

du **30 mars** au **1^{er} avril 2016**

Novotel Paris Tour Eiffel

Président du congrès : Pr François Cotton

Président de la SFNR : Pr Alexandre Krainik

43^{ème} CONGRÈS ANNUEL de la Société
Française de NeuroRadiologie

Qu'attend le neurologue de l'imagerie
avancée dans l'épilepsie ?

Sophie Dupont, Paris, Unité d'Epileptologie, Hôpital
Pitié-Salpêtrière

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Conflit d'intérêt

Nom de l'orateur:

Dupont Sophie

Je n'ai aucun conflît d'intérêt



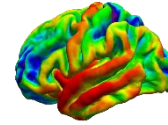
Qu'est-ce que l'imagerie avancée?

- Imagerie non réalisée systématiquement en routine clinique
- Analyses de post-processing: VBM, volumétrie,.....
- Imagerie fonctionnelle dérivée de l'IRM:
 - Spectroscopie
 - IRM de diffusion
 - IRM de perfusion : DSC ou ASL
 - Imagerie de susceptibilité magnétique
 - IRMf
- Nouveaux traceurs d'imagerie nucléaire

Qu'attend le neurologue de l'imagerie avancée dans l'épilepsie ?



Imagerie = biomarqueur de l'épilepsie ?



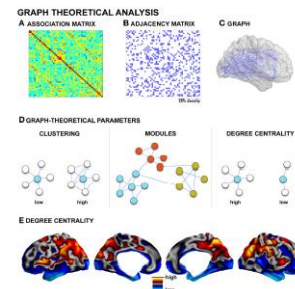
Imagerie = outil de localisation du foyer ?



Imagerie = outil de cartographie pré-opératoire ?



Imagerie = outil de compréhension de l'épileptogénèse ?



Imagerie = outil de compréhension cognitive ?

Imagerie = biomarqueur de l'épilepsie?

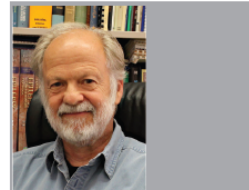


FOREWORD

For reprint orders, please contact: reprints@futuremedicine.com

Biomarkers in epilepsy: foreword

“The past three decades have borne witness to tremendous advances in our understanding of the basic mechanisms of epilepsy at both the molecular and cellular levels. This work ... could also elucidate targets for biomarkers that might indicate the development of epilepsy and the existence and severity of an epilepsy condition.”



Biomarqueur développement épilepsie

Biomarqueur épilepsie

Biomarqueur évolution épilepsie

Biomarqueur décès (SUDEP)

Imagerie = biomarqueur du développement de l'épilepsie?

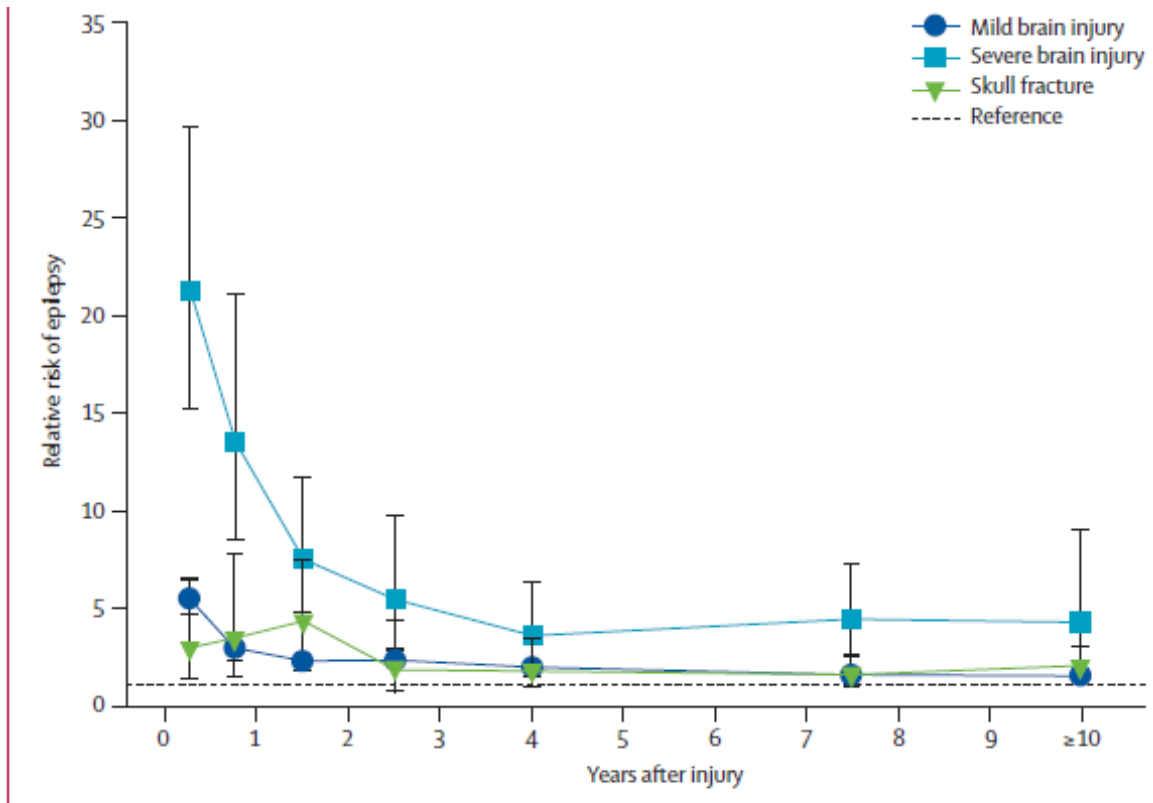


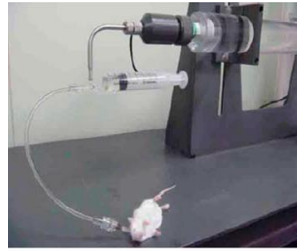
Figure: Relative risk of epilepsy after brain injury in Denmark (1977-2002)

Comment identifier les patients qui deviendront épileptiques dans une situation très à risque d'épilepsie?

Imagerie = biomarqueur du développement de l'épilepsie?

