

Consciousness and epilepsy

Seizures with altered, reduced, enhanced and fractionated consciousness.

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Alrek helseklynge,

basert på foredrag i København Feb '24.

Bergen 07.05. 2024.

Defining consciousness !?

- Consciousness is the individual awareness of your unique thoughts, memories, feelings, sensations, and environments
- Essentially, your consciousness is your **awareness of yourself and the world around you.** (“Verywell mind”**, 2023)

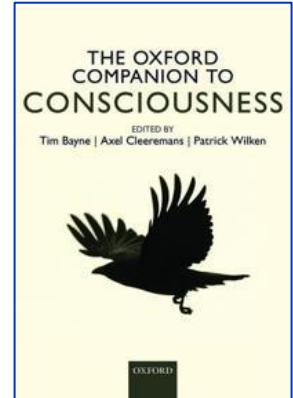
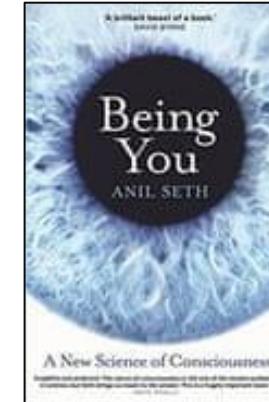
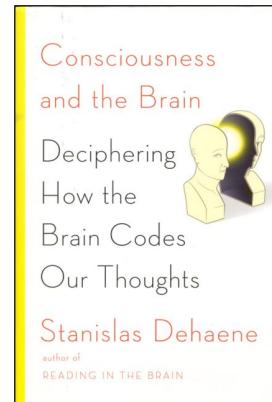
ILAE*-disk.: To be conscious = *To comprehend the totality of the situation!*

*ILAE: International league against epilepsy

Physicalists:

..and consciousness emerges from physical stuff.

**www.verywellmind.com



Consciousness gives us «the space of opportunity»

- We sense, analyze, describe, feel and remember. Take responsibility.

Consciousness has:

1. **Level;**
2. **Content;**

Vigilans: wakefulness

a) **Attention** /focus

b) **Conscious access**; test by/ *introspection* and report!

Language + (subjective experience (qualia + the art))

Conscious access assumes attention, but not inverted!

In epileptology (ILAE); «to be conscious» (to be *aware**):

To comprehend the totality of the situation.

- *Sensing, self-reflection, context.*



*We employ an operational definition of awareness as knowledge of self and environment. Epilepsia 58. Fisher et al. 2017

Consciousness

Consciousness has;

- 1. Level;**
- 2. Content;**

Vigilans: wakefulness

a) Attention /focus

b) Conscious access; test by/ *introspection* and report!

Language + (subjective experience (qualia + the art)

1 og 2 ikke alltid adskilt? – Integrated Information Theory IIT. (A Seth)

All conscious experience is: informative and integrated !

(*Integrated information theory of consciousness*;

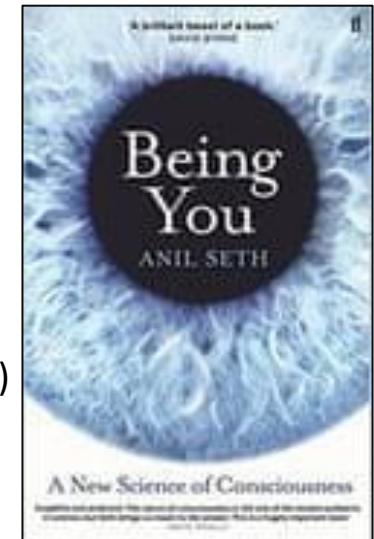
IIT. «measured» in Φ (phi). But how?

Information is reduction of uncertainty (mathematically) (*Invention of entropy?*)

(perturbation complexity index PCI)

Thus, examined by mathematical and statistical methods ? Phi.

Entropy?



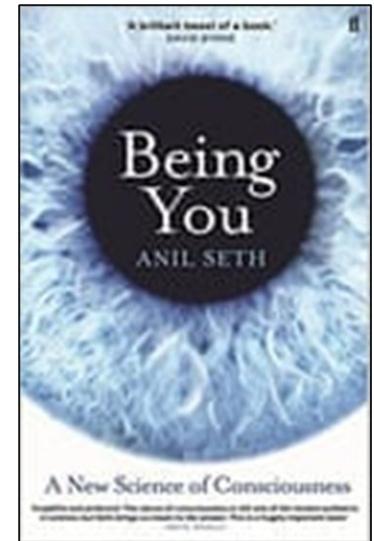
Anil Seth;

- For a conscious creature it is somethink it is like to be me !
- It feels like somethink to be me ! (p11)*.
- Were there is *phenomenology* there is consciousness.

*having qualia
Norsk: kvalia

BE: (**Clinically**) What is consciousness, and
how is it established and regulated?

Subjective *phenomenology*(*qualia*) «only» relevant/important for empathy !
but, *what about entropy* ? (*Giske 2024*)



Theories of consciousness

<https://www.nature.com/articles/s41583-022-00587-4>

Anil K. Seth^{1,2} and Tim Bayne^{2,3,4}

NATURE REVIEWS | NEUROSCIENCE

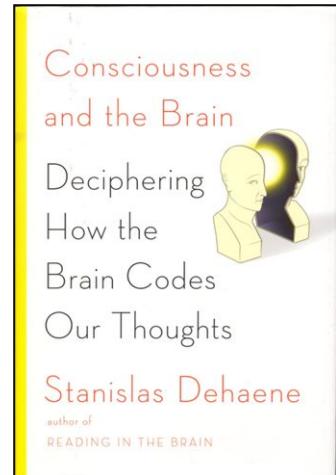
Abstract | Recent years have seen a blossoming of theories about the biological and physical basis of consciousness. Good theories guide empirical research, allowing us to interpret data.

Table 1 | A selection of theories of consciousness

Theory	Primary claim	Key refs
Higher-order theory (HOT)	Consciousness depends on meta-representations of lower-order mental states	31,46
Self-organizing meta-representational theory	Consciousness is the brain's (meta-representational) theory about itself	34,140
Attended intermediate representation theory	Consciousness depends on the attentional amplification of intermediate-level representations	141,142
Global workspace theories (GWTs)	Consciousness depends on ignition and broadcast within a neuronal global workspace where fronto-parietal cortical regions play a central, hub-like role	47–49
Integrated information theory (IIT)	Consciousness is identical to the cause–effect structure of a physical substrate that specifies a maximum of irreducible integrated information	57,59,60
Information closure theory	Consciousness depends on non-trivial information closure with respect to an environment at particular coarse-grained scales	143
Dynamic core theory	Consciousness depends on a functional cluster of neural activity combining high levels of dynamical integration and differentiation	144
Neural Darwinism	Consciousness depends on re-entrant interactions reflecting a history of value-dependent learning events shaped by selectionist principles	145,146
Local recurrency	Consciousness depends on local recurrent or re-entrant cortical processing and promotes learning	65,71
Predictive processing	Perception depends on predictive inference of the causes of sensory signals; provides a framework for systematically mapping neural mechanisms to aspects of consciousness	67,73,79
Neuro-representationalism	Consciousness depends on multilevel neurally encoded predictive representations	84

May 2022.

N=22



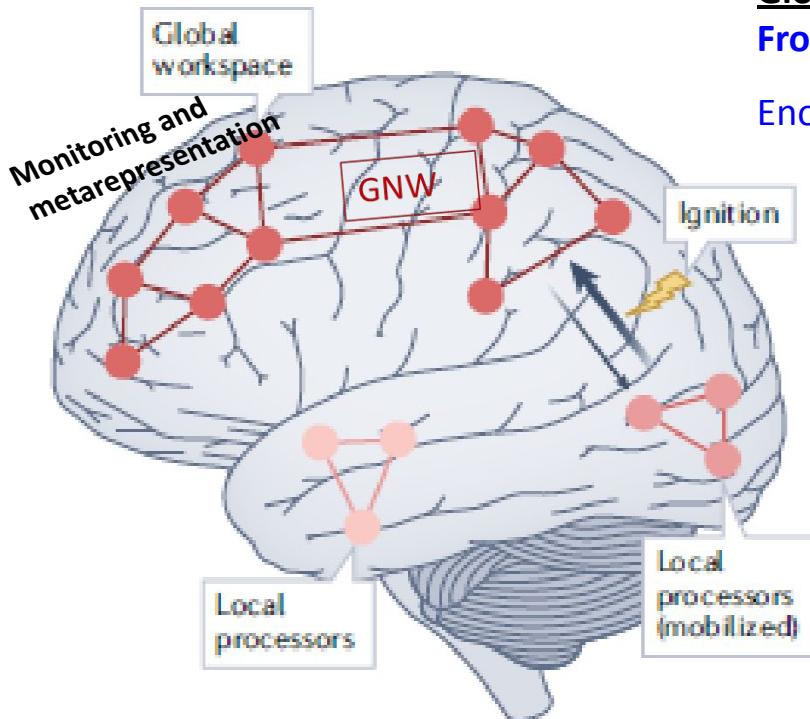
Review 2014 TDNLF

Focus on functional physiological rather than phenomenological aspects.

Tested in humans !

COGNITION!

Attention, evaluation, reflection and verbal response



Global neuronal workspace theory (GNWT).

Frontal lobe + parietal lobe* + + (temp).

Enough to guide flexible behavior and cognition

* After ca. 300 msec

Consciousness «signatures»;

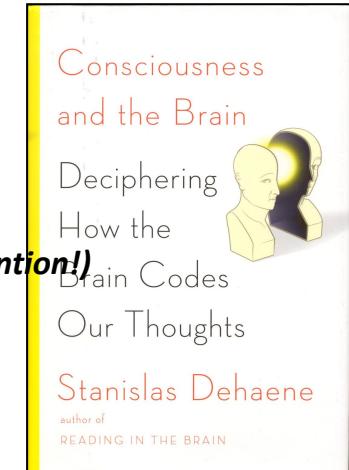
Fronto-parietal activation,

P3a/b,

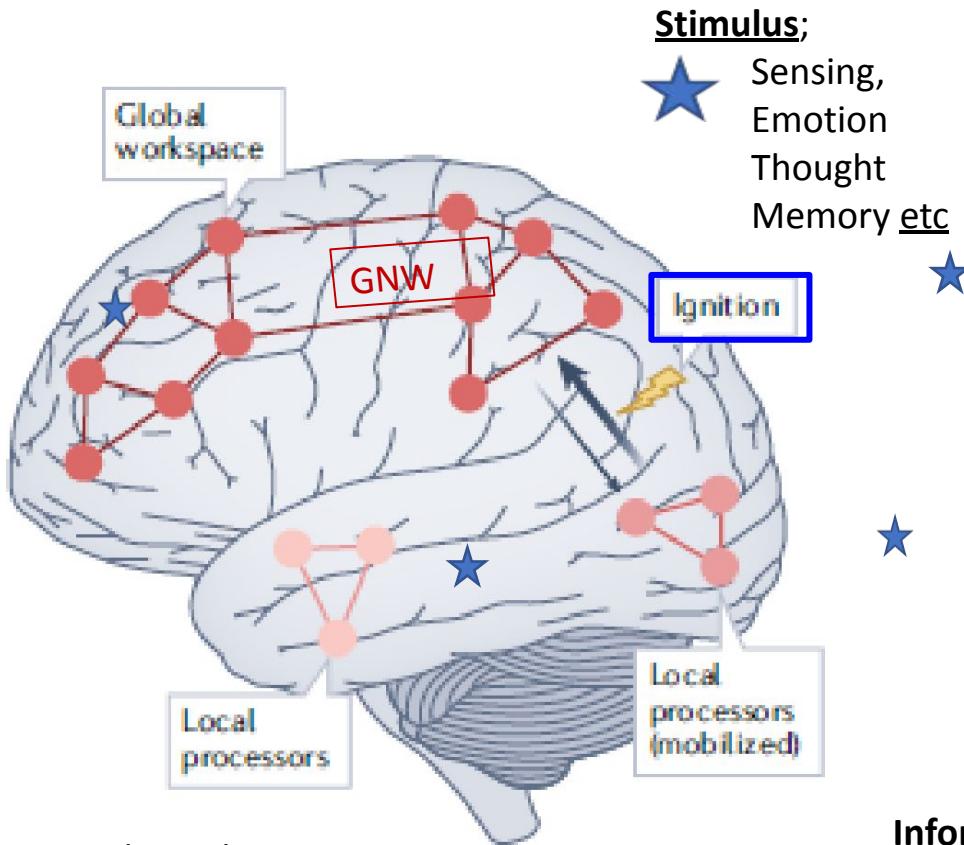
Highfreq. oscillation etc.

