

FDG-Positron emission tomography: a measure of brain metabolism

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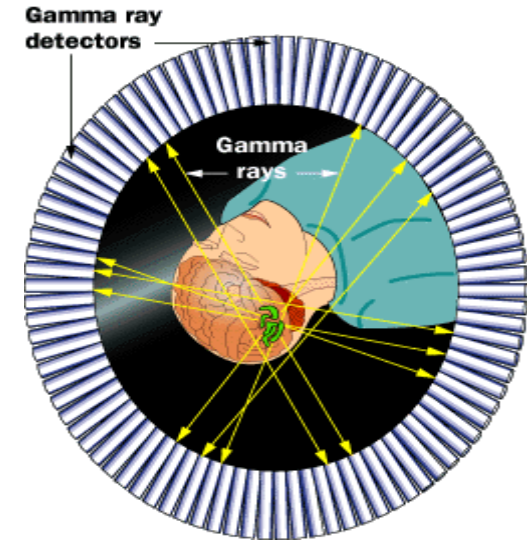
ASSC 22, June 26th 2018

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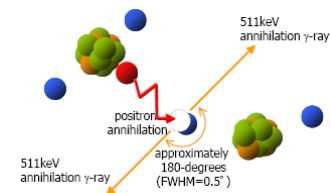
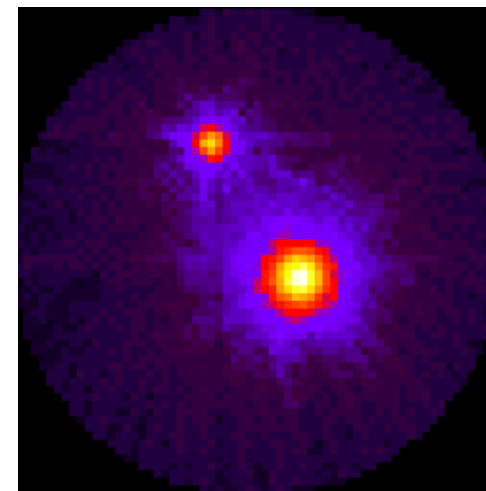
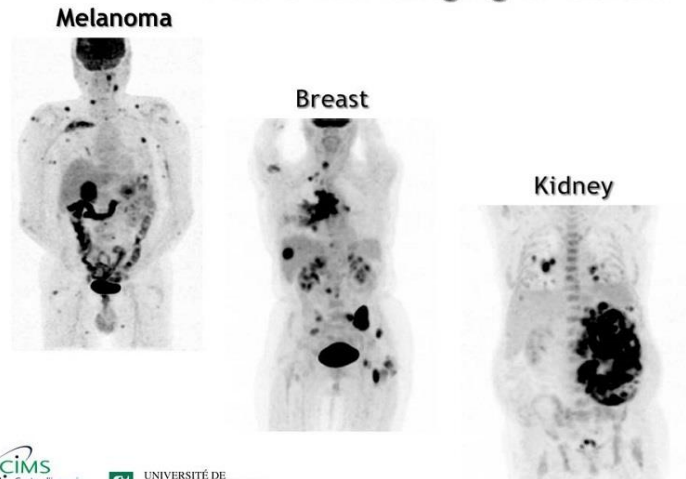


PET-scan – how does it work?

- PET = injection of radioactive isotopes
 - ^{18}F -Fluorodopa $\rightarrow$ Parkinson disease
 - ^{18}F -Fluorodesoxyglucose $\rightarrow$ oncology
 - H_2O^{15} $\rightarrow$ active tasks
- ^{18}F Fluorodesoxyglucose (FDG) = marker for glucose tissue uptake in the brain

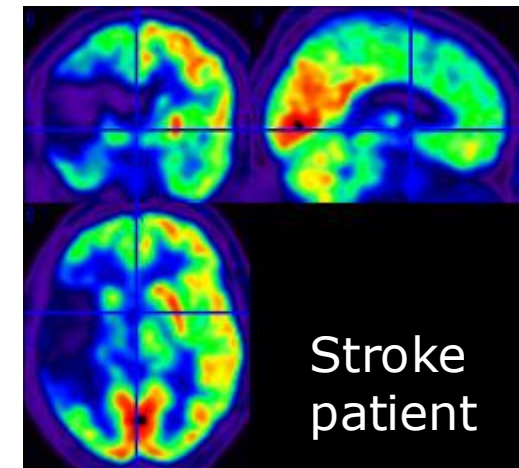


^{18}F -FDG PET Imaging of Cancer



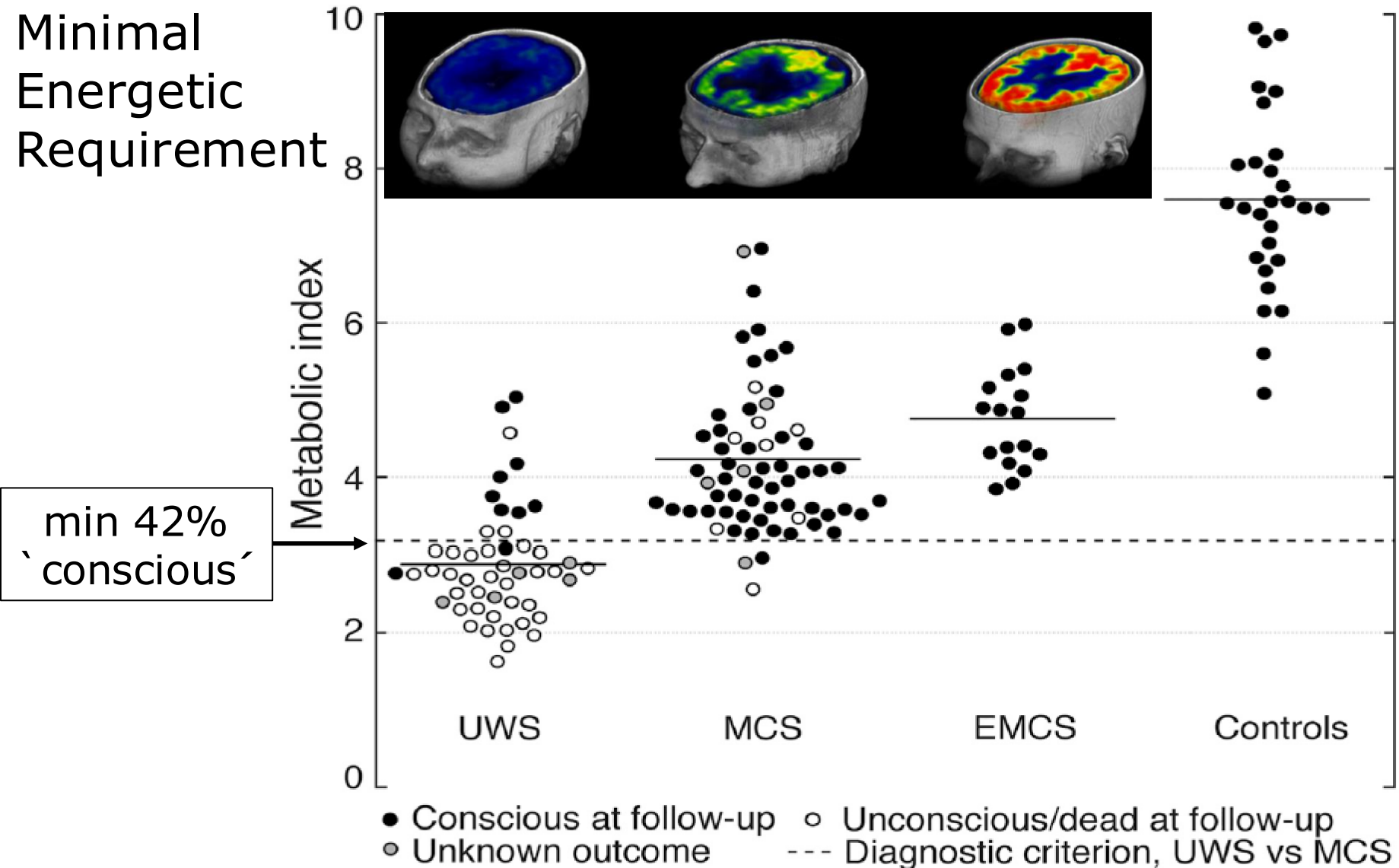
FDG-PET-scan – what do we measure?

