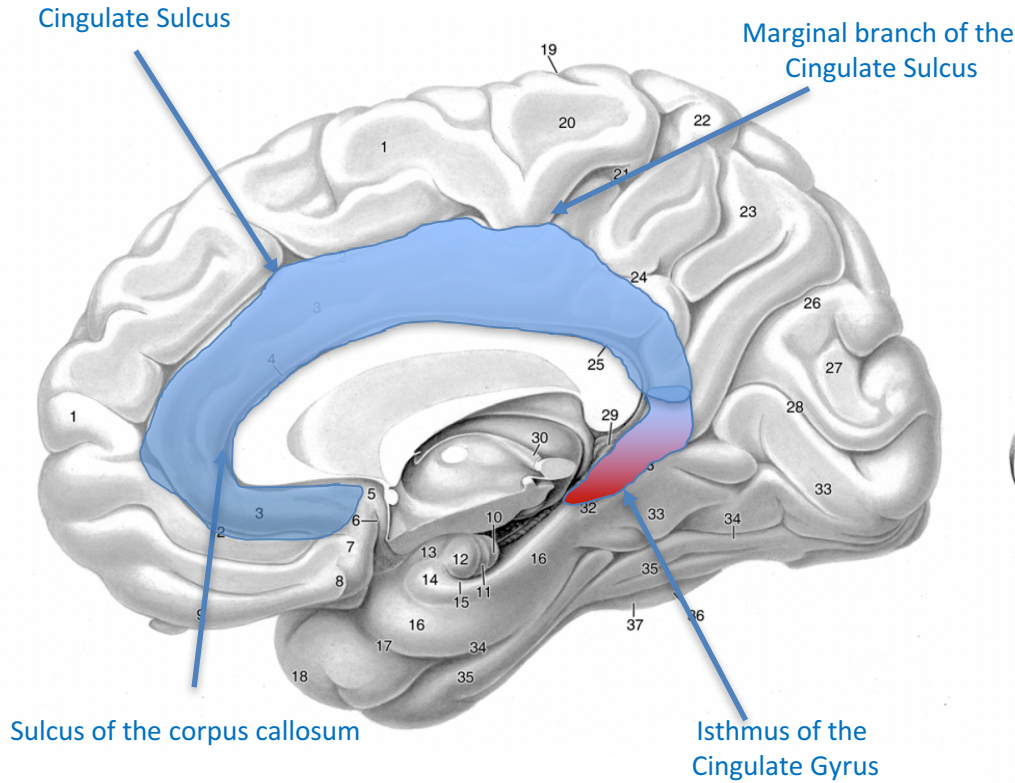
THE GEORGE WASHINGTON UNIVERSITY

WASHINGTON, DC

Introduction

- Cingulate epilepsy is rare
- Can mimic other focal epilepsies → electroclinical characterization can be challenging
- Cingulate involvement should be considered in the workup of frontal and extrafrontal SOZ
- Cingulate cortex has wide connectivity with other structures
- Scalp EEG has poor utility in SOZ localization and lateralization because of the deep position of the cingulate cortex

Anatomy



THE GEORGE WASHINGTON UNIVERSITY

WASHINGTON, DC

Introduction

- The cingulate can be divided into at least 3 main sectors
 - The anterior CC [ACC] → emotional and social behavior
 - The mid-CC [MCC] → feedback-guided decision making & premotor functions
 - anterior midcingulate cortex [aMCC]
 - posterior midcingulate cortex [pMCC]
 - The posterior CC [PCC] → visuospatial orientation & memory functions
- Each has a different set of connections

Motor and emotional behaviours elicited by electrical stimulation of the human cingulate cortex

Fausto Caruana,¹ Marzio Gerbella,² Pietro Avanzini,³ Francesca Gozzo,⁴ Veronica Pelliccia,^{1,4} Roberto Mai,⁴ Rouhollah O. Abdollahi,¹ Francesco Cardinale,⁴ Ivana Sartori,⁴ Giorgio Lo Russo⁴ and Giacomo Rizzolatti^{1,3}