Incl. depthelectrodes in
Human brains (N400 in
temporal lobe)

(N2pc; unconscious parietal attention!)



Focus on functional physiological rather than phenomenological aspects.



Stanislas Dehaene, 2014.

Global neuronal workspace (GNW).

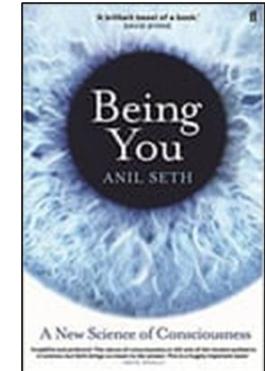
Frontal lobe + parietal lobe* ++ (Temp lobe)

Initiation in GNW assumes;

1. Input from «ignition». (Bottom – up*)
P3a,b

2. Response «reentry» (Top-down)
Y-waves & synchronisation
*with regard to GNW

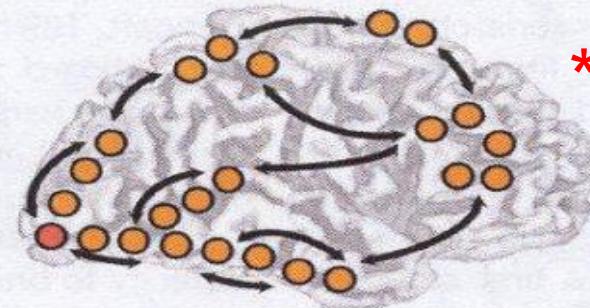
Information processing in GNW: IIT:
Measure of consciousness. *phi*. ?



**A Feed-forward propagation
(subliminal processing)**



**Reverberating global neuronal workspace
(conscious access)**

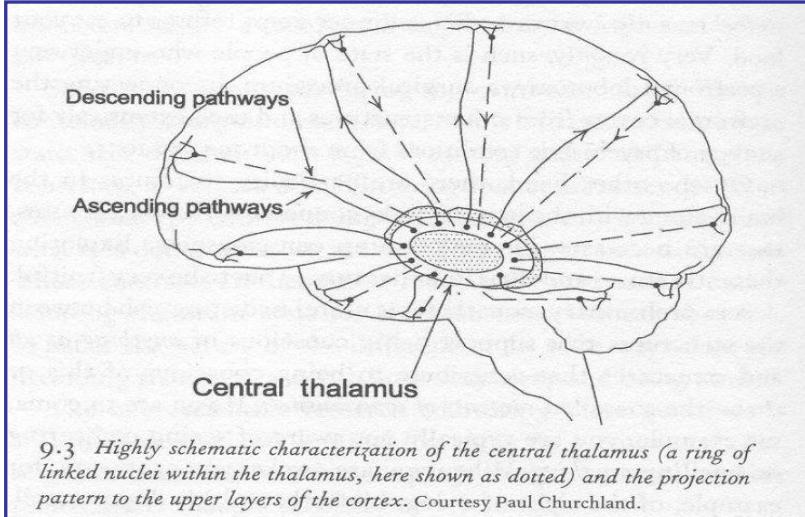


*

Important for
human SIM
(subjective internal
model)
Giske2024.

Dehaene, 2014.

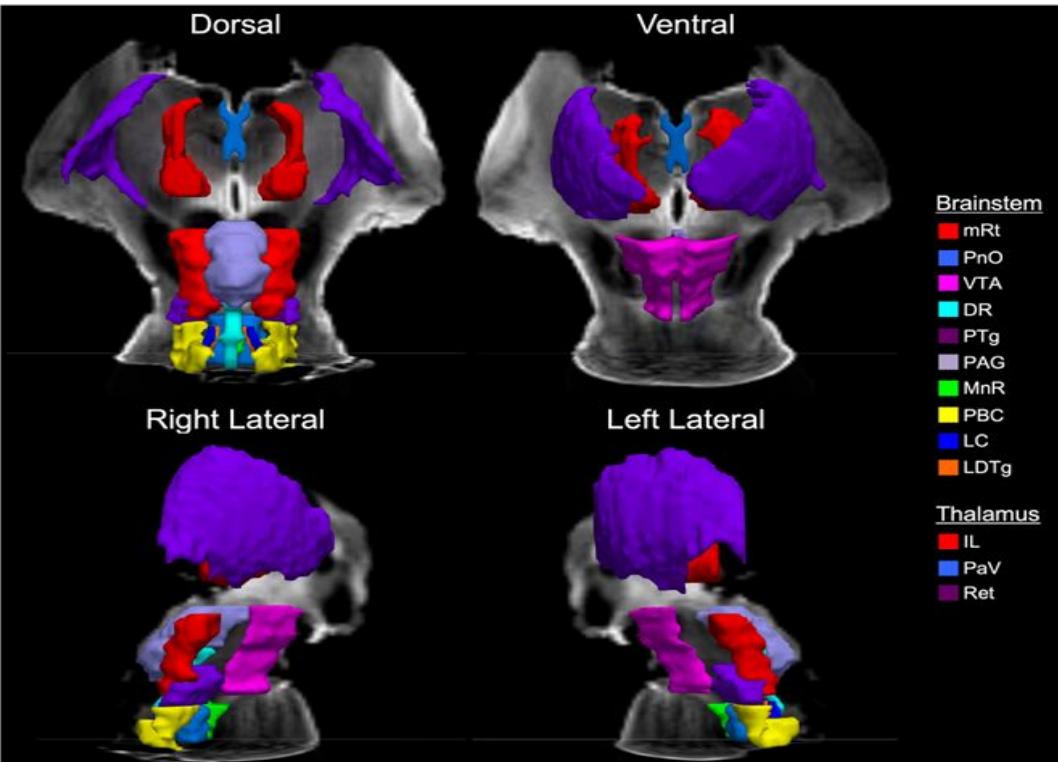
Cortex and Thalamus in GNW
«Regional Thalamic activation» !



9.3 Highly schematic characterization of the central thalamus (a ring of linked nuclei within the thalamus, here shown as dotted) and the projection pattern to the upper layers of the cortex. Courtesy Paul Churchland.

Multimodal MRI reveals brainstem connections that sustain wakefulness in human consciousness

Brian L. Edlow *et al.*



[DOI: 10.1126/scitranslmed.adj4303](https://doi.org/10.1126/scitranslmed.adj4303)

ex vivo diffusion magnetic resonance imaging (MRI) of three human brains, obtained at autopsy from neurologically normal individuals, with immunohistochemical staining of subcortical brain sections. We identified nodes of the proposed **default ascending arousal network (dAAN)** in the brainstem, hypothalamus, thalamus, and basal forebrain

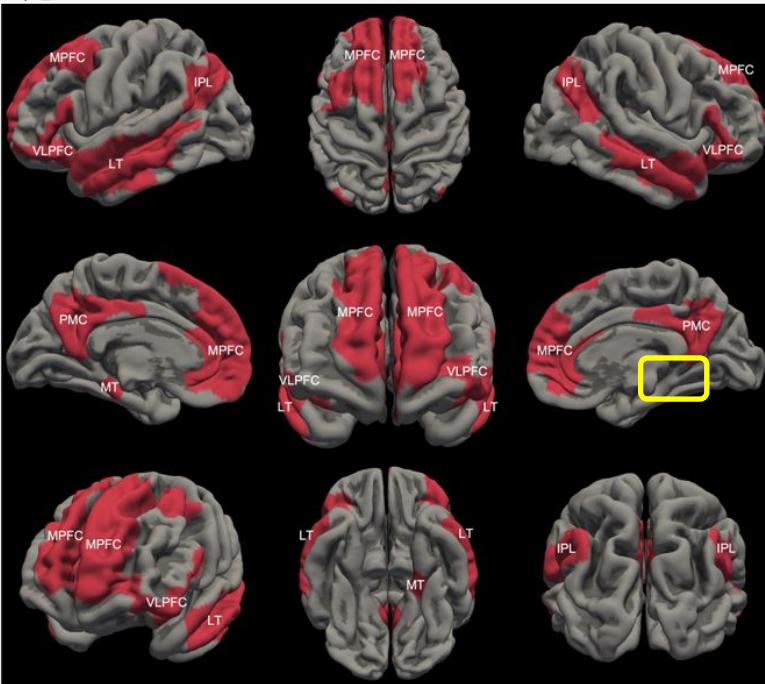


Fig. S9. Default Mode Network Nodes. Cortical nodes of the Yeo atlas' default mode network are shown in red, superimposed on an inflated surface of the cerebral hemispheres in standard FsAverage space. Abbreviations: IPL = inferior parietal lobule; LT = lateral temporal; MPFC = medial prefrontal cortex; MT = medial temporal; PMC = posteromedial complex (i.e., posterior cingulate cortex and precuneus); VLPFC = ventrolateral prefrontal cortex.

Deterministic and probabilistic tractography analyses of the ex vivo diffusion MRI data revealed projection, association, and commissural pathways linking dAAN nodes with one another and with DMN nodes.

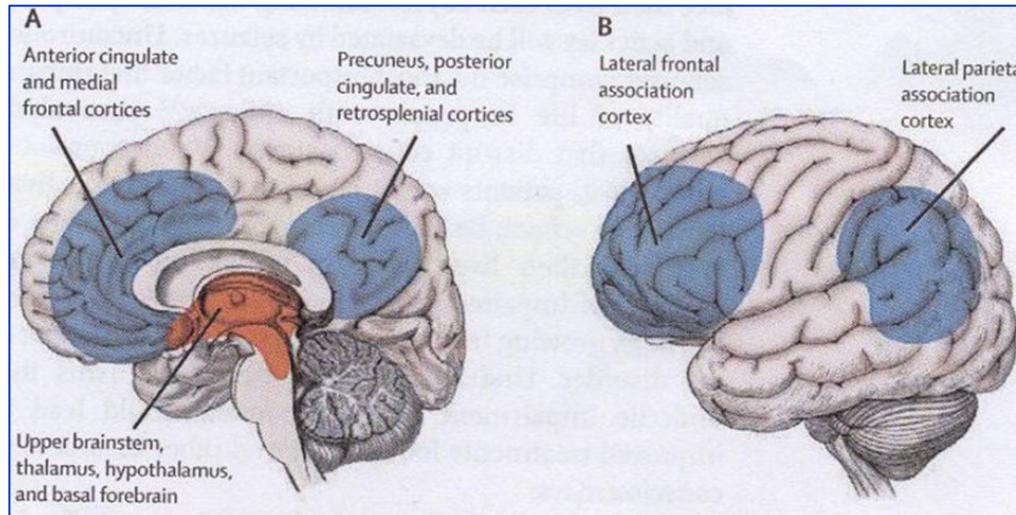
Complementary analyses of in vivo 7-tesla resting-state functional MRI data from the Human Connectome Project identified the dopaminergic ventral tegmental area in the midbrain as a widely connected hub node at the nexus of the subcortical arousal and cortical awareness networks. Our network-based autopsy methods and connectivity data provide a putative neuroanatomic architecture for the integration of arousal and awareness in human consciousness.