- Resting state (no passive or active tasks)
- Dark and quiet environment
- Scan 30 minutes after injection = incubation time
- Measures global & regional brain metabolism

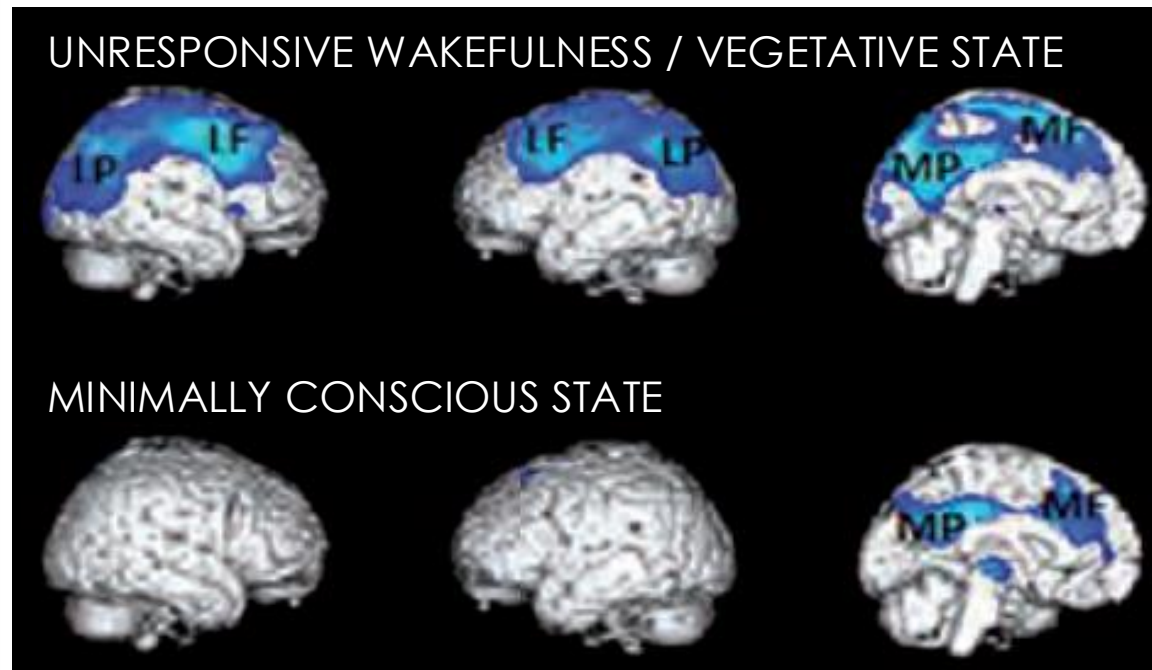
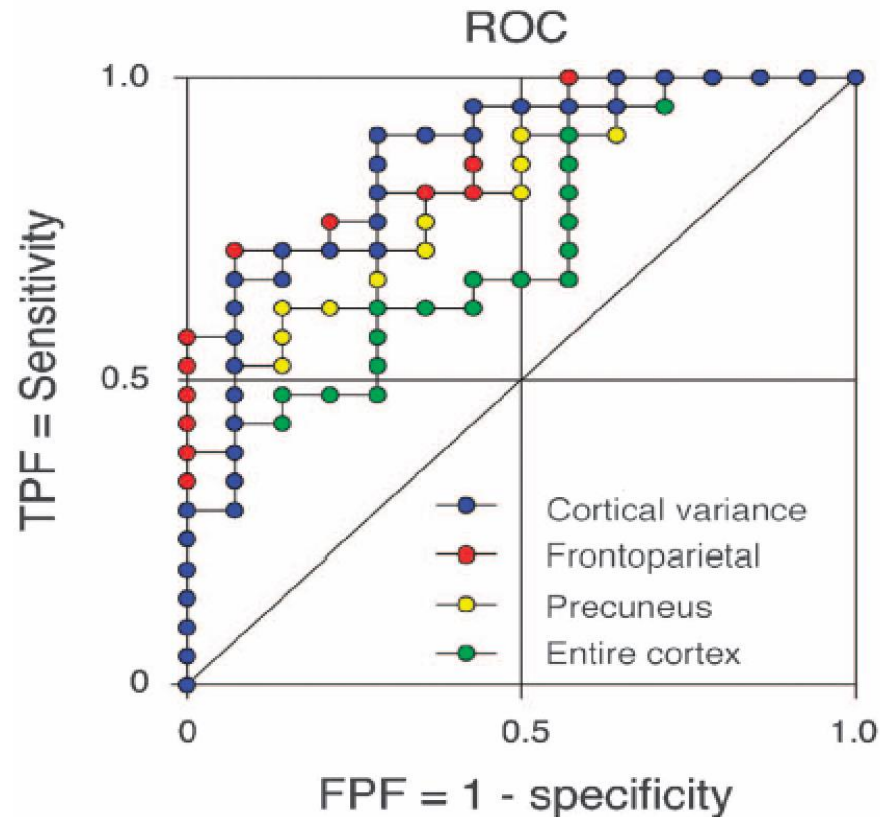