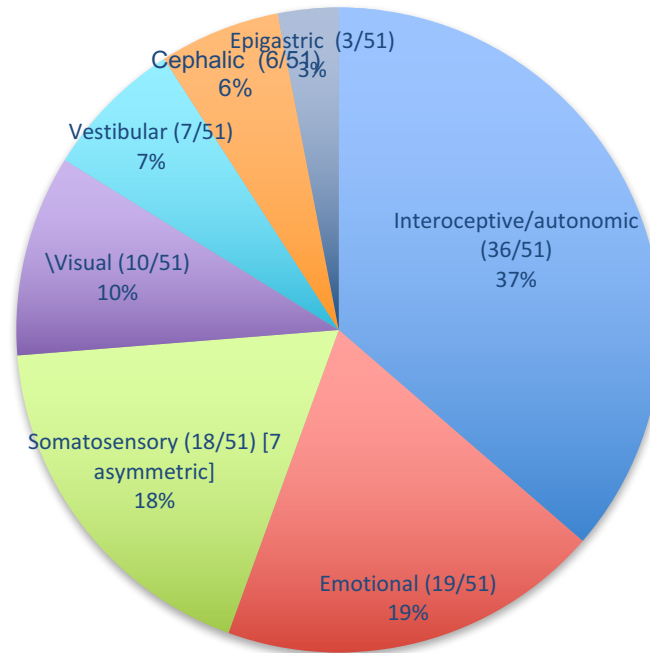
- ACC Emotive, autonomic, and interoceptive functions
- aMCC Goal-oriented behaviors
- pMCC Vestibular and somatosensory responses
- PCC Largely unresponsive and associated with visual sensations

THE GEORGE WASHINGTON UNIVERSITY

WASHINGTON, DC

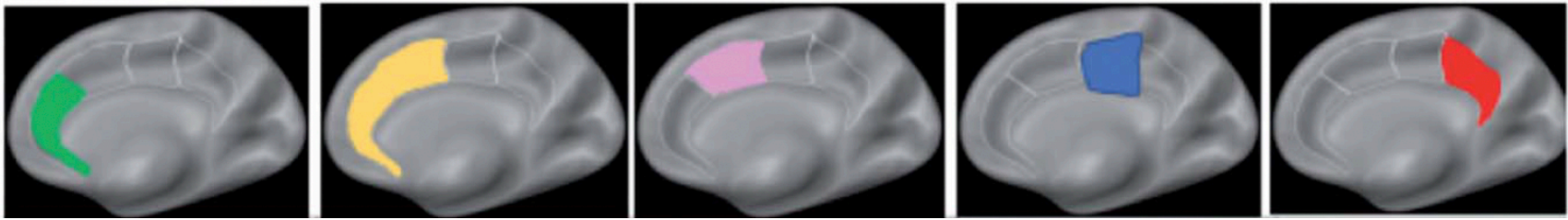
Subjective Symptoms

- Reported by 51 patients (89.5%)
- 6 patients (one child) without subjective symptoms