Blumenfeld's suggested network versus The Global Neuronal Workspace (GNW).

1. Time-limited.
2. Regulated by **Thalamus** (intralam. nevr. + BS)
«regional» thalamic activ?
3. Involving activation of **front/par & temp cortex.** ++
(Cingulum, Precuneus, Insula)

Relevant for epilepsy

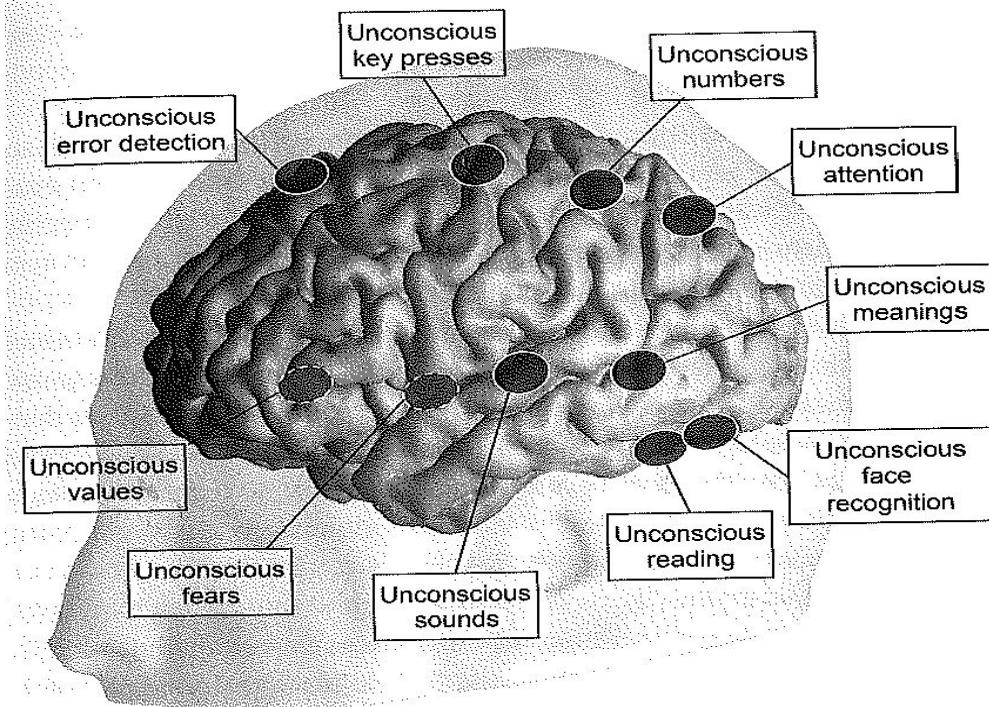
FR seizures: Thalamic inactivation with shutdown of fronto-par assoc cortex !



Un-/sub-conscious (subliminal) activated areas in test situations

Almost all parts of the neo- and allocortex can be activated briefly without reaching consciousness. (However, such activation may lead to *facilitation*!)

Cortical vs «sub-cortical». No



Facilitation: unconscious words (< 40 msec)
Prior to a word or motor respons may enhance the speed of a respons.

«Blue»/vs consonants: increased choice of colored «patch» ! NB: meaning!

The subconscious importance for behaviour and «normativ biology»!

What is influenced by the subconscious ? **motivation!** (for wellbeing and behaviour*).

Prof. Stefan Kölsch

Die dunkle Seite
des Gehirns

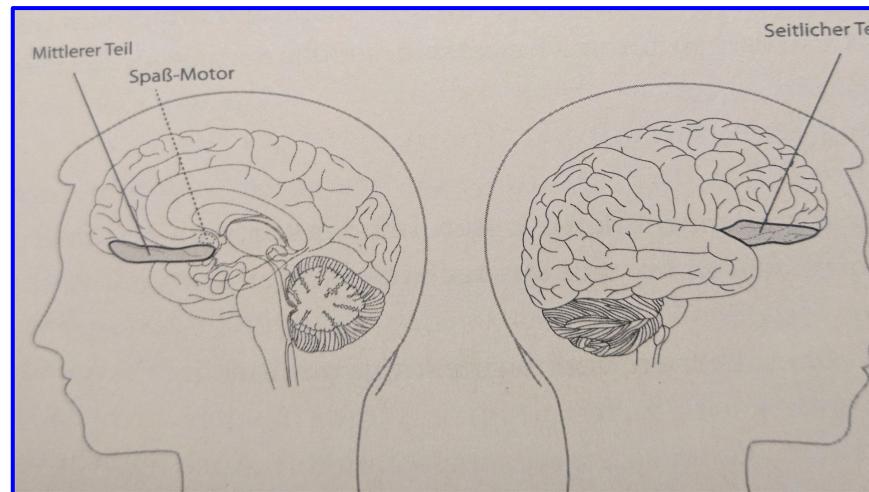


Wie wir unser
Unterbewusstes überlisten und
negative Gedankenschleifen
ausschalten

ulstein extra

Moral emotions/Social rules etc.
Value systems / evaluations
Emotional control

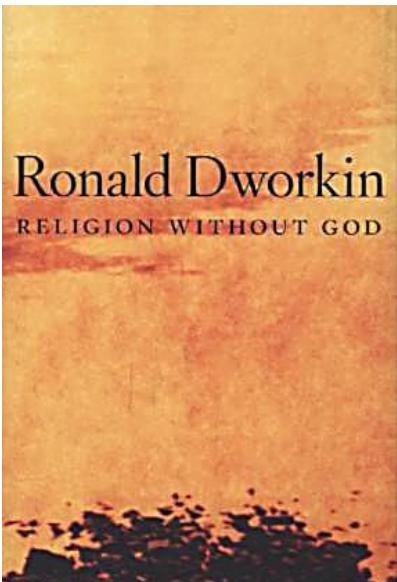
Orbitofrontal cortex
+ ***vmPFC (BE 😊)***



Values are biologically subconsciously and emotionally (?) «rooted»!

Normative social influence; rules – norms and «conformation urge/compulsion» are biologically rooted.

Creates motivations and meaning!

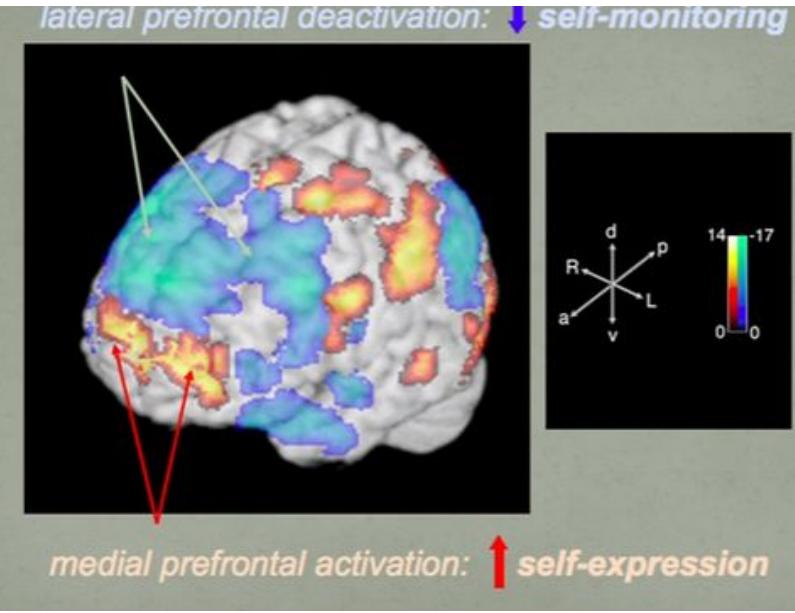


Values leads us to **maximize well being by behavioral decisions** (Giske 2024), but it's more complicated in humans than in salmon!

Professor of Law and Philosophy;
«Values are real and fundamental»

Impaired consciousness during deep sleep.

(slow wave sleep) and **hypofrontality** !



*Resembles the activation pattern and EEG slow wave pattern in NON-REM sleep.
However, this illustration pertains to Jazz improvisation !*

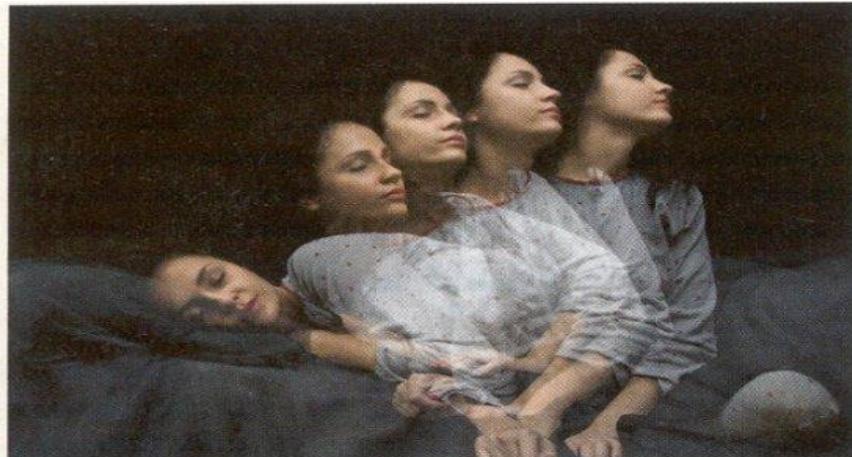
Several studies of consciousness and *self monitoring* /self expression reveal impairment in lateral hypofrontality!

JA Hobson & E Pace-Schott. Nat Rev Neurosci. 2002;3:679-
CJ Limb & A Baun; DOI:10.1371/journal.pone.0001679

Non-REM arousal (*dissociative?*) conditions

Complex behavior in deep sleep

Low frontal activation !



People suffering from an arousal disorder enter a dissociative state, as if beginning to wake up but failing to do so completely.

- **Sleep walking**, etc.
- Sleep-related *violence*.
- Sleep-eating (4.5% life prev)
- Sleep-sex (7.1 % life prev *Bjorvatn, 2010*).

Impaired consciousness = reduced responsibility

Lee Hadwin has been scribbling in his *sleep* since early childhood. By the time he was a teen, he was creating elaborate, accomplished drawings and paintings that he had no memory of making – a process ...