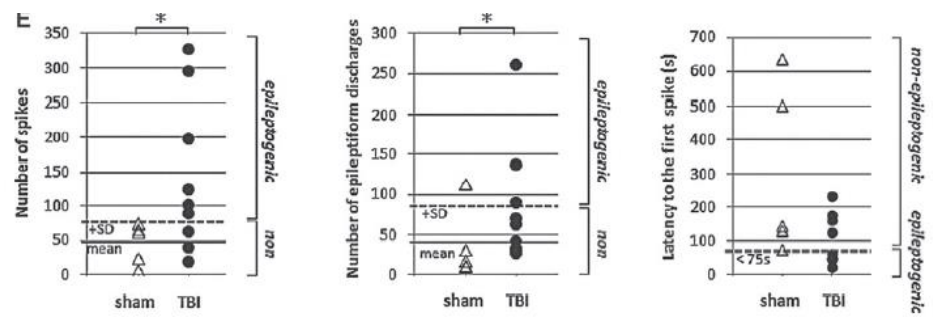
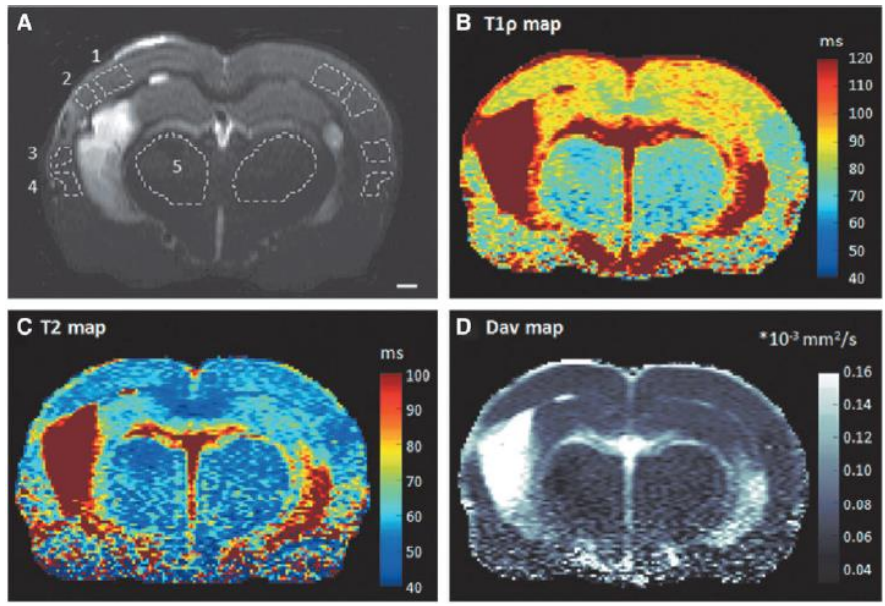
JOURNAL OF NEUROTRAUMA 30:1305-1309 (July 15, 2013)
 © Mary Ann Liebert, Inc.
 DOI: 10.1089/neu.2012.2815

Modèle animal d'épilepsie post-traumatique: lateral fluid percussion injury (FPI) (rat adulte)



MRI Biomarkers for Post-Traumatic Epileptogenesis

Riikka Immonen,¹ Irina Kharatishvili,³ Olli Gröhn,¹ and Asla Pitkänen^{1,2}



Excellente valeur prédictive de l'imagerie à 2 mois pour prédire le développement de l'épilepsie

IRM quantitative T2, T1 relaxation et diffusion à 9 j, 23 j et 2 mois post-TC

Imagerie = biomarqueur de l'épilepsie?

NeuroImage: Clinical 8 (2015) 322–328

Contents lists available at ScienceDirect

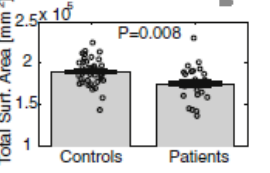
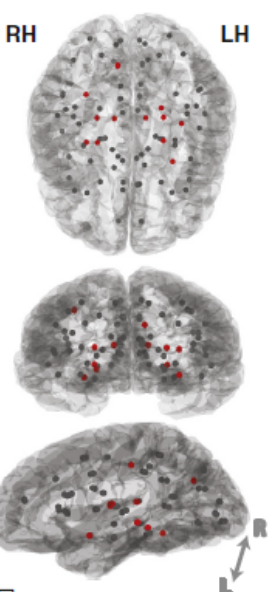
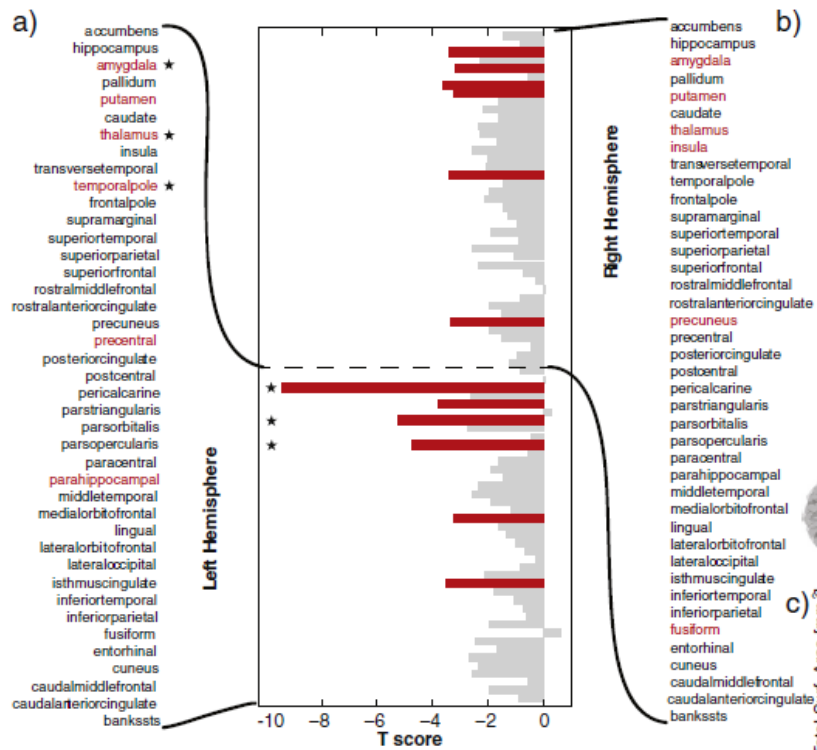
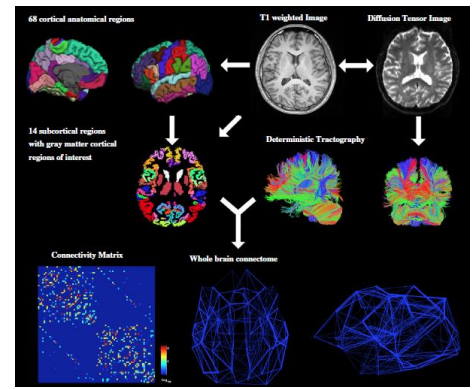
NeuroImage: Clinical

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




Structural connectivity changes in temporal lobe epilepsy: Spatial features contribute more than topological measures

Peter N. Taylor ^{a,1}, Cheol E. Han ^{b,c,1}, Jan-Christoph Schoene-Bake ^{d,e}, Bernd Weber ^{e,f}, Marcus Kaiser ^{a,g,*}



Comment identifier les patients épileptiques?
Connectomes spécifiques

Imagerie = biomarqueur de l'évolution de l'épilepsie?