Global brain metabolism

Minimal
Energetic
Requirement



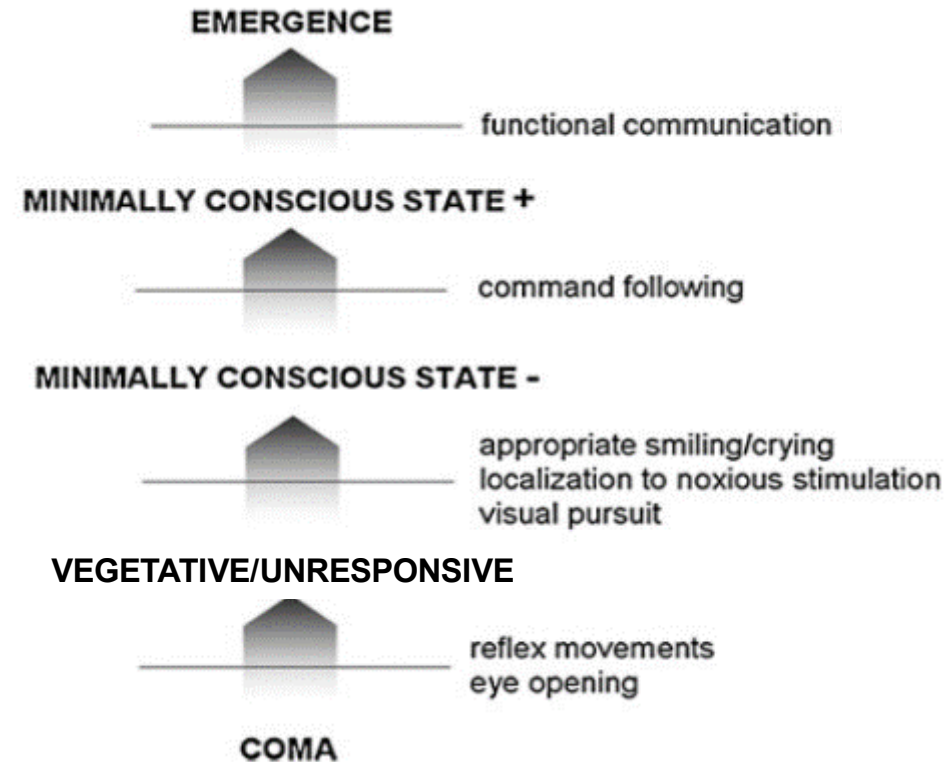
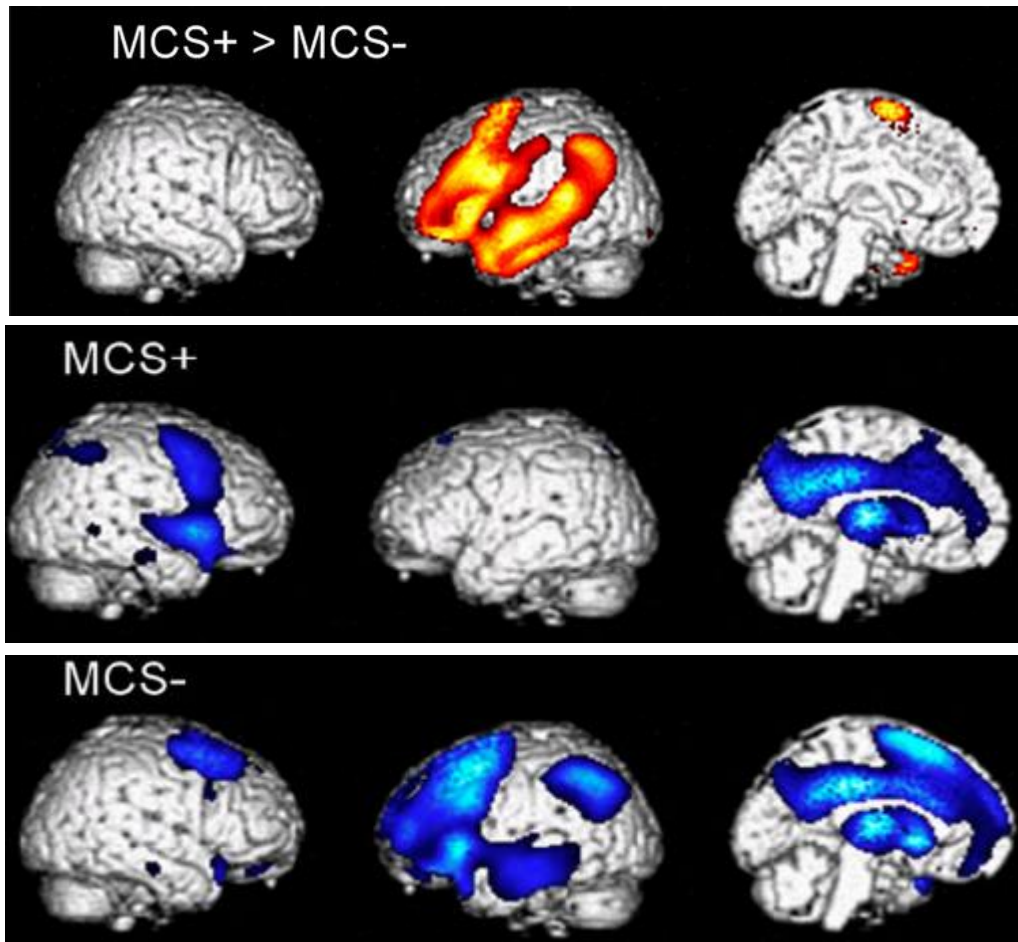
Regional brain metabolism



Stender et al, *J Cereb Blood Flow & Metab*, 2015

Thibaut et al, *J Rehabil Med*, 2012

≠ brain metabolisms underlie ≠ behaviors

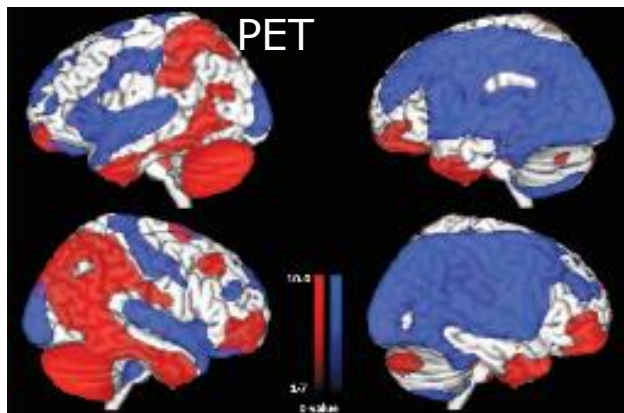


FDG-PET as a diagnostic tool

128 patients

81 MCS, 41 UWS, 4 LIS

110 chronic, 50 TBI



	Coma Recovery Scale-Revised results		
	UWS	MCS	Total
Clinical consensus diagnosis			
VS/UWS	33 (37%)	18 (20%)	51 (57%)
MCS	2 (2%)	36 (40%)	38 (43%)
Total	35 (39%)	54 (61%)	89 (100%)
¹⁸F-FDG PET			
VS/UWS	24 (21%)	5 (4%)	29 (26%)
MCS	12 (11%)	71 (63%)	83 (74%)
Total	36 (32%)	76 (68%)	112 (100%)
Mental imagery fMRI			
VS/UWS	25 (36%)	23 (33%)	48 (69%)
MCS	3 (4%)	19 (27%)	22 (31%)
Total	28 (40%)	42 (60%)	70 (100%)

UWS=unresponsive wakefulness syndrome. MCS=minimally conscious state.

Table 2: Diagnostic results by modality

35% clinical misdiagnosis

33% CRS-R misdiagnosis

75% recovered csc

THE
LANCET

PET to complement clinical assessment

30minutes of incubation

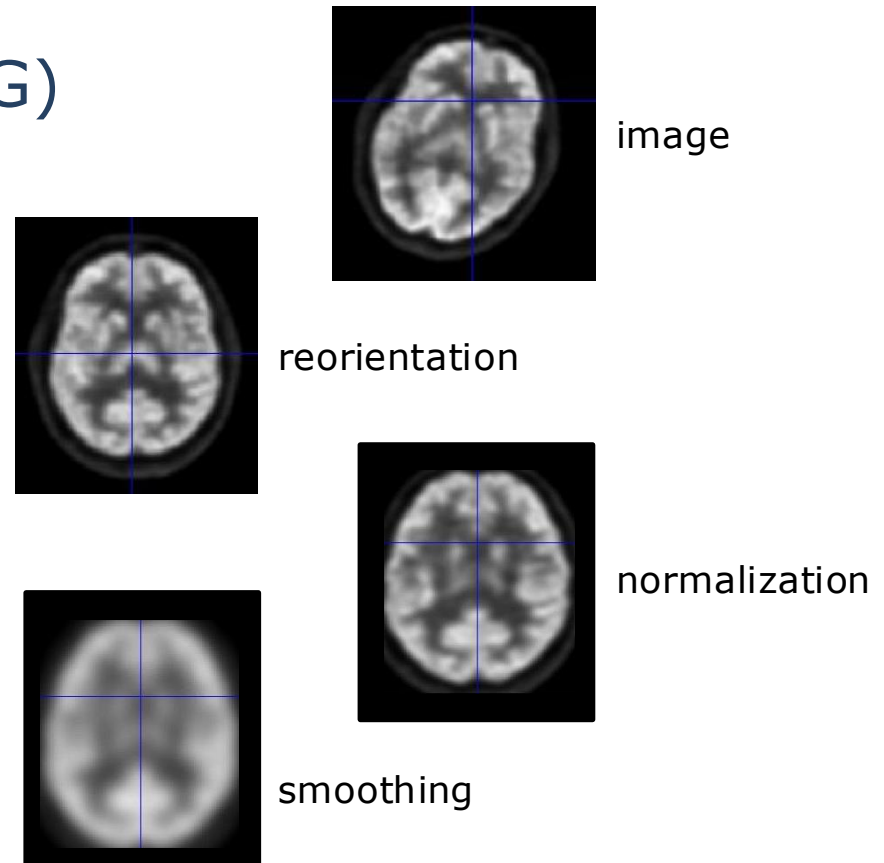
Acquisition = 12 min (PET-FDG)