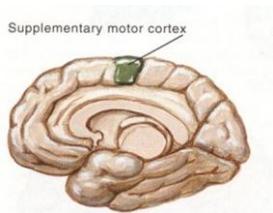
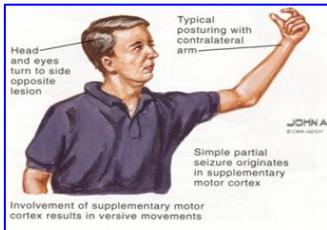
2011

<https://aeon.co/videos/the-work-of-a-sleepwalking-artist-offers-a-glimpse-into-the-fertile-slumbering-brain>

Aware seizures with altered consciousness.

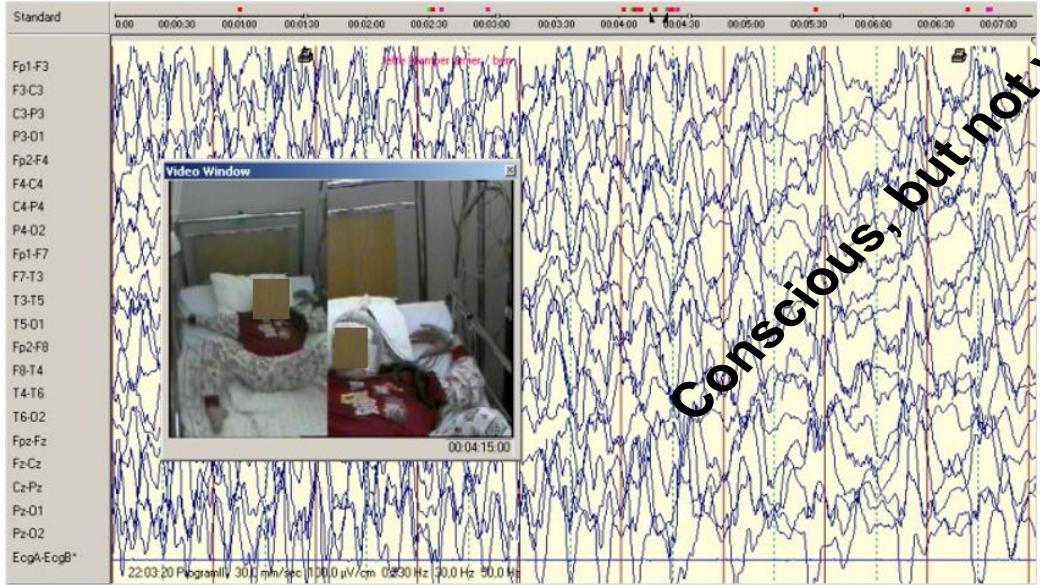
Seizures with «intact» consciousness.

SMC seizure; Frontal midline seizures.



b.1987, 10 yrs.

2004; seizure free



Conscious, but not willed!

Transfiguration 1520



Out-of-body experience and autoscopy of neurological origin

Olaf Blanke,^{1,2,3} Theodor Landis,³ Laurent Spinelli^{1,2} and Margitta Seeck¹

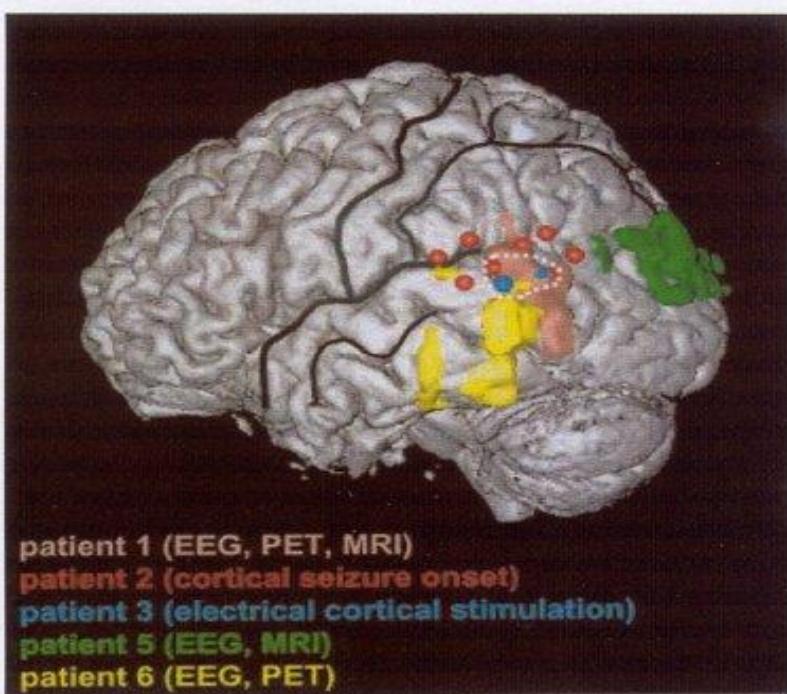


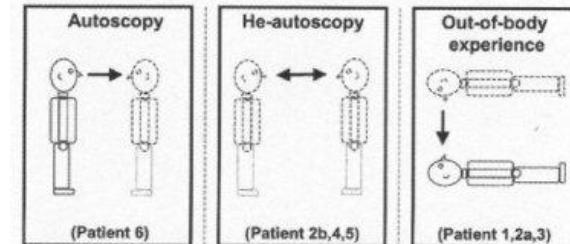
Fig. 4 Mean lesion overlap analysis of the five patients in whom a lesion could be defined (Patients 1, 2, 3, 5 and 6). Each patient is

Right & left

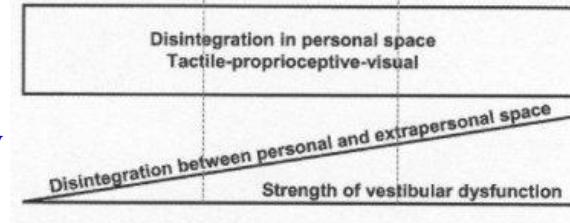
All had epilepsy



Phenomenology and pathophysiology of autoscopic phenomena



Disintegration in personal space
Tactile-proprioceptive-visual



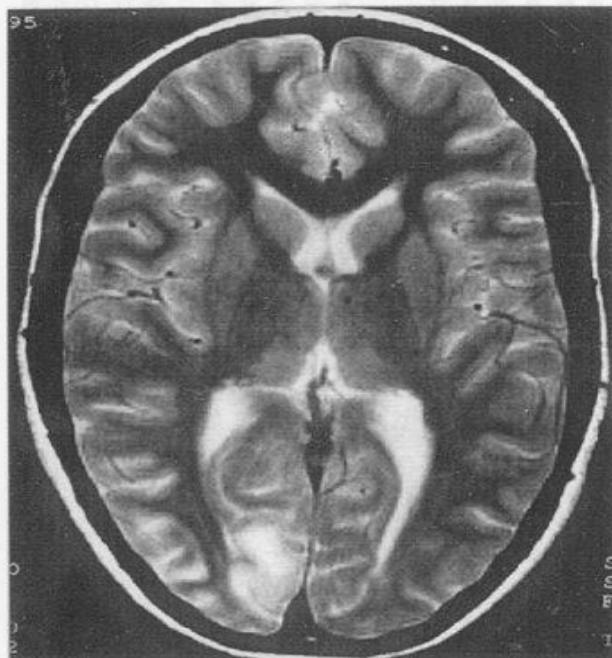
***Epilepsy is an episodic condition/dysfunction
which fills consciousness with unwanted
content and meaning.***

Seizure symptoms and context are often attempted **understood** !

Our brain is a hypothesis generator!

X ♀ ; Seizures with long lasting simple and complex visual hallucinations and headache and vomiting. Status epilepticus. Early in the course small green men occurred.

Another POLG patient; *flashing lights, intense feelings, confusion, and ictal/postictal blindness for over a week.*

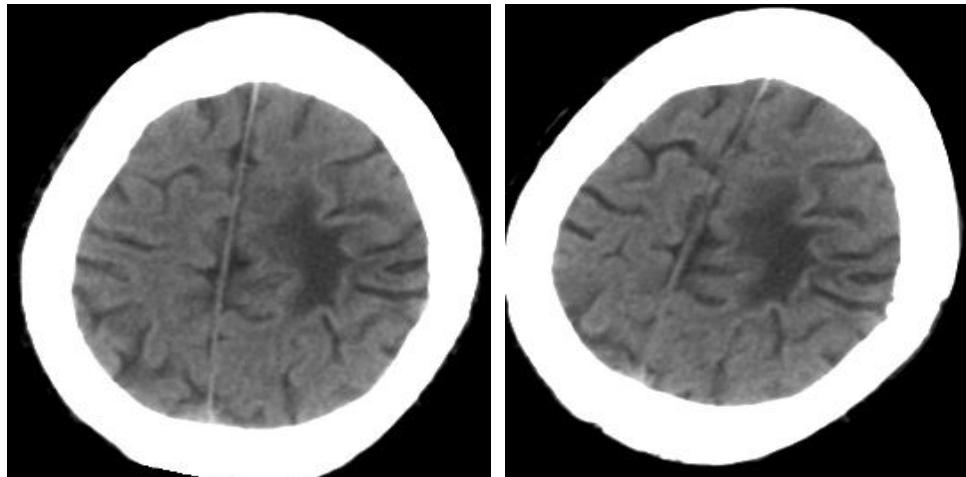


OCCIPITAL LOBE EPILEPSIES

Man, b. 72. In 1995 FTC seizure, and seizure with facial clonic movements, «numbness» in the nose and feeling of «something in the nose» !

On a tour in England he experienced "thoughts forced upon him" associated with anxiety, feeling of impending death and a feeling the head should explode. Several episodes of **forced thinking** ! Sometimes partly impaired consciousness.

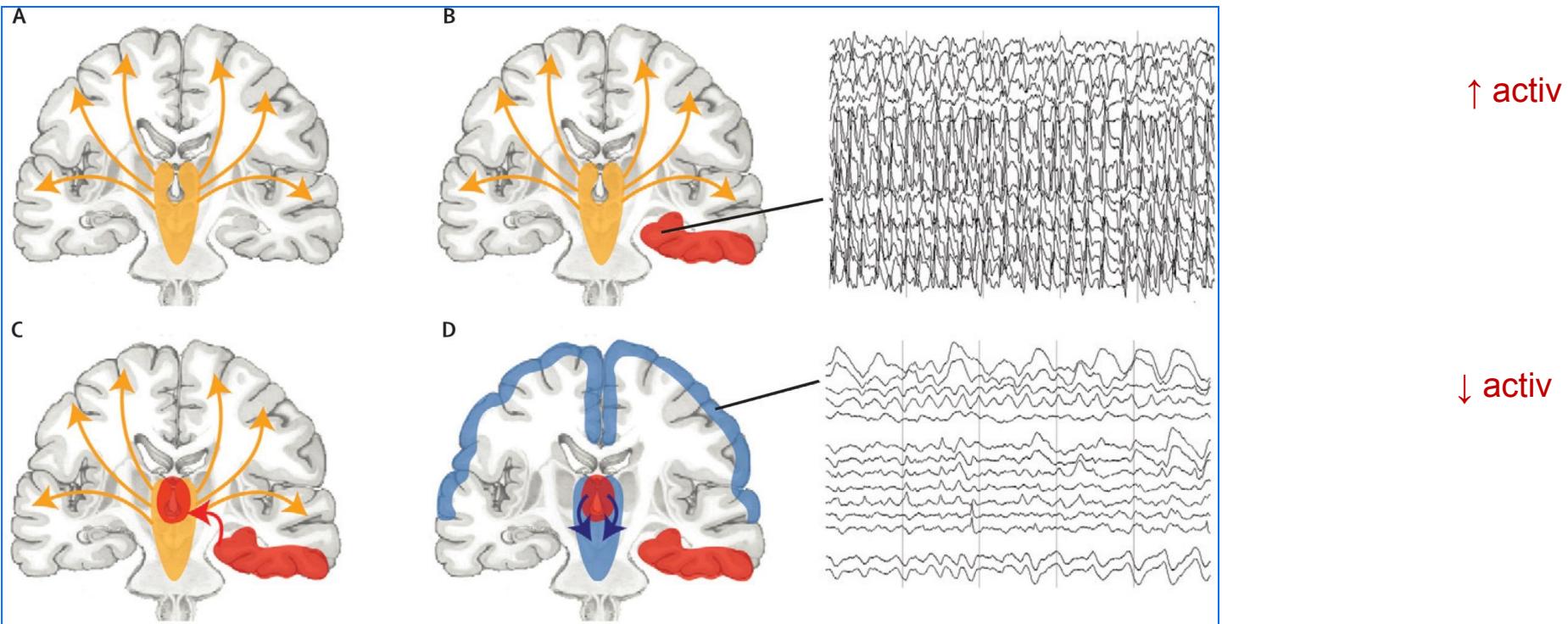
Right spastic hemiparesis.