Epilepsia, 52(Suppl. 4):7-9, 2011
doi: 10.1111/j.1528-1167.2011.03143.x

IS THERE SUCH A THING AS NONLESIONAL EPILEPSY?

Neuroimaging predictors of AED resistance in new-onset epilepsies

Fernando Cendes

Department of Neurology, University of Campinas, UNICAMP, Campinas, SP, Brazil

Comment identifier
les patients
épileptiques qui
seront
pharmacorésistants ?

Epilepsia, 54(Suppl. S2):67-70, 2013
doi: 10.1111/epi.12188

NEURODIAGNOSTICS OF PHARMACORESISTANCE

Multimodal neuroimaging: Potential biomarkers for response to antiepileptic drugs?

Ana C. Coan and Fernando Cendes

Neuroimaging Laboratory, Department of Neurology, University of Campinas, Campinas, SP, Brazil

Imagerie = biomarqueur de l'évolution de l'épilepsie?

Epilepsia, 51(5):783–788, 2010
doi:10.1111/j.1528-1167.2009.02379.x

FULL-LENGTH ORIGINAL RESEARCH

Proton MRS may predict AED response in patients with TLE

*Bruno A. G. Campos, *Clarissa L. Yasuda, †Gabriela Castellano, *Elizabeth Bilevicius,
*Li M. Li, and *Fernando Cendes

*Department of Neurology, FCM, University of Campinas – UNICAMP, Campinas, São Paulo, Brazil; and
†Institute of Physics, University of Campinas – UNICAMP, Campinas, São Paulo, Brazil

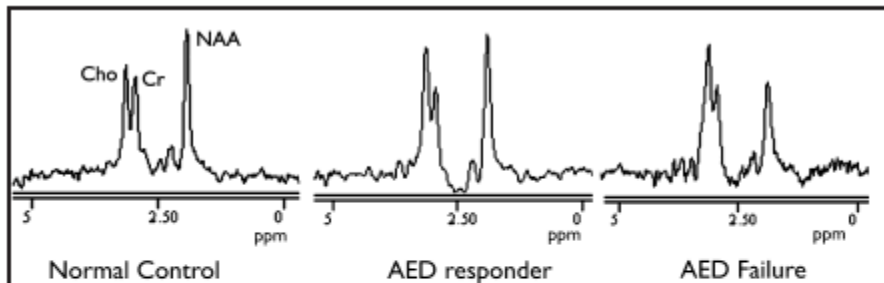


Figure 2.

Proton magnetic resonance spectroscopy (¹H-MRS) of hippocampal region in control group and ipsilateral to electroencephalography (EEG) in responders and failure groups.

Epilepsia © ILAE

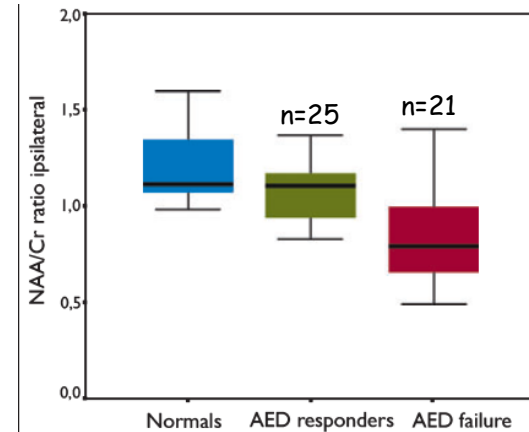


Figure 3.

N-Acetylaspartate/creatinine (NAA/Cr) ratios ipsilateral to electroencephalography (EEG) focus. Tukey's post hoc pairwise comparisons showed differences between the first antiepileptic drug (AED) failure group versus controls ($p < 0.001$) and responders group ($p = 0.001$).

Epilepsia © ILAE

Patients répondeurs à un premier traitement anti-épileptique ont moins de dysfonctionnement neuronal

Imagerie = biomarqueur de décès dus à l'épilepsie?

- SUDEP:
 - Mort soudaine inexplicée de l'épileptique
 - Incidence: 0,1 à 9 décès pour 1000 patients/année
 - Risque cumulatif : jusqu'à 12% sur 40 ans si FDR

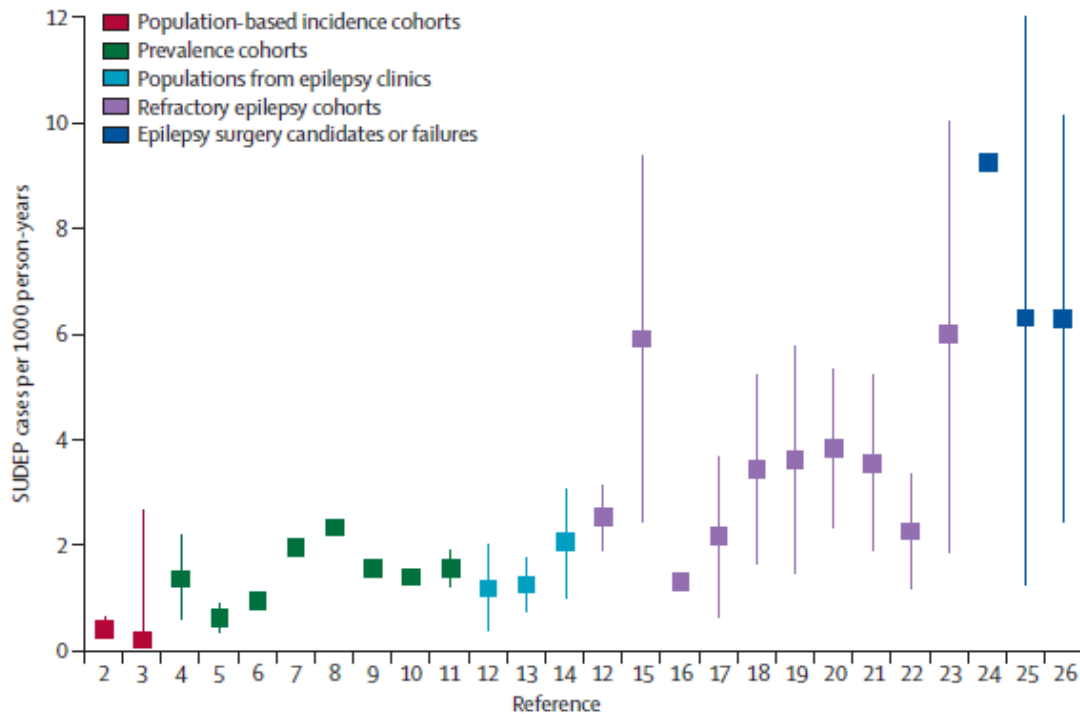


Figure 1: Incidence rates of SUDEP in 26 studies in different epilepsy populations