1. 90 slices => 1 image

2. Reorientation

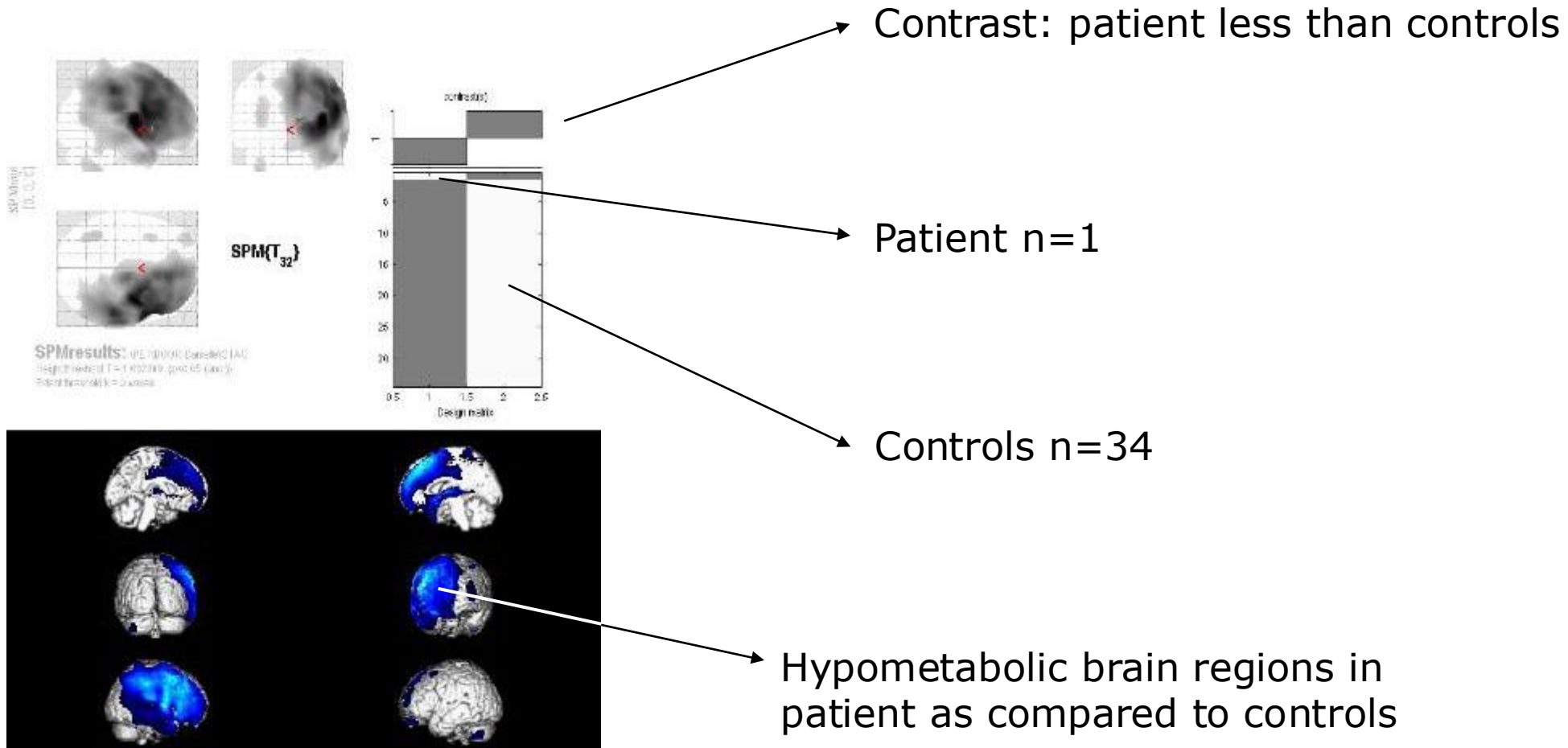
3. Normalization (template)