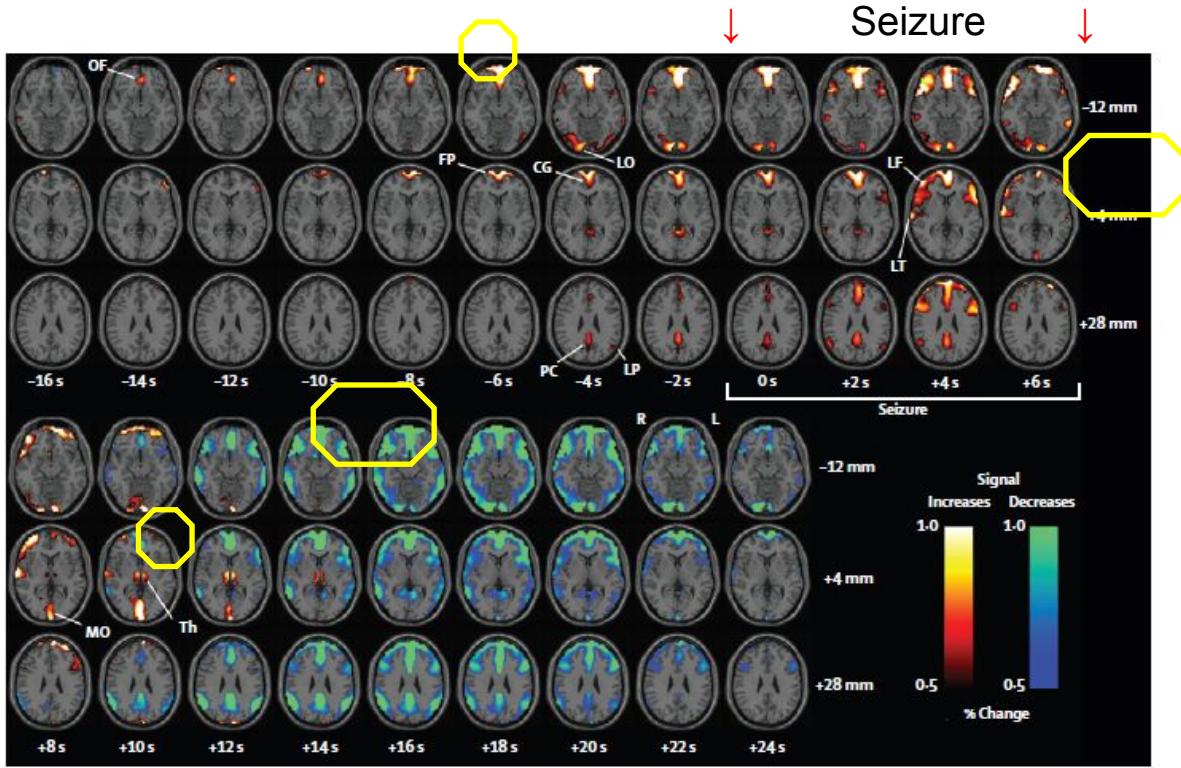


Dangerous and evil thoughts!

Seizures with impaired consciousness.

Impaired consciousness in epilepsy!





Before absence; Frontopolar / medial frontal cortex **activation**

During absence; Frontal association/lat cortex **activation**

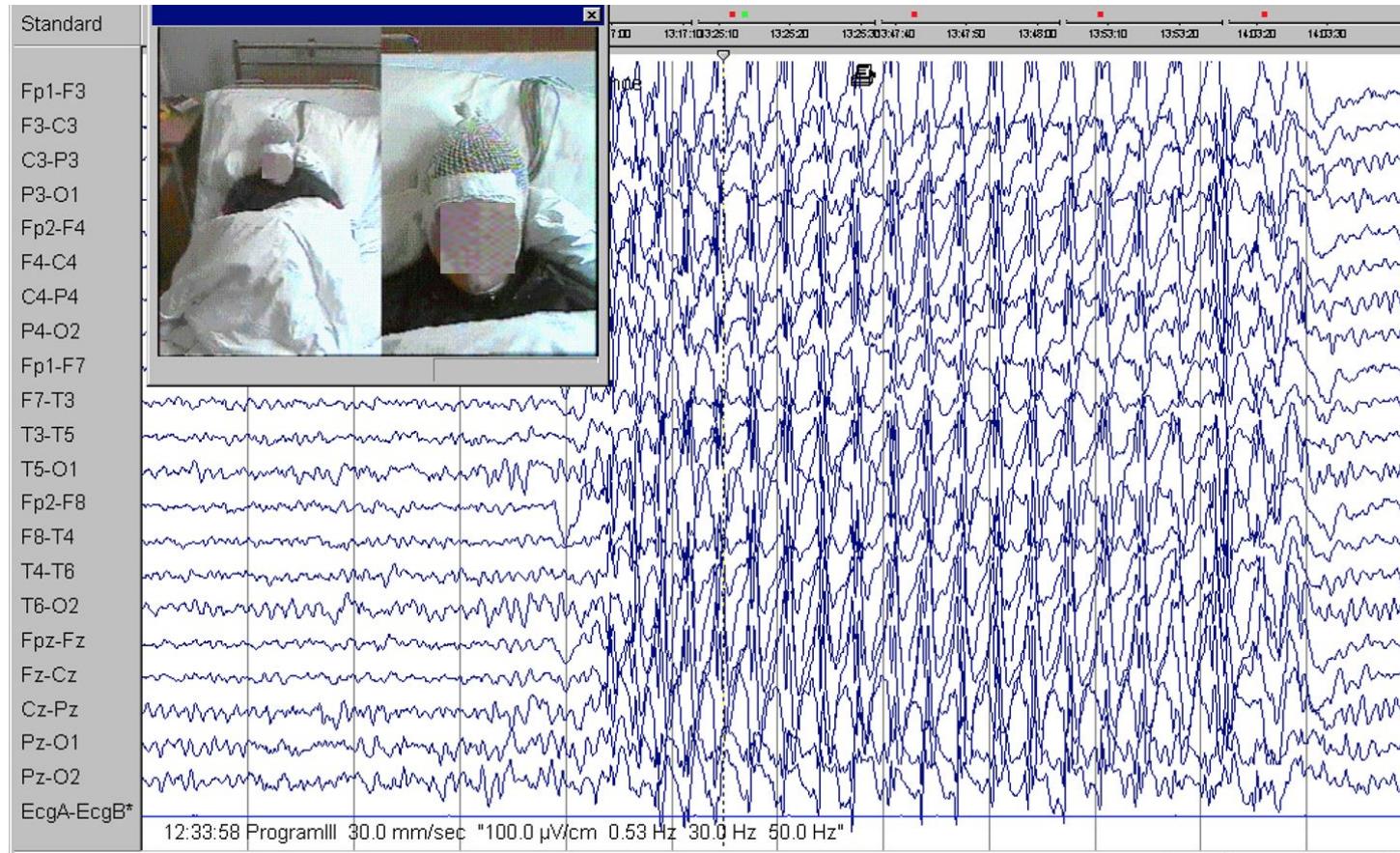
After absence; **Significant neocortical hypoactivity; cognition?**

Blumenfeld Lancet Neurol.2012;11:814-26

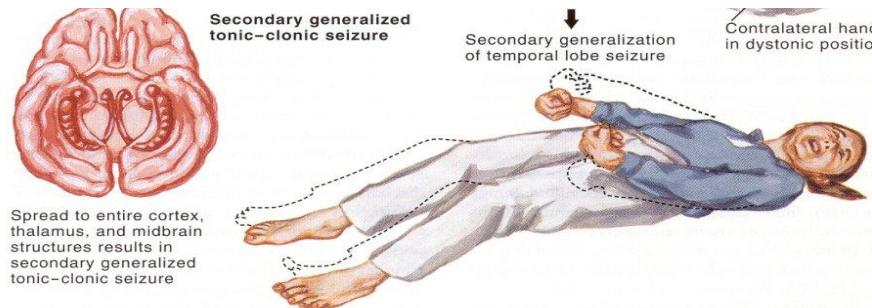
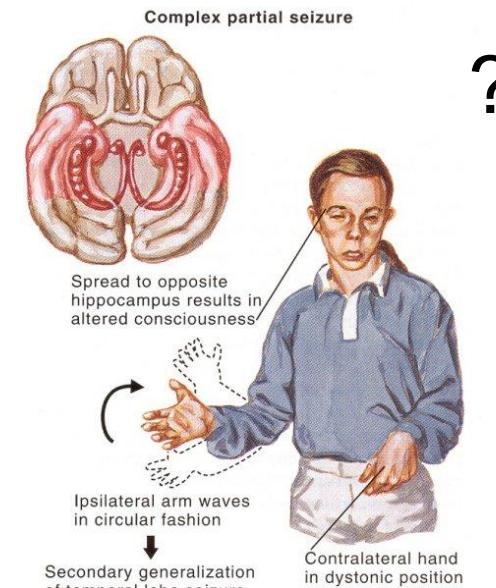
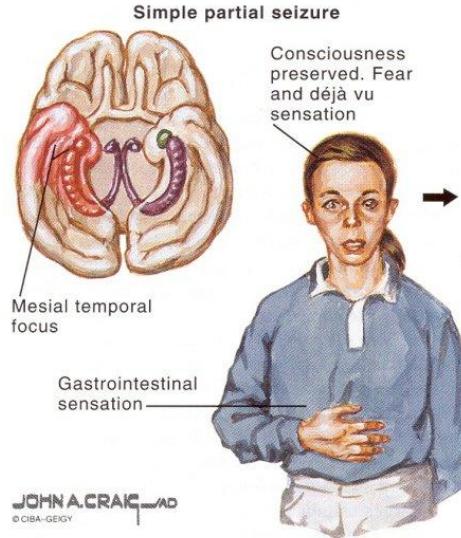
Epilepsy and
Impaired
consciousness.
51 seiz. mean 6.6 sec

**Loss of consciousness
due to activation/epil.
activity**

Generalised spikes and «possible absence»

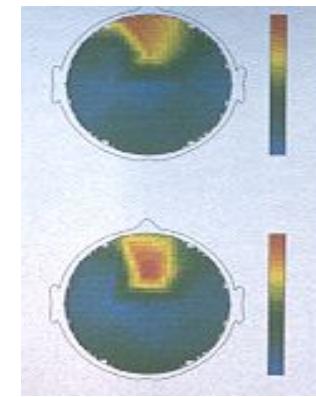


Temporal lobe seizures



Thalamus and FP cortex

Normal (a) og ictal (b) EEG of patient B, 79 yrs.