- FDR:
 - Sujets jeunes
 - Epilepsie pharmacorésistante ayant débuté dans l'enfance, de longue évolution, en polythérapie
 - Haute fréquence de crises généralisées tonico-cloniques

Imagerie = biomarqueur de décès dus à l'épilepsie?

doi:10.1093/brain/aww233

BRAIN 2015; 138; 2907-2919 | 2907

BRAIN
A JOURNAL OF NEUROLOGY

Structural imaging biomarkers of sudden unexpected death in epilepsy

Britta Wandschneider,^{1,2} Matthias Koepf,^{1,2} Catherine Scott,^{1,2} Caroline Micallef,^{1,2} Simona Balestrini,^{1,2,3} Sanjay M. Sisodiya,^{1,2,4} Maria Thom,^{1,2,4} Ronald M. Harper,^{4,5} Josemir W. Sander,^{1,2,4,6} Sjoerd B. Vos,^{1,2,7} John S. Duncan,^{1,2} Samden Lhatoo^{4,8} and Beate Diehl^{1,2,4}

Analyse rétrospective:

12 cas de SUDEP

34 patients à haut risque de SUDEP

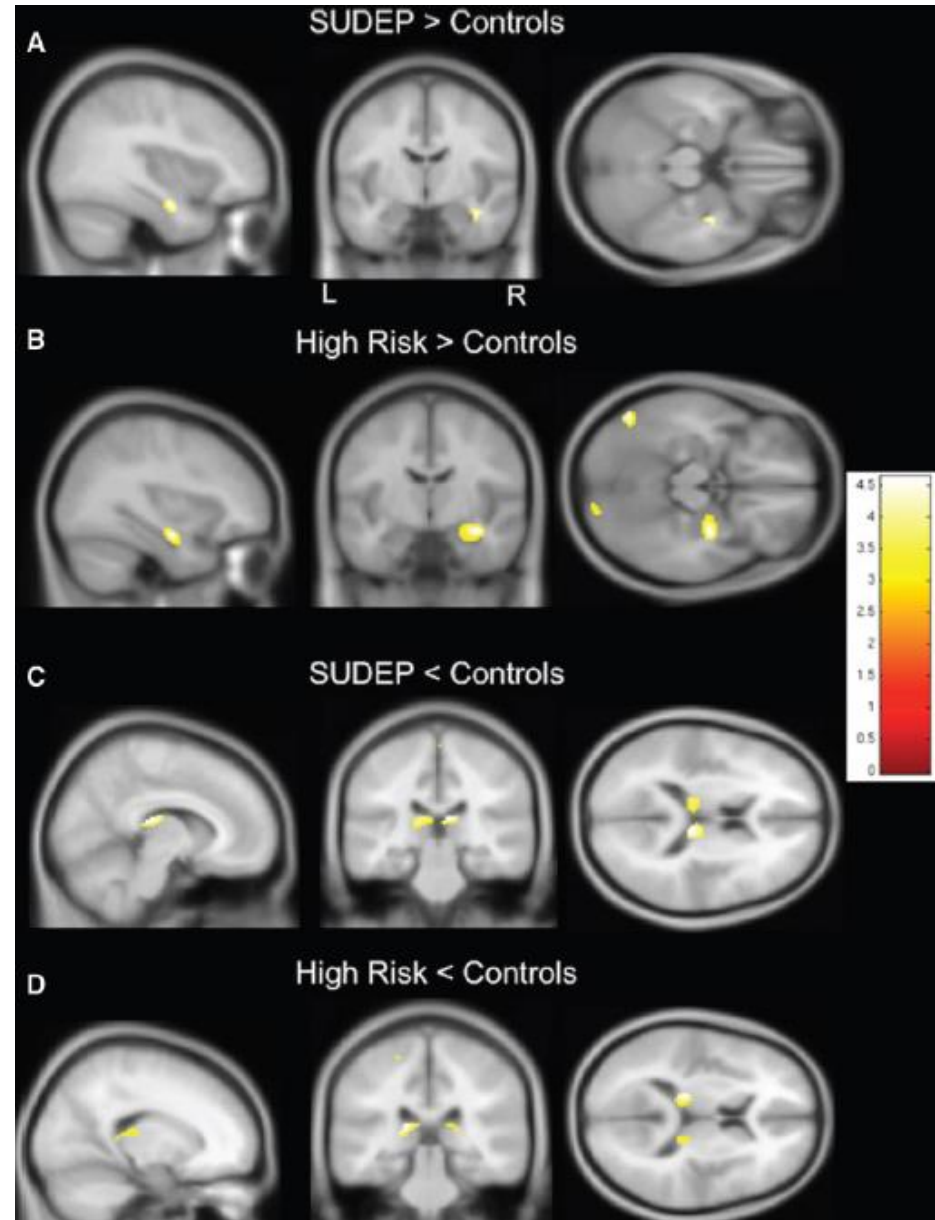
19 patients à faible risque de SUDEP

15 contrôles

Résultats

↑ substance grise hippocampe droit (idem mort subite nourrisson-régulation centrale dysautonomique cardiaque asymétrique?)

↓ substance grise thalamus postérieur (zone médiant régulation O2)



Imagerie = compréhension de l'épileptogénèse ?