4. Smoothing (14mm FWHM)



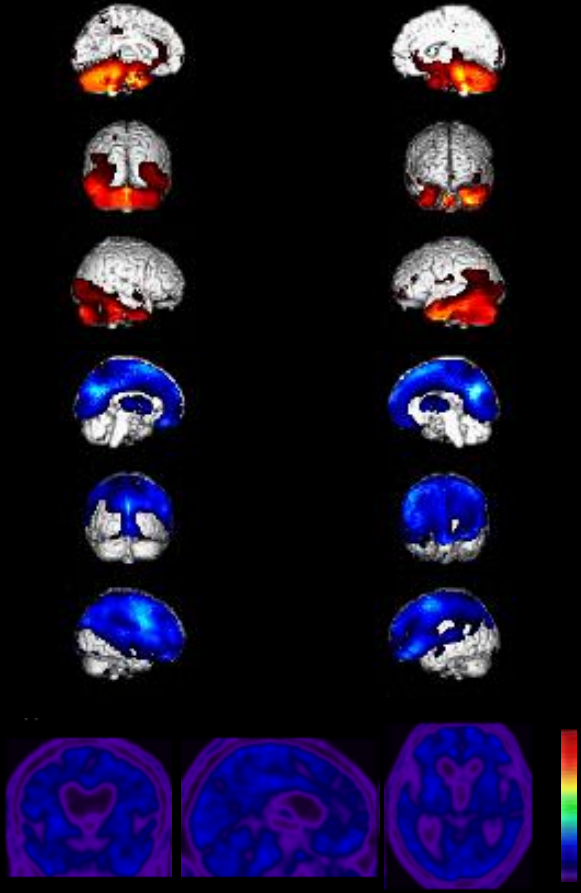
PET to complement clinical assessment

1. Reorientation, normalization (optimized template), smoothing
2. Statistics



PET to complement clinical assessment

Typical UWS

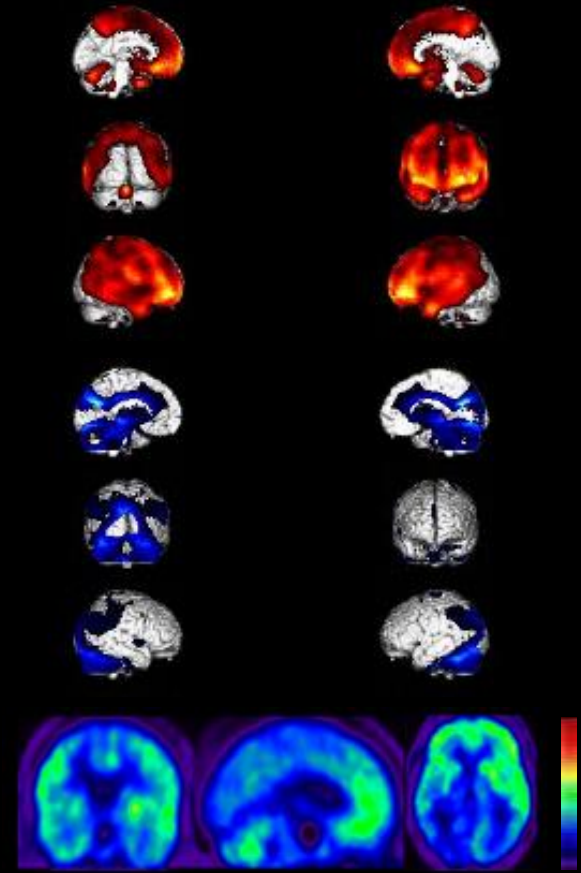


preserved
brain regions

hypometabolic
brain regions

SUV

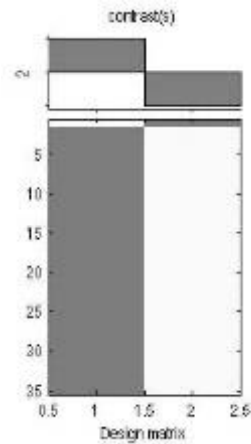
Typical MCS



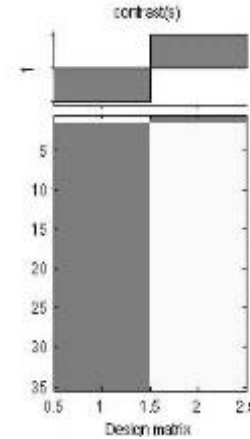
PET to complement clinical assessment

Patient

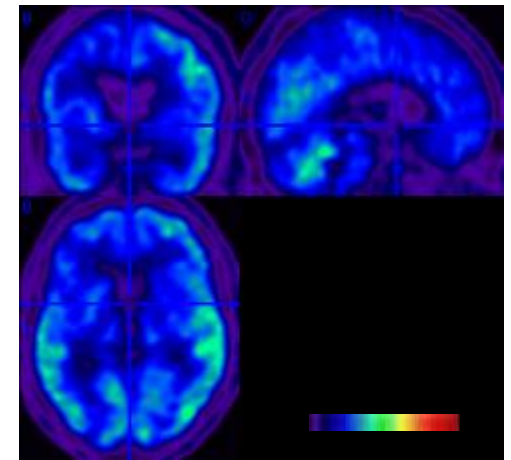
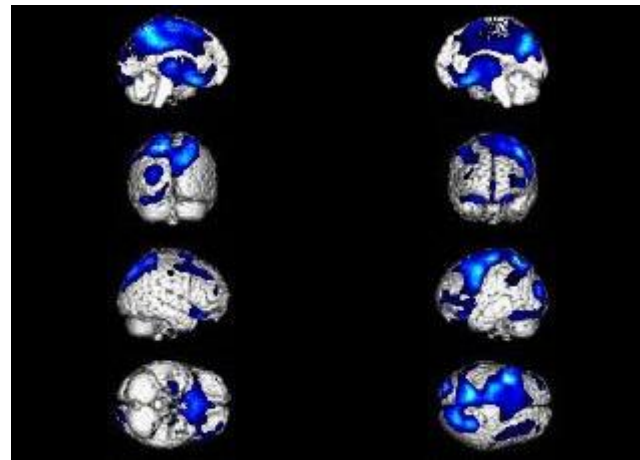
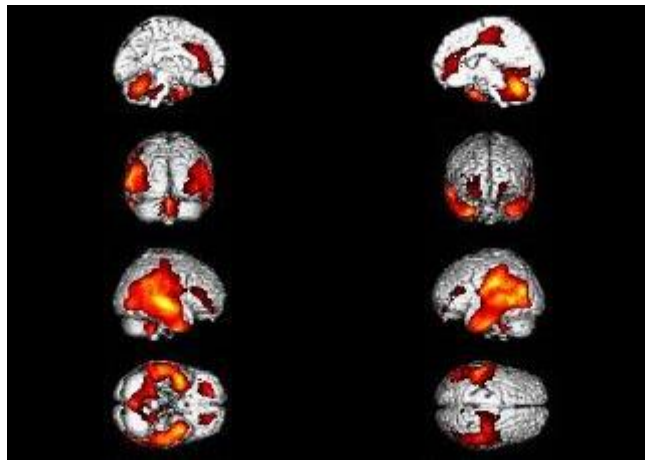
preserved
areas