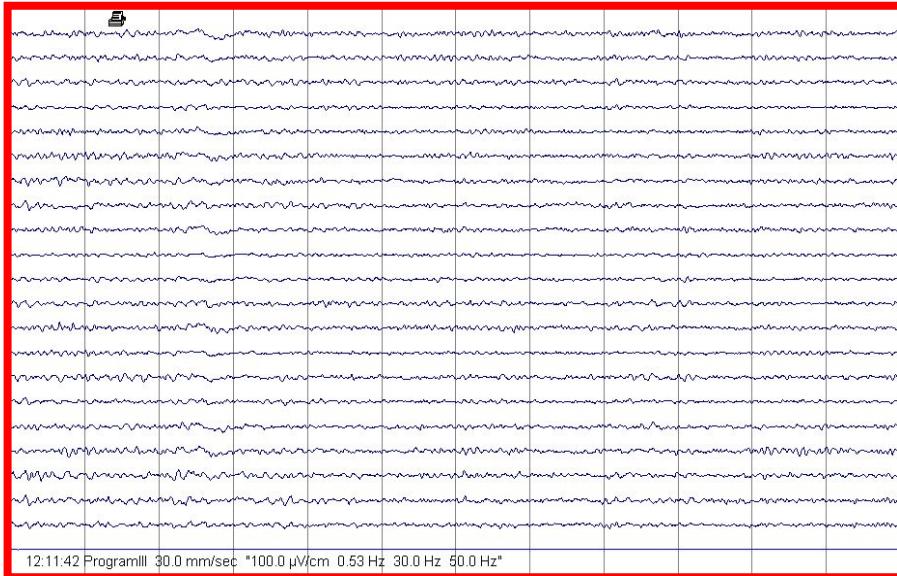
Seizures with confusion and speech problems **from 1993**. 1994 psychiatr. clin (depression/psychosis)? CBZ+DPH (cognitively impaired!) Diagnosed as **dementia?**

AED stopped.

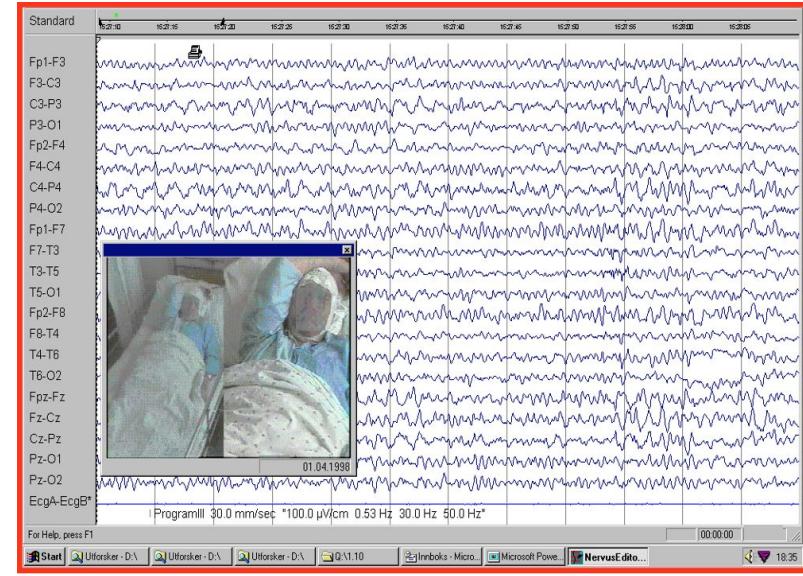
At arrival in **1999**; normal MMS 29.

Each week for **5 years** ca. 2 episodes of **24-48 hrs duration** with confusion, afasia, unrest and urine retention starting during sleep.

a



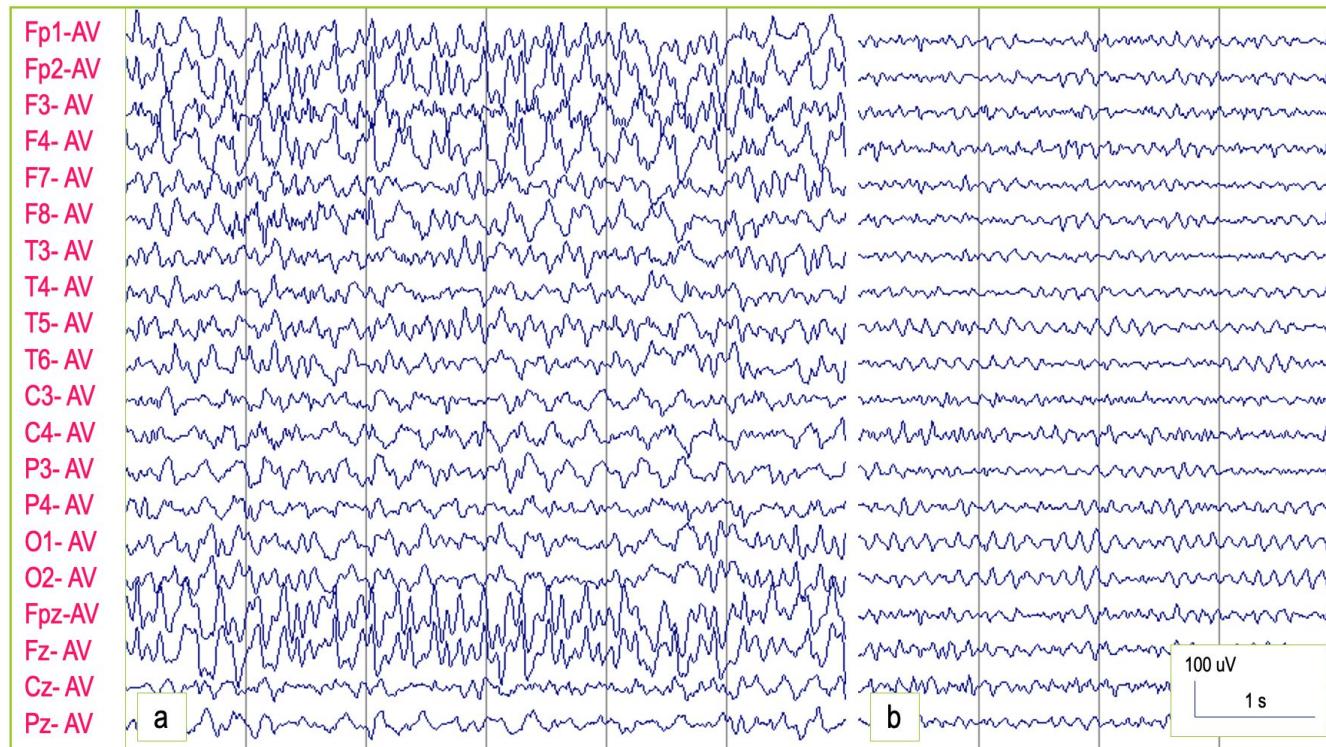
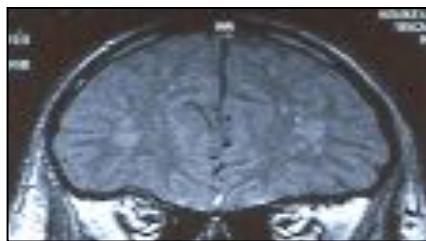
b



12:11:42 Programill 30.0 mm/sec *100.0 μ V/cm 0.53 Hz 30.0 Hz 50.0 Hz*

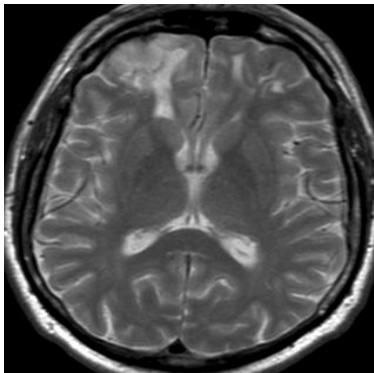
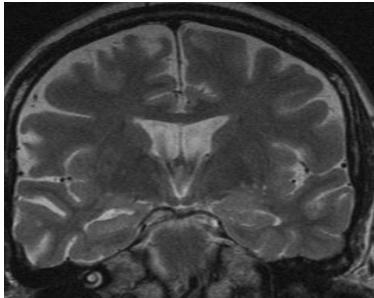
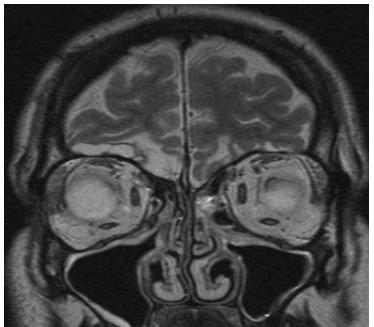
For Help, press F1
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NCSE in patient B, 79 yrs.

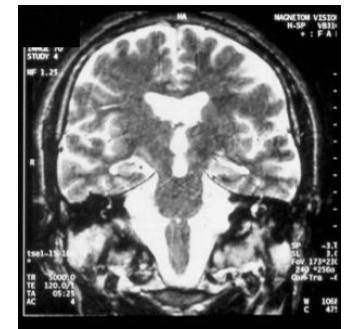
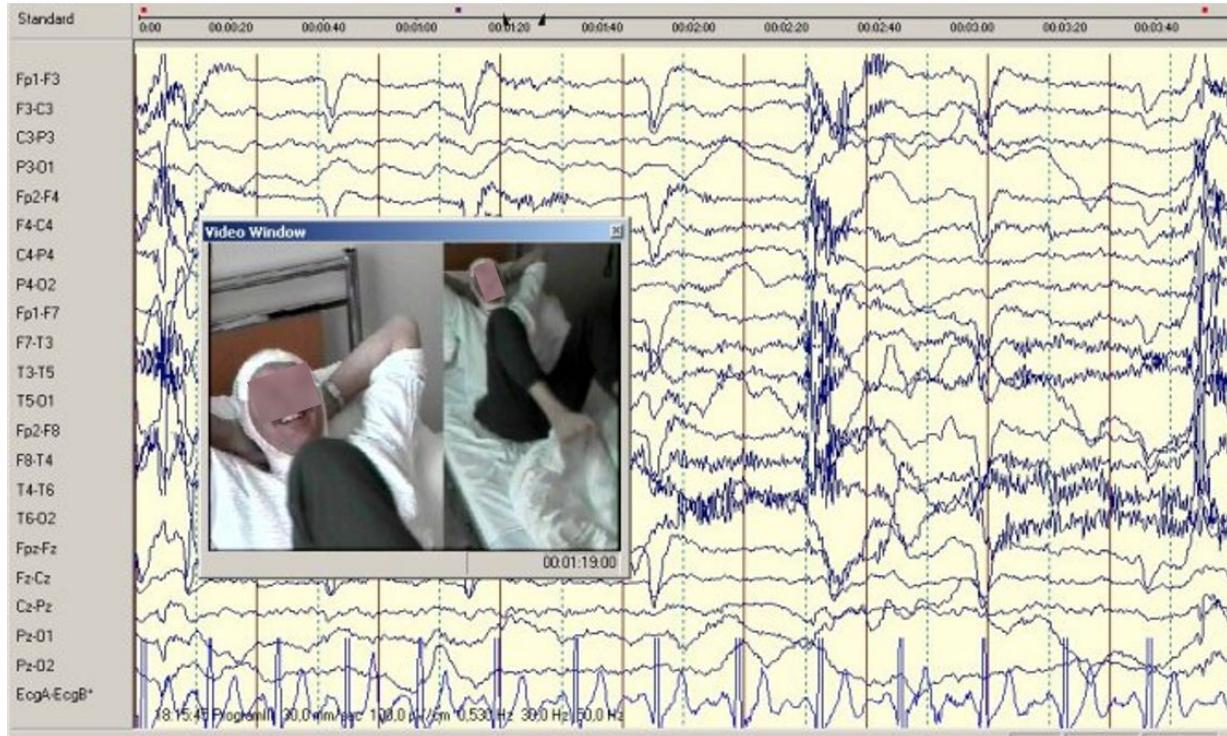
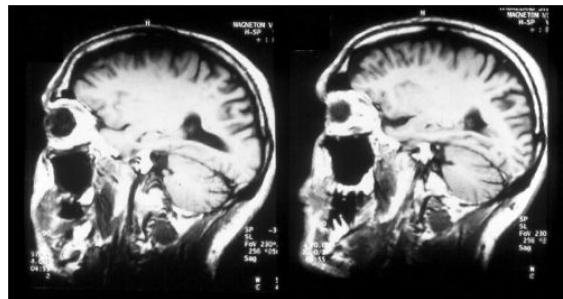


Shoo-peer from Loddefjord.