Neurotherapeutics (2014) 11:347–357
DOI 10.1007/s13311-014-0258-1

REVIEW

Neuroimaging the Epileptogenic Process

Sandy R. Shultz · Terence J. O'Brien ·
Maria Stefanidou · Ruben I. Kuzniecky

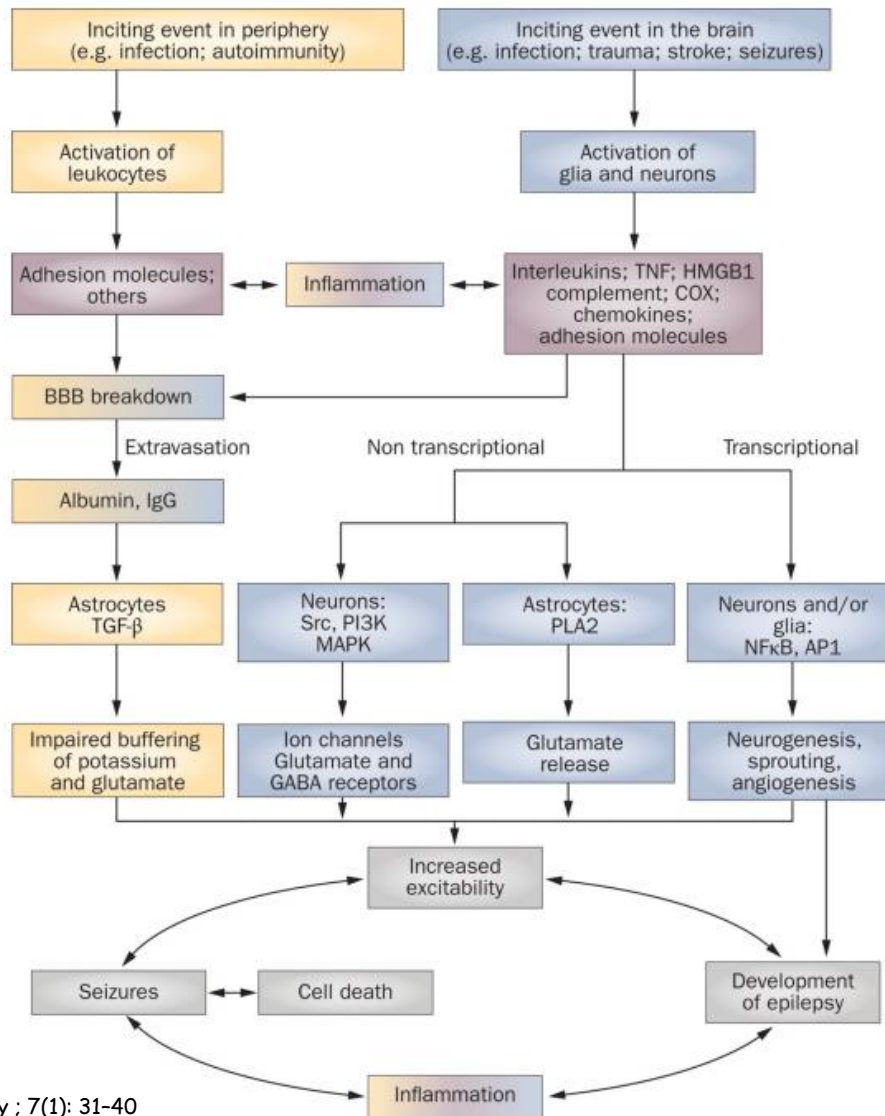
The need for biomarkers of epileptogenesis

- To prevent epilepsy, we must stop epileptogenesis.
- At present, we cannot directly identify or measure the progress of epileptogenesis in humans.
- Noninvasive biomarkers are needed to facilitate trials of antiepileptogenic therapy.

Table 1 Neuroimaging biomarkers in animal models

Imaging modality	Animal model	Potential biomarker	Related pathophysiology
MRI—T2 signal	Post-SE, FPI, kindling, FS	Acute T2 signal increase and T2W hyperintensity	Edema, gliosis, cell loss
MRI—volumetrics	Post-SE, FPI	Decreased volume of limbic structures (i.e., hippocampus)	Structural atrophy
MRI—contrast agents	Post-SE	Mn ²⁺ - and Gd ³⁺ -enhanced signal change	Mossy fibers and BBB breakdown
DWI	Post-SE, FPI, absence epilepsy, FS	Altered ADC, FA, and tractography	Edema, axonal injury, connectivity
MRS	Post-SE	Reductions in glutamate, glutamine, GABA, and NAA, and increased myo-inositol and glutathione	Neurotransmitters, neuronal death and dysfunction, glia activation
PET	Post-SE, FPI	Decreases in [18F]FDG–PET signal, increases in [18F]PBR111–PET signal	Hypometabolism, inflammation
fMRI	Post-SE, absence epilepsy	Changes in BOLD signal	Neuronal activity and metabolism

Imagerie = compréhension de l'épileptogénèse ?



Inflammation =
cible potentielle

Figure 1. Pathophysiological cascade of inflammatory events in epilepsy

Imagerie = compréhension de l'épileptogénèse ?

Myeloperoxidase Nuclear Imaging for Epileptogenesis¹

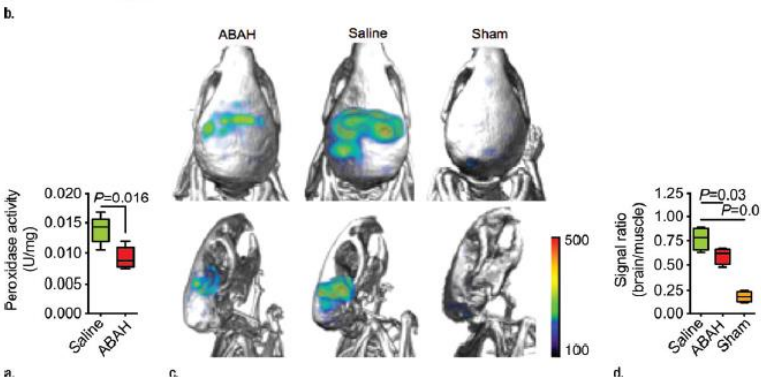
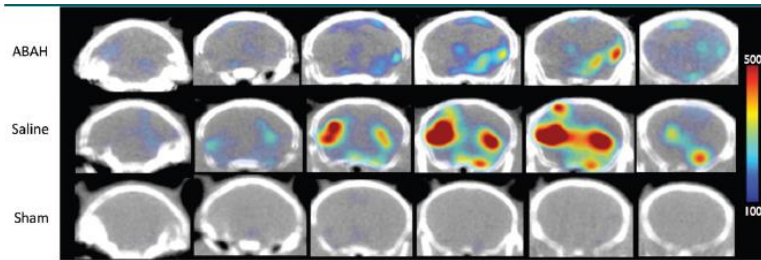
Yinan Zhang, MD, PhD
Daniel P. Saeburg, MD, PhD²
Benjamin Pulli, MD
Gregory R. Wojtkiewicz, MS
Lionel Bure, MD
Wendy Alkerson, MS
Stefan Schob, BS
Yoshiko Iwamoto, BS
Muhammad Ali, MBBS
Wei Zhang, MD, PhD
Elsaenda Rodriguez, PhD
Andrew Milewski, BS
Edmund J. Keilner, PhD
Cuihua Wang, PhD
Yawen Pan, MD
Filip K. Swirski, PhD
John W. Chan, MD, PhD

Purpose: To determine if myeloperoxidase (MPO) is involved in epileptogenesis and if molecular nuclear imaging can be used to noninvasively map inflammatory changes in epileptogenesis.

Materials and Methods: The animal and human studies were approved by the institutional review boards. Phenytoin-induced epileptic mice were treated with 4-aminobenzoic acid hydrazide ($n = 46$), a specific irreversible MPO inhibitor, or saline ($n = 42$). Indium-111-bis-5-hydroxytryptamide-diethylenetriaminepentaacetate was used to image brain MPO activity ($n = 6$ in the 4-aminobenzoic acid hydrazide and saline groups; $n = 5$ in the sham group) by using single photon emission computed tomography/computed tomography. The role of MPO in the development of spontaneous recurrent seizures was assessed by means of clinical symptoms and biochemical and histopathologic data. Human brain specimens from a patient with epilepsy and a pa-

Myeloperoxidase (MPO) = médiateur de l'inflammation intraleucocytaire

MPO impliqué dans l'inactivation de la matrice des métalloprotéinases et dans la rupture de la barrière hémato-encéphalique



Étude animale et sur tissu humain postopératoire (épileptique et contrôle)

Augmentation MPO et ses dérivés: dans région hippocampique animaux épileptiques

Dans hippocampe humain épileptique

Mais pas dans hippocampe humain non épileptique

Inhibition MPO → réduction crises

Imagerie = outil de localisation du foyer ?