hypometabolism

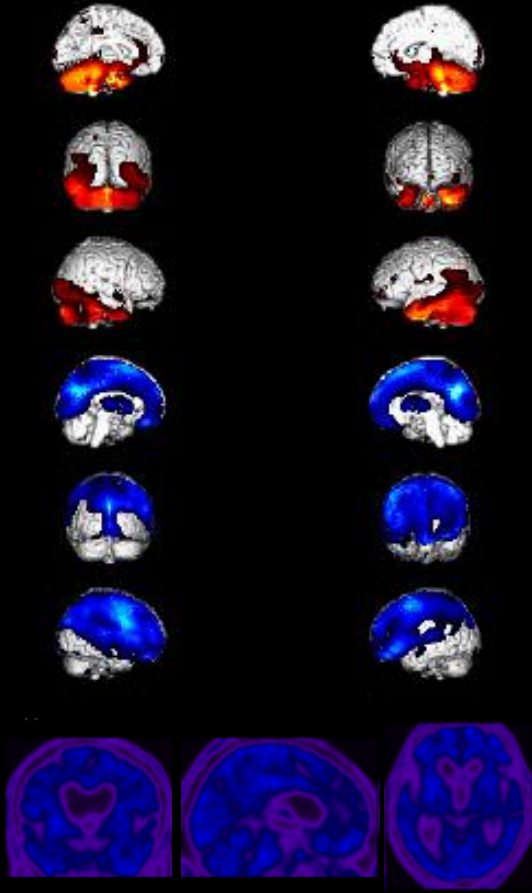


+ SUV (global metabolism)
% of decrease

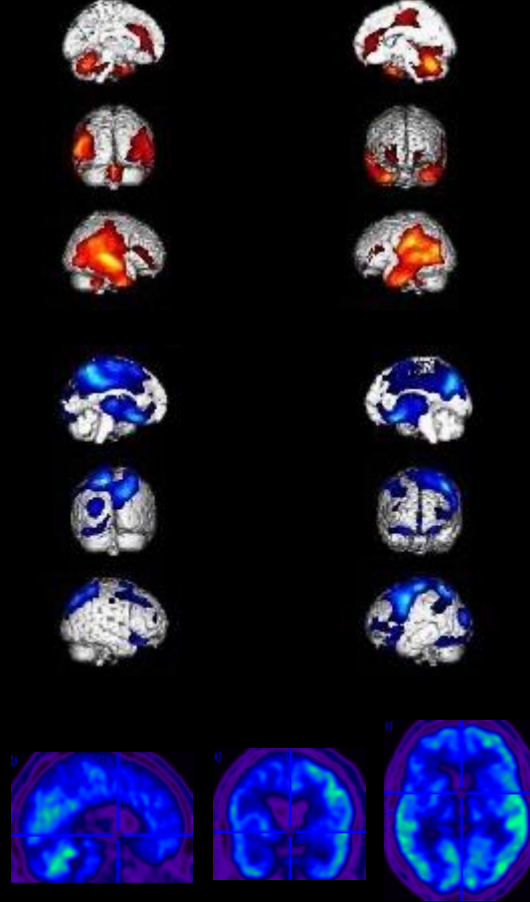


PET to complement clinical assessment

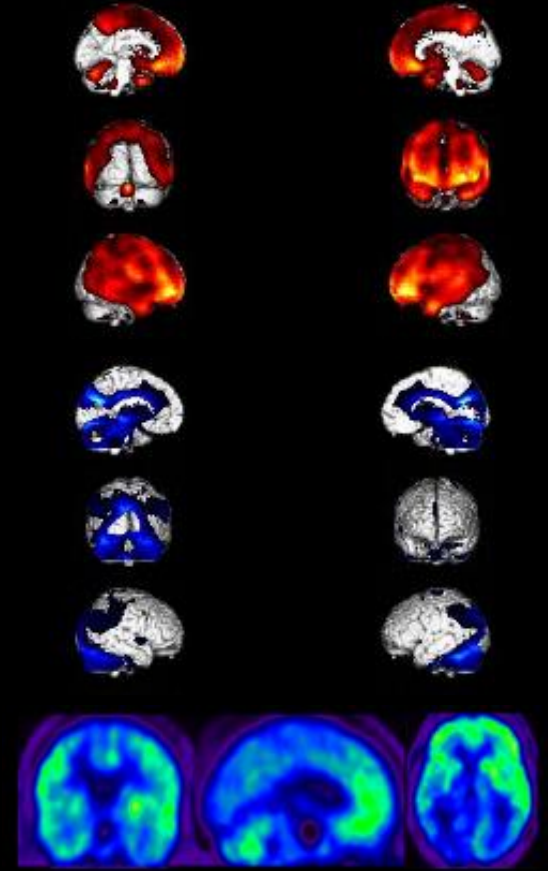
Typical UWS



Patient

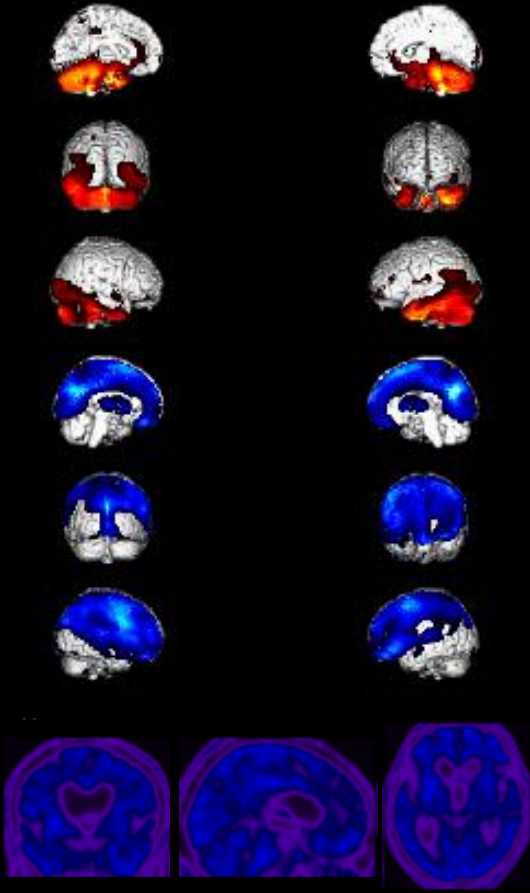


Typical MCS

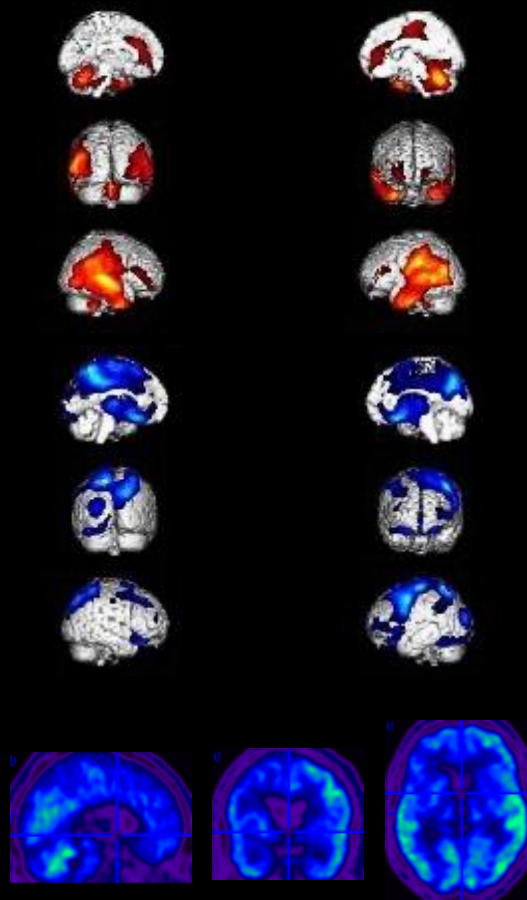


PET to complement clinical assessment

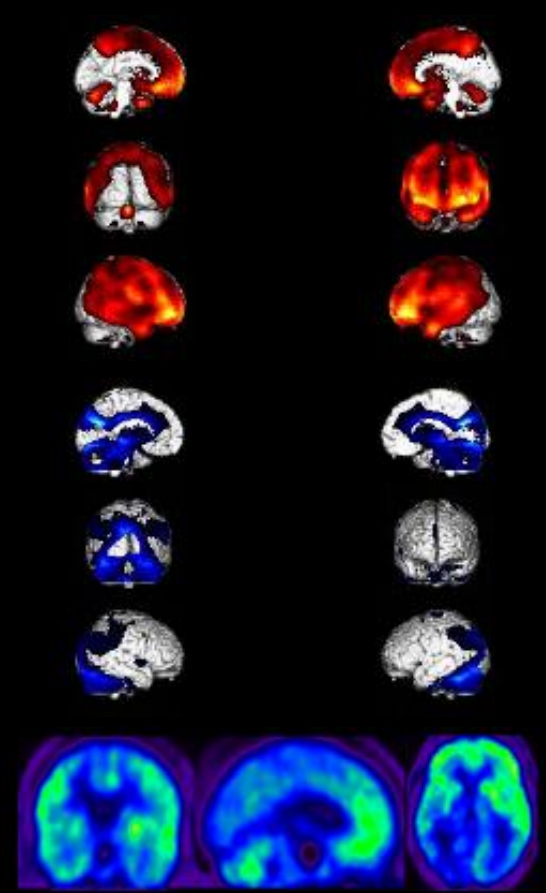
Typical UWS



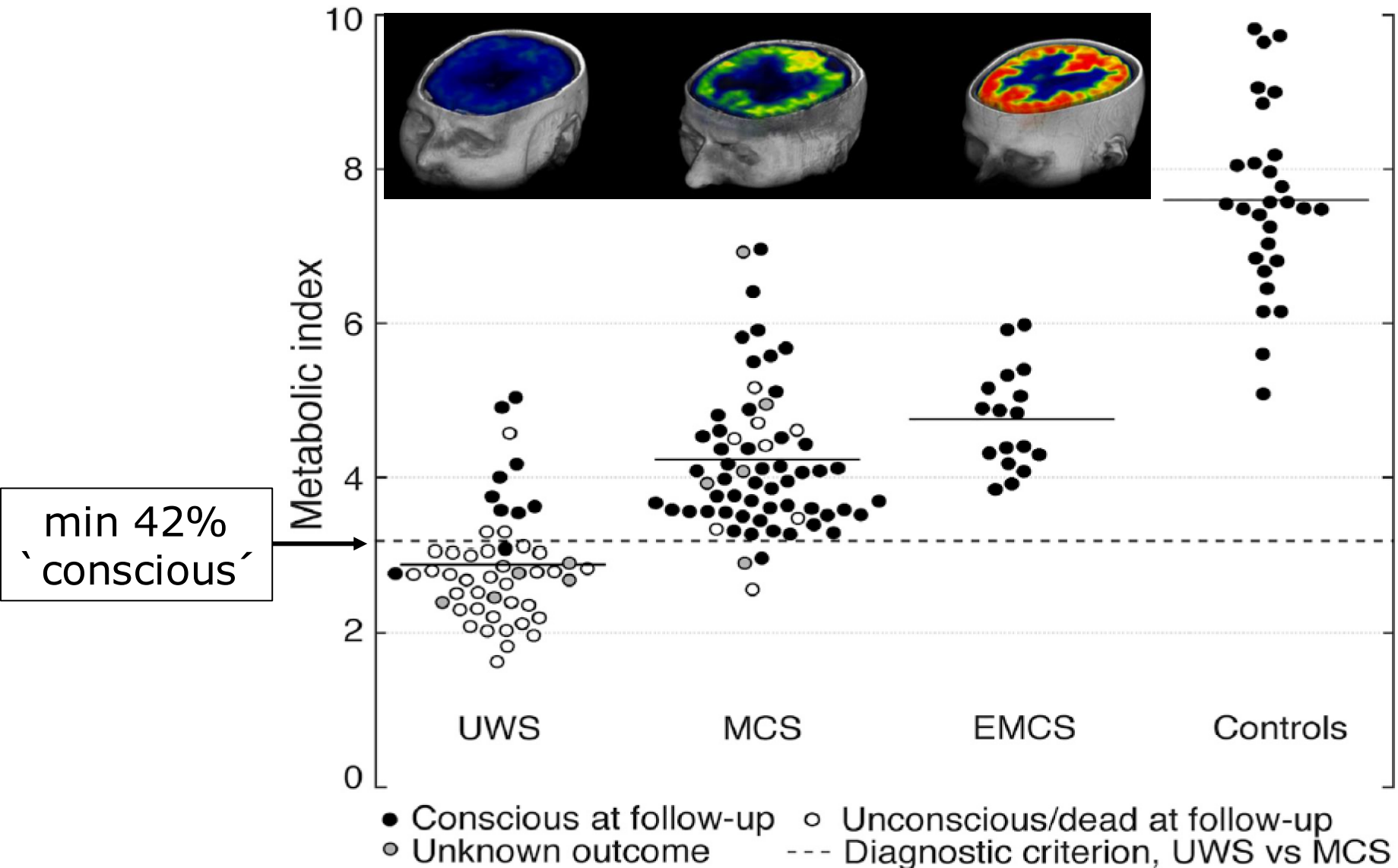
Patient



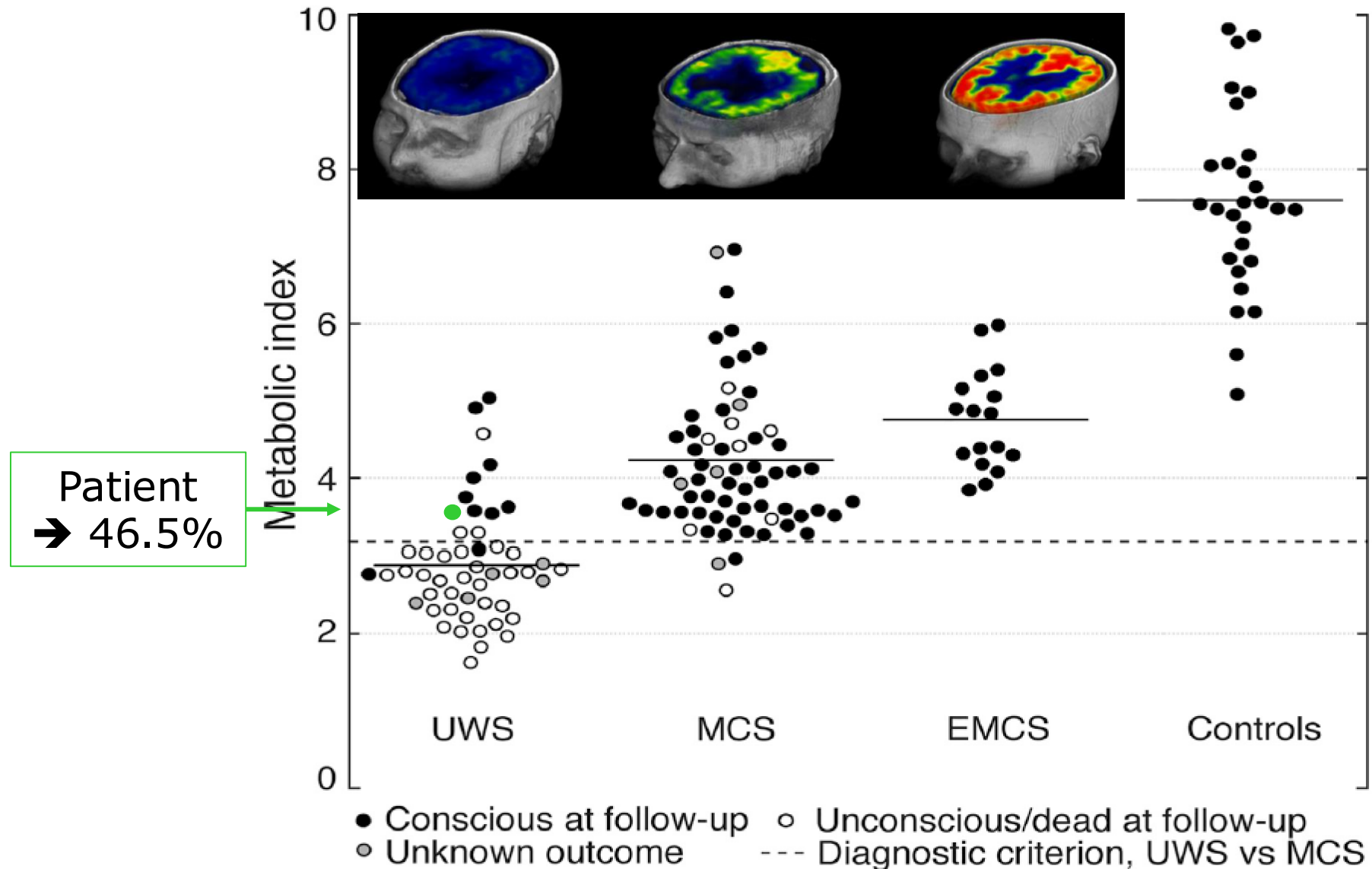
Typical MCS