FR seizure during sleep with minor clinical symptoms, right hand automatisms and postictal confusion.



"Having a good laugh"; impaired consciousness.



Bilat.(right>left)
Hipp.sclerosis

FR seizure with smile and short laughter.

Left hippocampal sclerosis
Postoperative seizure free.



V

**Seizures with fractionated
consciousness.
Dissociation !**

Dissociation by Network Integration

Vinod Menon, Ph.D.

Dissociation is a disconnection between a person's thoughts, memories, feelings, actions and sense of self

cognition (11). In this context, hyperconnectivity between the DMN and FPN in individuals with high levels of dissociation points to maladaptive integration and regulation of self-relevant internal mental processes. ↑ amygd. activ.

Increased coactivation of the control FPN (CEN), «ruminating» DMN and altered cooperation with the Salience (“viktighets”) networks

Given the complexity of the underlying psychological phenomena, it has been a challenge to determine the neurobiological signatures of trauma-related dissociation.

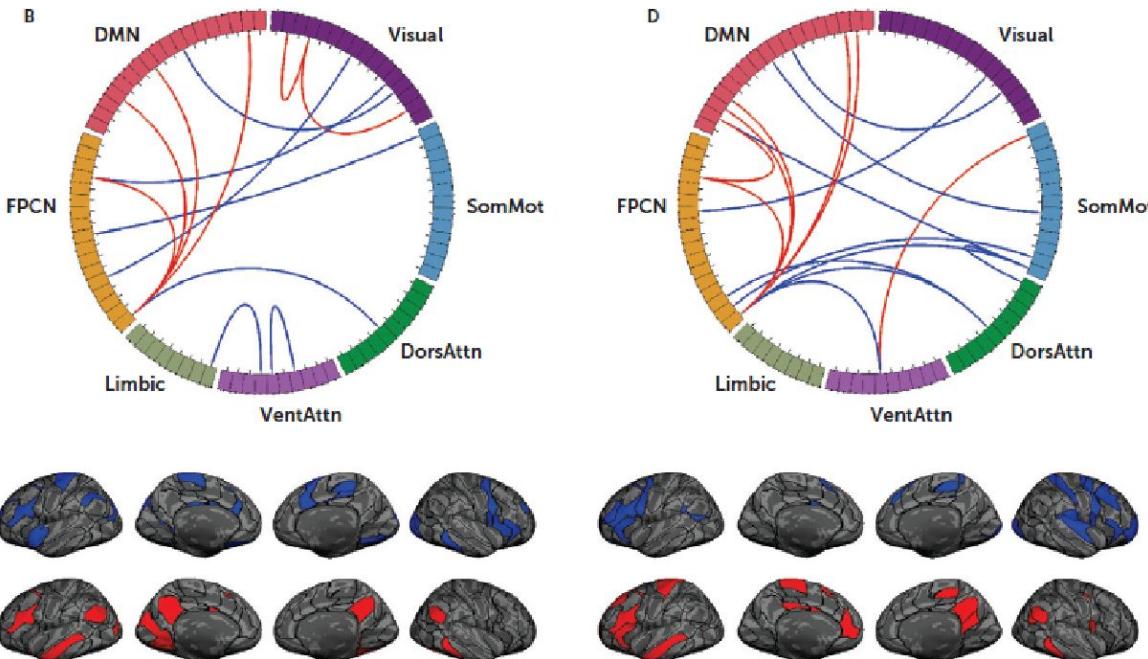


Large-Scale Functional Brain Network Architecture Changes Associated With Trauma-Related Dissociation

Lauren A.M. Lebois, Ph.D., Meiling Li, Ph.D., Justin T. Baker, M.D., Ph.D., Jonathan D. Wolff, B.S., Danhong Wang, M.D., Ph.D., Ashley M. Lambros, B.S., Elizabeth Grinspoon, Ph.D., Sherry Winternitz, M.D., Jianxun Ren, B.S., Atilla Gönenç, Ph.D., Staci A. Gruber, Ph.D., Kerry J. Ressler, M.D., Ph.D., Hesheng Liu, Ph.D., Milissa L. Kaufman, M.D., Ph.D.

Dissociation = changed activation pattern!

2021





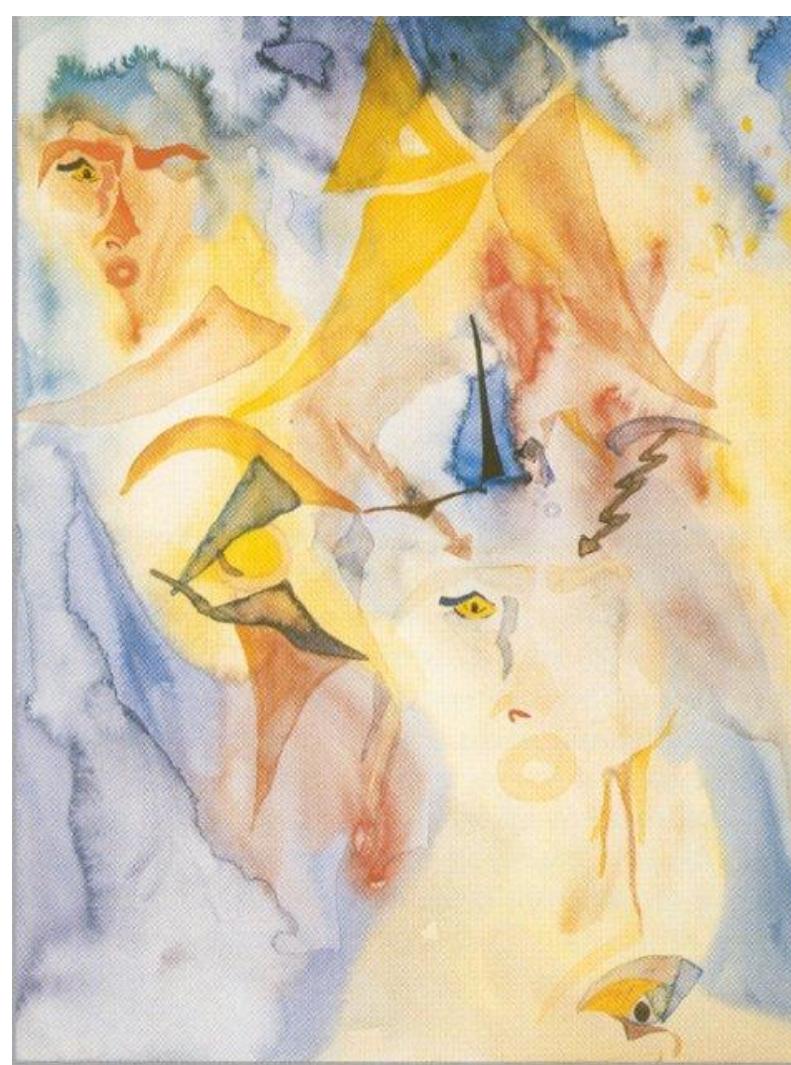
«Fragmentation of self » and out of body feeling in epileptic seizure. *Dissociation*.

Jennifer Hall

Transcending

From the Storm; Artists with temporal lobe epilepsy. 1993.

Slide for free use.



Juliane Ahrens, 1996.

Seizures like a dream.

Dissociation !?

Something conscious, something «fuzzy»

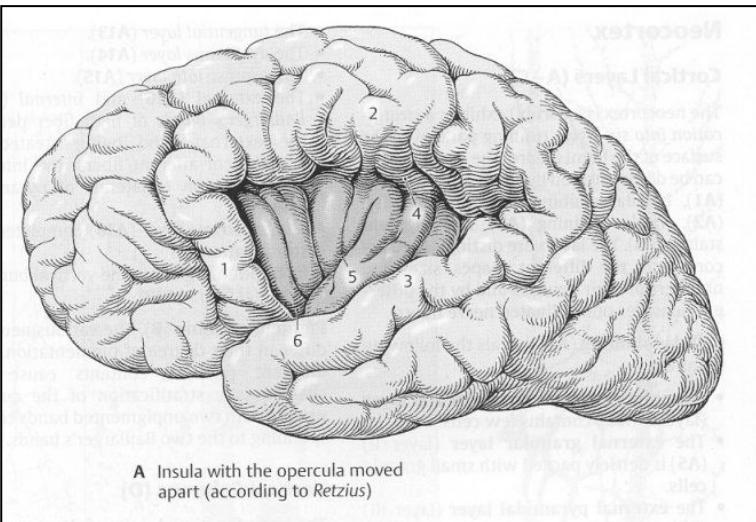
Slide for free use.

Seizures with «enhanced» or intensified consciousness.