Discordance données électro-
cliniques/lésion sur imagerie

Imagerie négative +++
30% épilepsies focales
Intérêt de localiser le
foyer à visée
préchirurgicale +++

But:

Éviter SEEG ou la guider



Imagerie = outil de localisation du foyer ?

Discordance données
électro-cliniques/lésion
sur imagerie

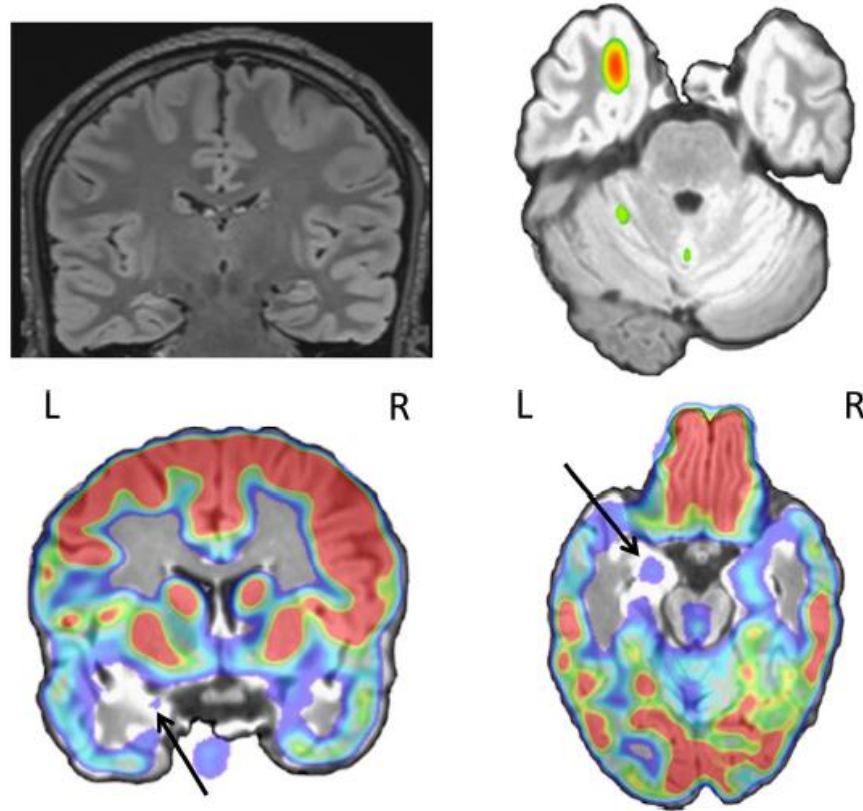


FIGURE 4 | Twenty-seven-year-old patient with left mesial temporal lobe sclerosis (FLAIR sequence, coronal view) and bitemporal interictal spikes. PET showed hypometabolism on the left mesial temporal structures and temporal pole (black arrow). SISCOM showed concordant ictal hyperperfusion (maximum in the temporal pole, shown in the figure).

Imagerie = outil de localisation du foyer ?

Imagerie négative : imagerie avancée classique

Epilepsia, 52(Suppl. 4):32-34, 2011
doi: 10.1111/j.1528-1167.2011.03149.x

CONNECTIVITY

Diffusion tensor imaging in temporal lobe epilepsy

Donald W. Gross

2E3.19 Mackenzie Health Sciences Centre, University of Alberta, Edmonton, Alberta, Canada

Review Article

Utility of magnetic resonance spectroscopic imaging for human epilepsy

Julie W. Pan¹, Ruben I. Kuzniecky²

¹Departments of Neurology and Radiology, University of Pittsburgh School of Medicine, Pittsburgh, USA; ²Department of Neurology, NYU School of Medicine, New York, USA

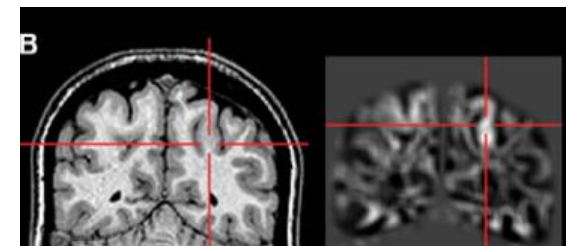
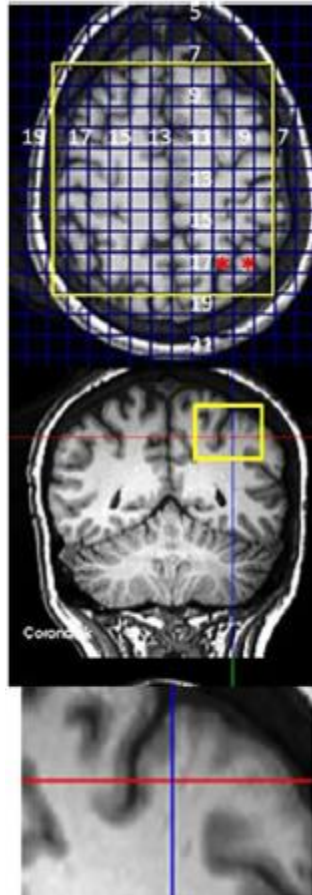
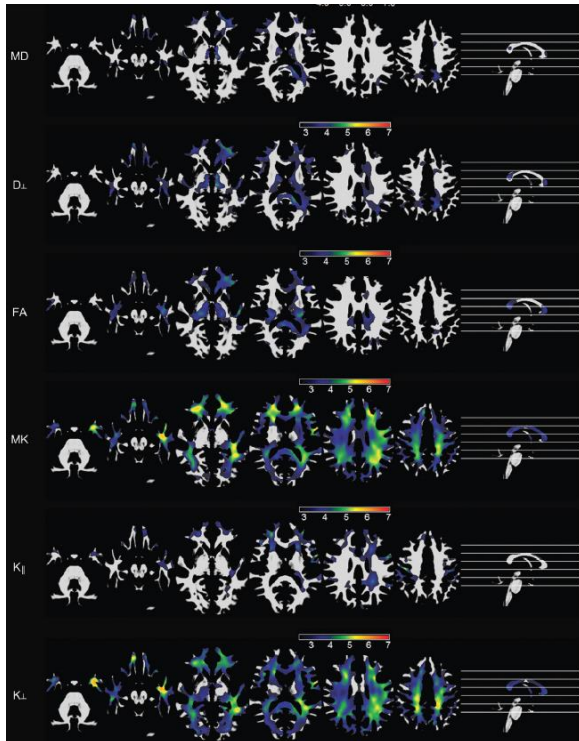
Epilepsia, 52(Suppl. 4):20-24, 2011
doi: 10.1111/j.1528-1167.2011.03146.x

IS THERE SUCH A THING AS NONLESIONAL EPILEPSY?