PET to complement clinical assessment



PET to complement clinical assessment



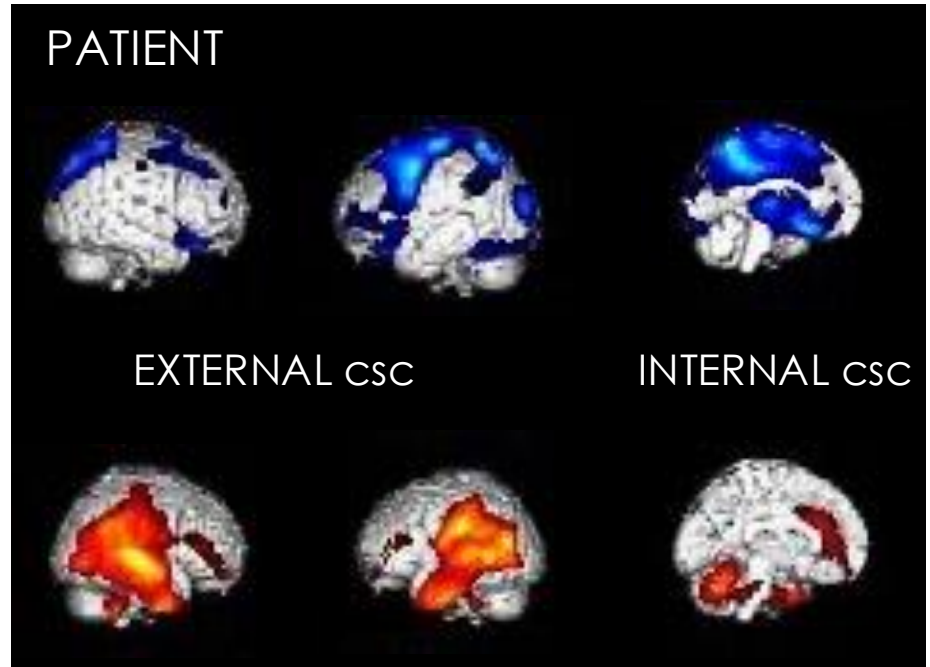
PET to complement clinical assessment

Regional brain metabolism – internal & external csc networks

UNRESPONSIVE WAKEFULNESS



PATIENT



➔ Partial preservation of both internal & external csc networks

Extensive brain damage **BUT...**

Brain metabolism (global®ional) closer to **MCS** than UWS

➔ Pain perception & emotion – quality of life

FDG-PET scan does not require patient's participation,
So far, best **diagnostic tool**