Enhanced **self experience** &
Feeling of meaning/truth &
clearity +
Altered perception of time

Ecstatic Epileptic Seizures: A Glimpse into the Multiple Roles of Insula

Markus Gschwind^{1,2} and Fabienne Picard^{1*}



Sizures with:

- *Intense happiness; «Bliss, clarity, serenity»
- *Intensified self-awareness and experience of the surroundings and clarity.
- *Meaning + truth ! Intensely felt values

Right > Left ?
Antero-dorsal Insula

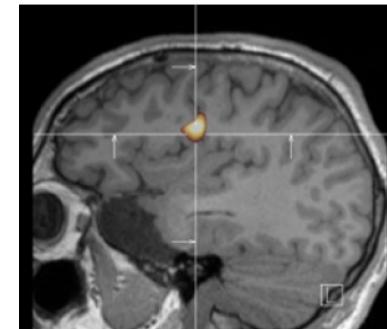
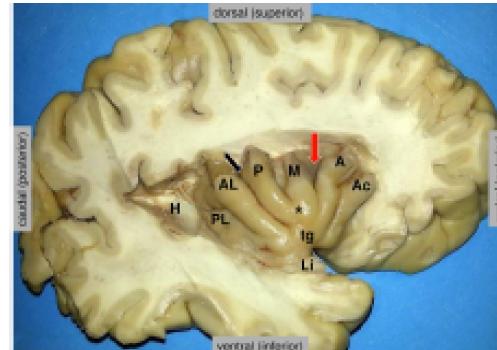


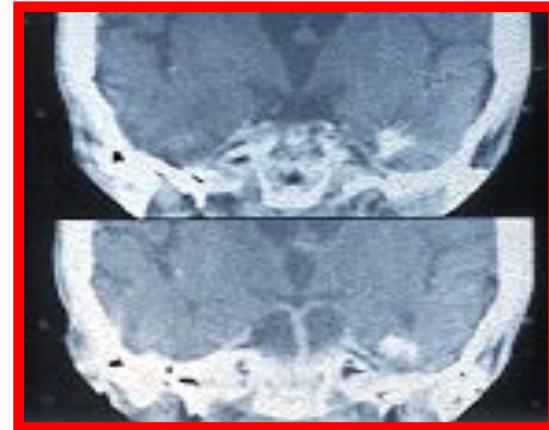
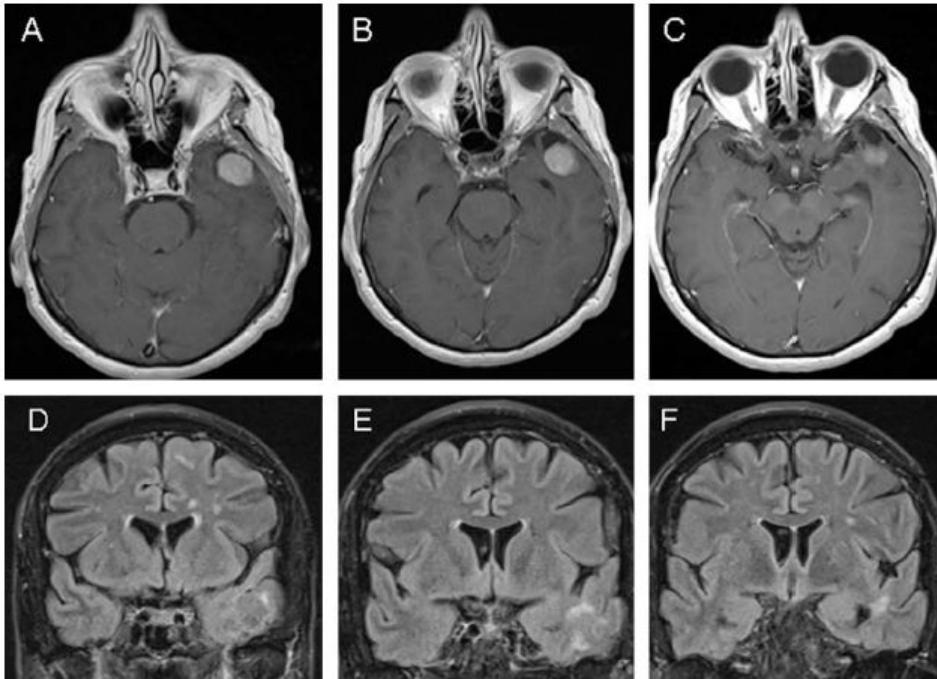
Figure 1. Cerebral MRI (sagittal view) and ictal/interictal

Ecstatic epileptic seizures: A potential window on the neural basis for human self-awareness

F. Picard^{a,*}, A.D. Craig^b

♀ 64 år.

F. Picard, A.D. Craig / Epilepsy & Behavior 16 (2009) 539–546

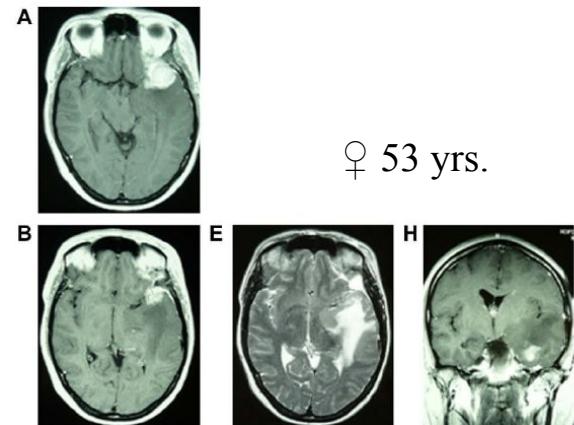


F. Picard, A.D. Craig / Epilepsy & Behavior 16 (2009) 539–546



b. 1921
1990.

Had "been
in heaven"
and often
saw Jesus.



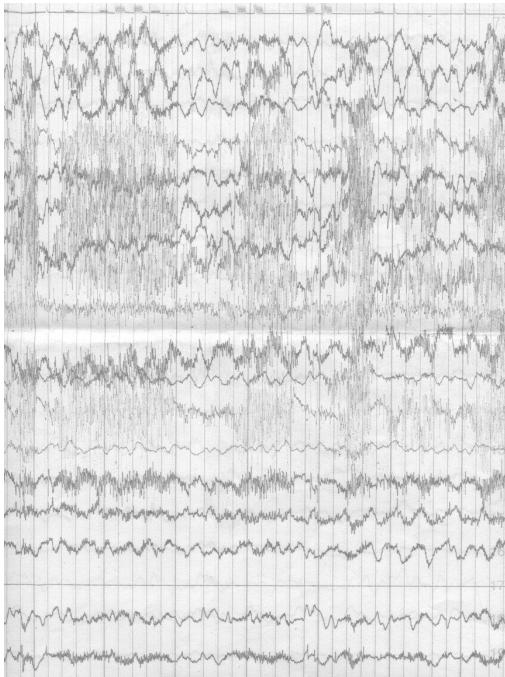
♀ 53 yrs.

b.64. Car accident 7-8 år old.

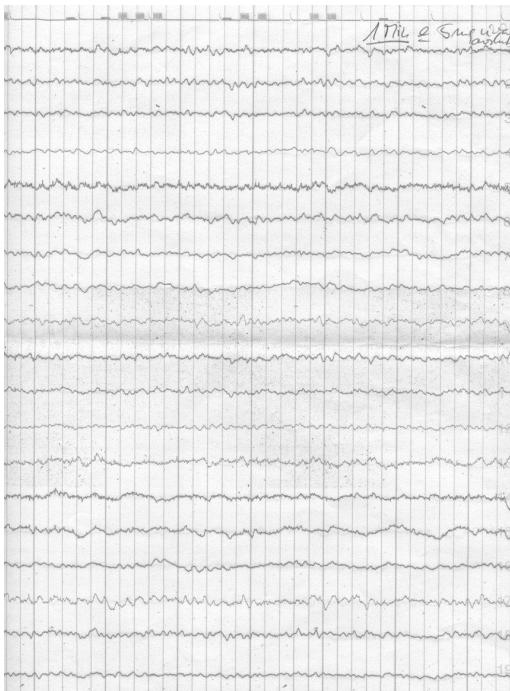
Loss of consciousness

Epilepsy from age 16. FTK, FB/FR w/religious feelings and thoughts.

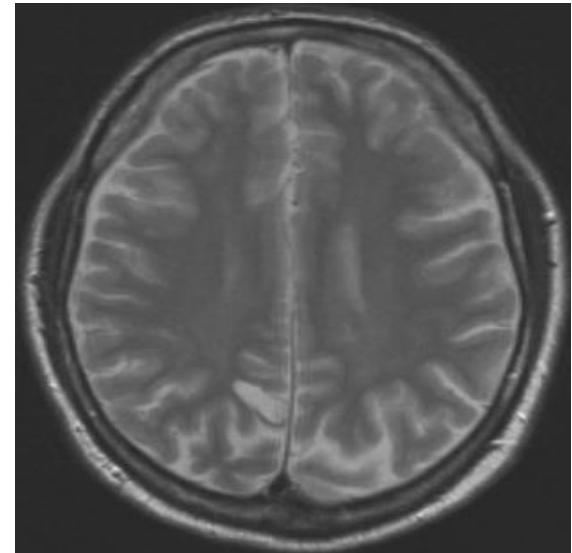
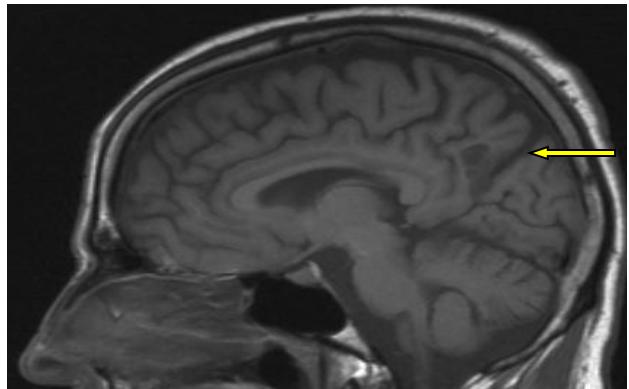
EEG under the feeling of being i heaven



1989

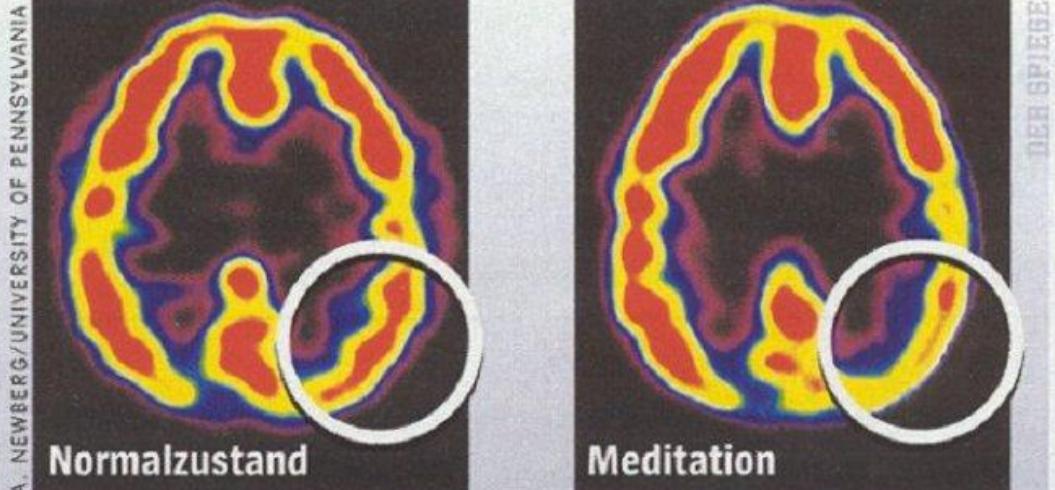


EEG 1 min a 5 mg DZP iv



Losgelöst vom Hier und Jetzt

PET-Aufnahmen Meditierender



Auf Positronen-Emissions-Tomogrammen (PET) leuchten nur die aktiven Hirnregionen intensiv auf (rot). Während der Meditation (rechts) ist die Aktivität vor allem im Scheitellappen deutlich geringer als im Normalzustand (links) – möglicherweise die Ursache dafür, dass der Geist sich von allem Irdischen losgelöst fühlt.

Reduced parietal activation during meditation with a feeling of «going up into something greater outside oneself»

Der Spiegel.

Patient C, woman 60 yrs

First attack in 1992 (age 52). She wakes up with a headache that worsens with physical activity, nausea and gets better within 24 hours. Eventually problems organizing thoughts and actions (for example, paying the correct amount in a shop). (Dyscognitive seizures!).