Unveiling epileptogenic lesions: The contribution of image processing

Andrea Bernasconi and Neda Bernasconi

Neuroimaging of Epilepsy Laboratory, Department of Neurology and McConnell Brain Imaging Center, Montreal Neurological Institute and Hospital, McGill University, Montreal, Quebec, Canada



Imagerie = outil de localisation du foyer ?

Imagerie négative:
outils avancés nouveaux

Original Article

pASL versus DSC perfusion MRI in lateralizing temporal lobe epilepsy

A Yusuf Oner¹, Bulent Eryurt¹, Murat Ucar¹, Irem Capraz², Gokhan Kurt³, Erhan Bilir² and Turgut Tali¹

Acta Radiologica
2015, Vol. 56(4) 477–481
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DOI: 10.1177/0284185114531128
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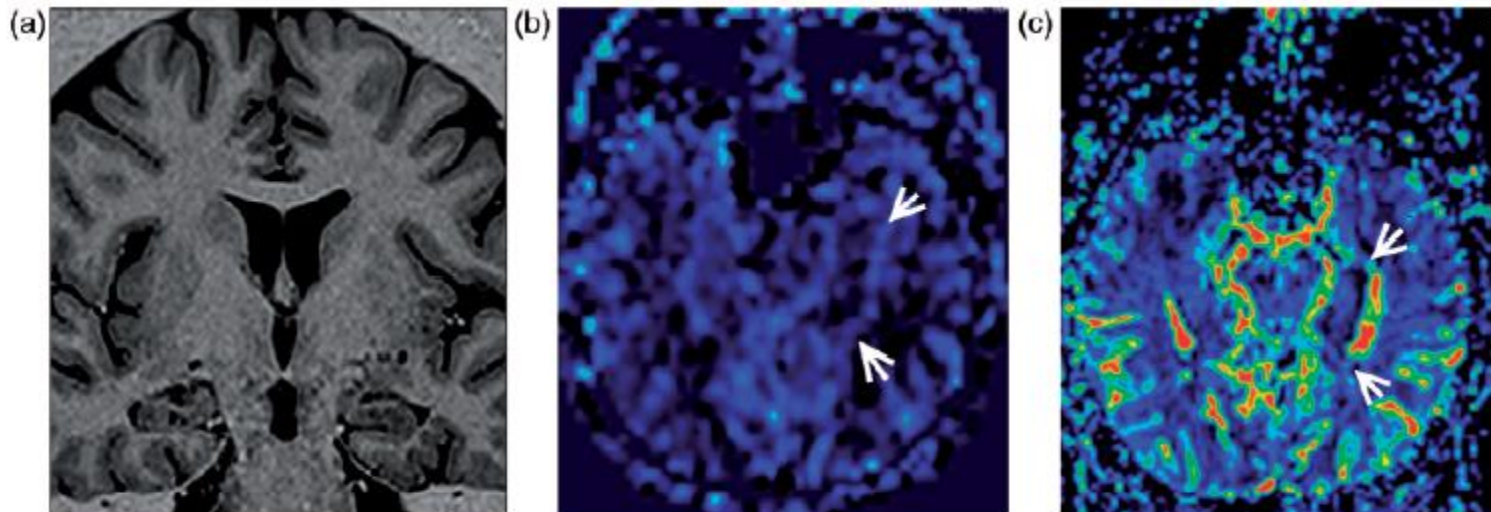
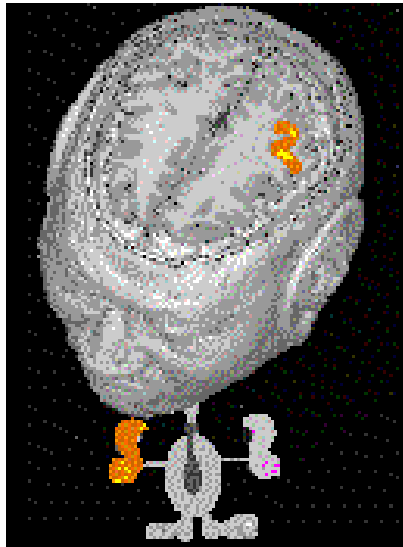


Fig. 2. 3D coronal inversion recovery image (a) from a patient with left temporal lobe epilepsy with no structural abnormality depicted fails to lateralize the epileptogenic focus. pASL (b) and DSC (c) perfusion MR images at the same anatomic levels show hypoperfusion in the anterior left mTL (white arrow) which is well correlated with clinical lateralization.

Imagerie = outil de cartographie pré-opératoire ?



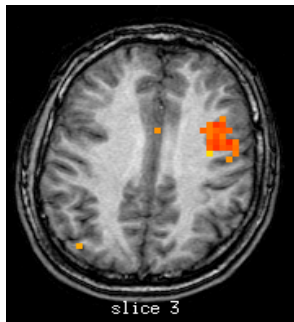
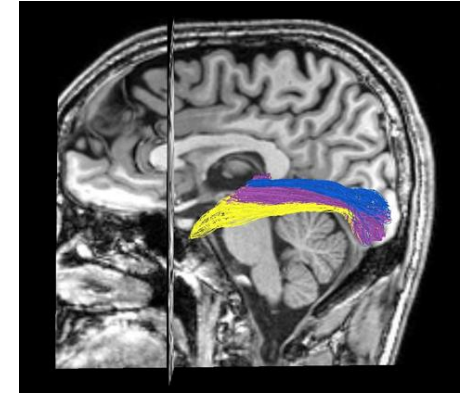
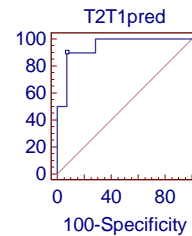
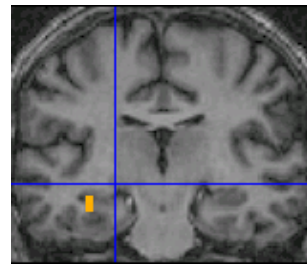
FUNCTIONAL MR IMAGING or Wada Test: Which Is the Better Predictor of Individual Postoperative Memory Outcome?

Purpose: To retrospectively determine whether blood oxygen level-dependent functional magnetic resonance (fMRI) imaging can aid prediction of postoperative memory changes in epileptic patients after temporal lobe surgery.

Materials and Methods: This study was approved by the local ethics committee, and informed consent was obtained from all patients. Data were analyzed from 25 patients (12 women, 13 men; age range, 19-52 years) with refractory epilepsy in whom temporal lobe surgery was performed after they underwent preoperative functional MRI imaging, the Wada test, and the memory outcome.