THE GEORGE WASHINGTON UNIVERSITY

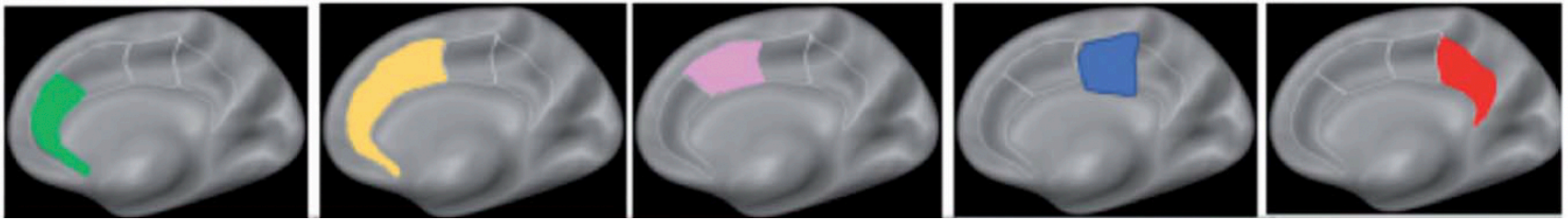
WASHINGTON, DC



- ACC seizures were characterized by complex primordial behaviors, which could include violent reactions or sexual actions, & strong emotional components with impaired awareness, with excessive vocalizations
- The ACC plays a role in vocalization associated with the expression of internal states
- These closely resemble parasomnic and psychiatric manifestations
- ACC has a role in violent behaviors in psychiatric diseases
- Akinetic mutism (bilateral).

THE GEORGE WASHINGTON UNIVERSITY

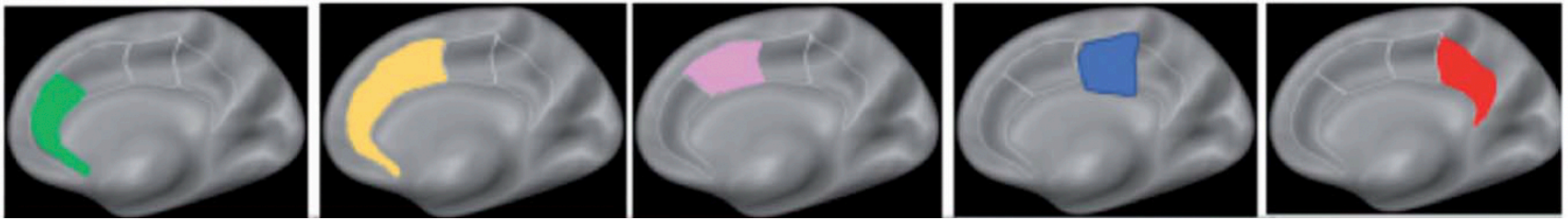
WASHINGTON, DC



- pMCC, seizures became slower and stiffer, without productive vocalizations, but rather with the emission of guttural sounds

THE GEORGE WASHINGTON UNIVERSITY

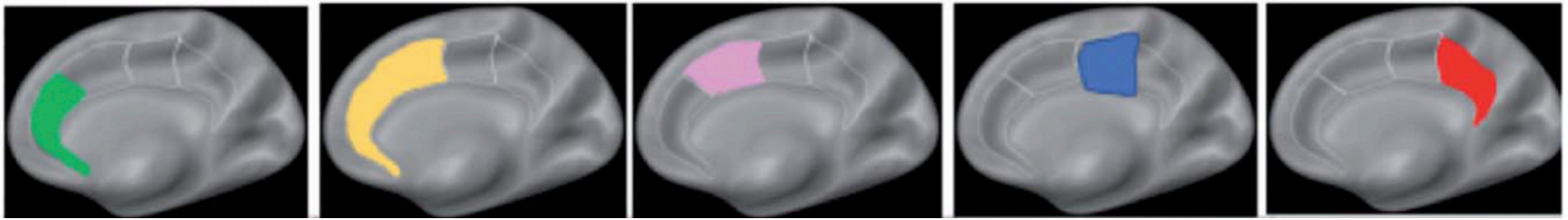
WASHINGTON, DC



- From ACC to pMCC, there are different ictal movement patterns
- pMCC seizures showed asymmetric tonic/dystonic postures, especially arms less fluidity, and less repetitiveness
- Clonic jerks and postictal deficit were seen

THE GEORGE WASHINGTON UNIVERSITY

WASHINGTON, DC



- PCC seizures were paucisymptomatic or similar to MTLE
- The PCC is connected with the hippocampus
- Ictal propagation to the PCC is frequently observed among patients with TLE
- Explanation for persistence of seizures after surgery in nonlesional patients undergoing anteromesial temporal resection

THE GEORGE WASHINGTON UNIVERSITY

WASHINGTON, DC



School of Medicine
& Health Sciences

The Epilepsy Center

Thank you