Authors: Sophie Dupont, MD, PhD; Emmanuelle Duron, MD; Sylvaine Samson, PhD; Marisa Demos, PhD; Emmanuelle Vaille, MD, PhD; Christine Delmaire, MD, PhD; Vincent Navarro, MD, PhD; Jacques Chrast, MD; Stéphane Lehericy, MD, PhD; Yves Samson, MD, PhD; Michel Baulac, MD.

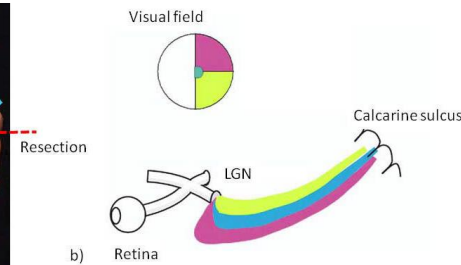
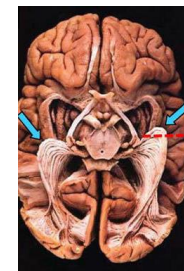
Journal: RADIOL



Activation hippocampique gauche pendant rappel différé = meilleur prédicteur déclin postopératoire mémoire verbale

Prédiction correcte aggravation mnésique dans 90% des cas

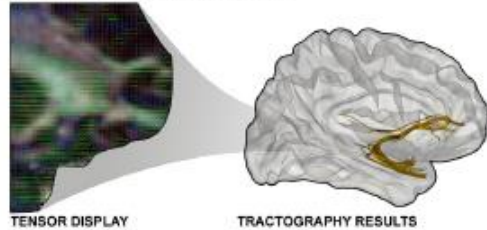
Cartographie fonctionnelle/IRMf



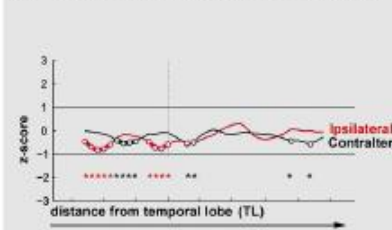
Cartographie structurale/tractographie

Imagerie = outil de compréhension cognitive ?

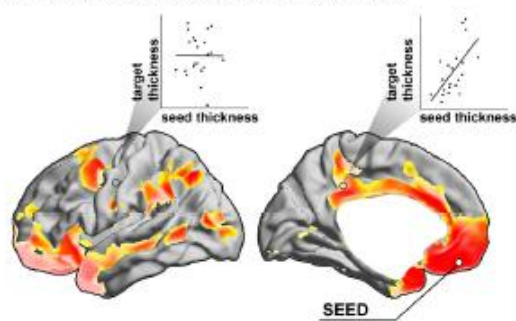
A DIFFUSION TRACTOGRAPHY



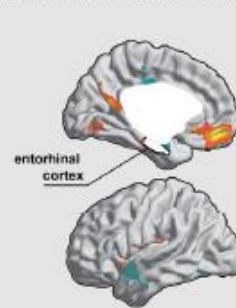
B WM TRACT ALTERATIONS IN TLE



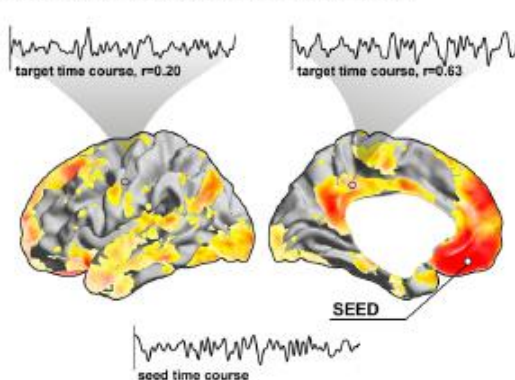
C STRUCTURAL COVARIANCE ANALYSIS



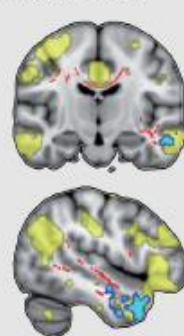
D COVARIANCE ALTERATIONS IN TLE



E FUNCTIONAL CONNECTIVITY MAPPING



F FUNCTIONAL CONNECTIVITY DISRUPTIONS IN TLE



Interaction réseaux
épileptiques-
réseaux cognitifs-
réseaux structurels

Imagerie = outil de compréhension cognitive ?

Concept de TCI = transitory cognitive impairment

Déficits cognitifs transitoires contemporains de décharges épileptiques interictales généralisées ou focales

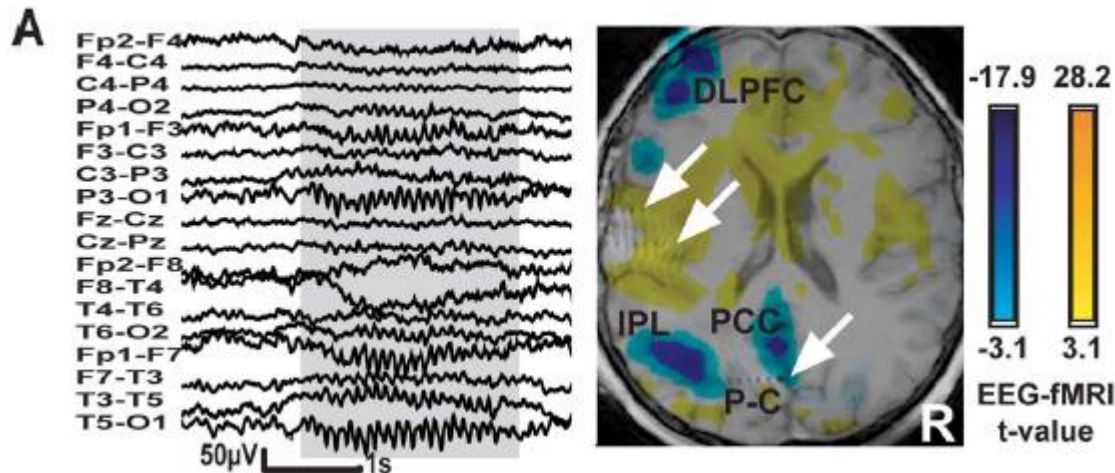
OPEN ACCESS Freely available online

PLOS ONE

Epileptic Discharges Affect the Default Mode Network – fMRI and Intracerebral EEG Evidence

Firas Fahoum^{1*}, Rina Zelmann¹, Louise Tyvaert², François Dubeau¹, Jean Gotman¹

¹ Montreal Neurological Institute, McGill University, Montréal, Québec, Canada, ² Clinical Neurophysiology Department, Roger Salengro Hospital, Lille University Medical Center, Lille, France



Déactivation régions du DMN contemporaines des décharges IC

Hypothèse: déficit attentionnel induit par décharges