BUT

- expensive
- low accessibility
- tracers (radiation)
- expertise
- patient has to be awake
- poor spatial resolution

THANK YOU



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Studying Consciousness
in the electrical brain
luminous

fnr
FREEDOM TO RESEARCH


Université
de Liège

CHU
de Liège

James S. McDonnell Foundation

HORIZON 2020
LE PROGRAMME DE RECHERCHE ET
D'INNOVATION DE L'UNION EUROPÉENNE



Human Brain Project

esa
European Space Agency

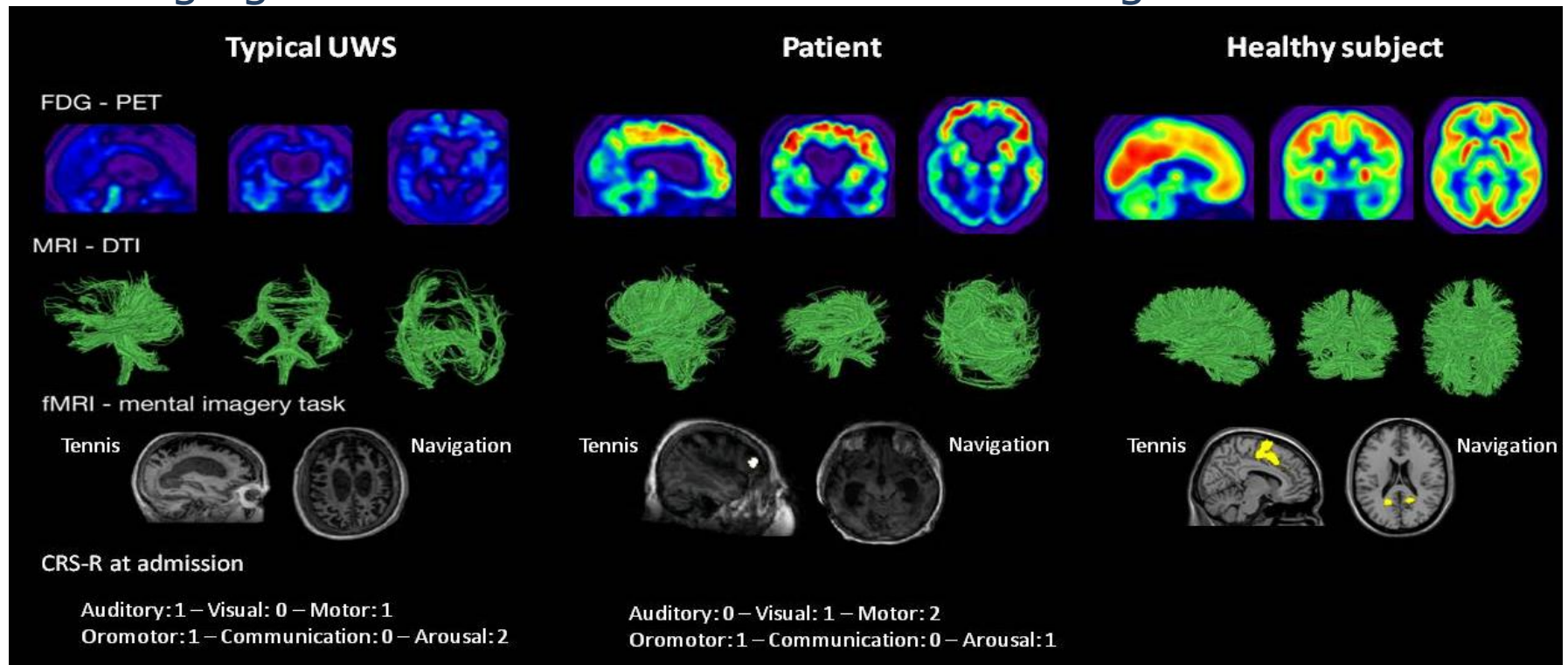


W
RÉGION WALLONNE

MIND SCIENCE
FOUNDATION

tDCS to unveil covert consciousness

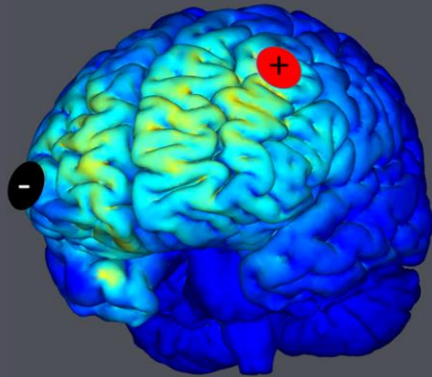
- 67yo woman in UWS for 4 years after a subarachnoid hemorrhage
- Out of 7 standardized CRS-R she showed 1 localization to pain
- She demonstrated consistent response to command only after tDCS
- Neuroimaging exams were consistent with the diagnosis of MCS*



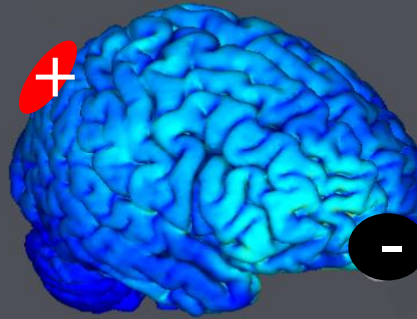
➔ tDCS may facilitate motor execution of the command when cognitive functions are preserved

tDCS - which area to target?

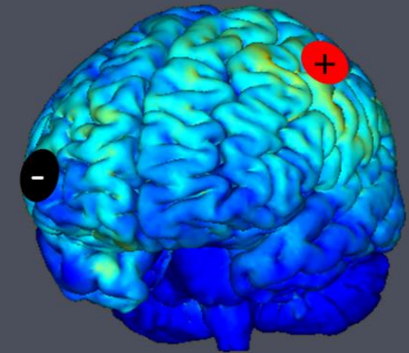
Prefrontal ↗



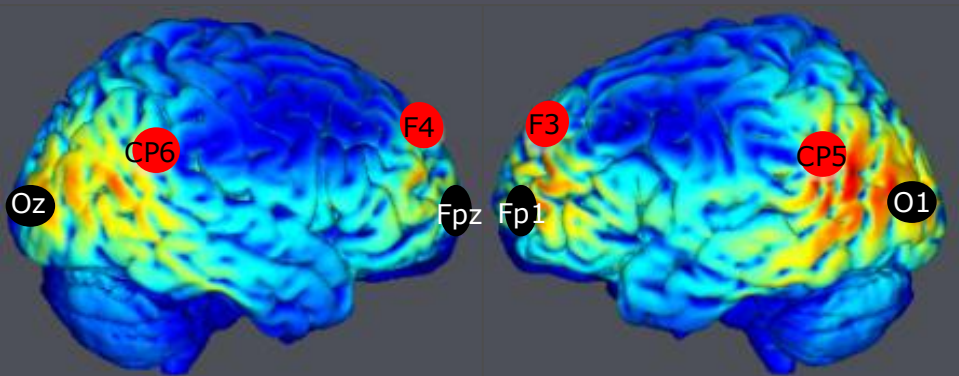
Precuneus →



Motor ≡



Multichannel frontoparietal ≡



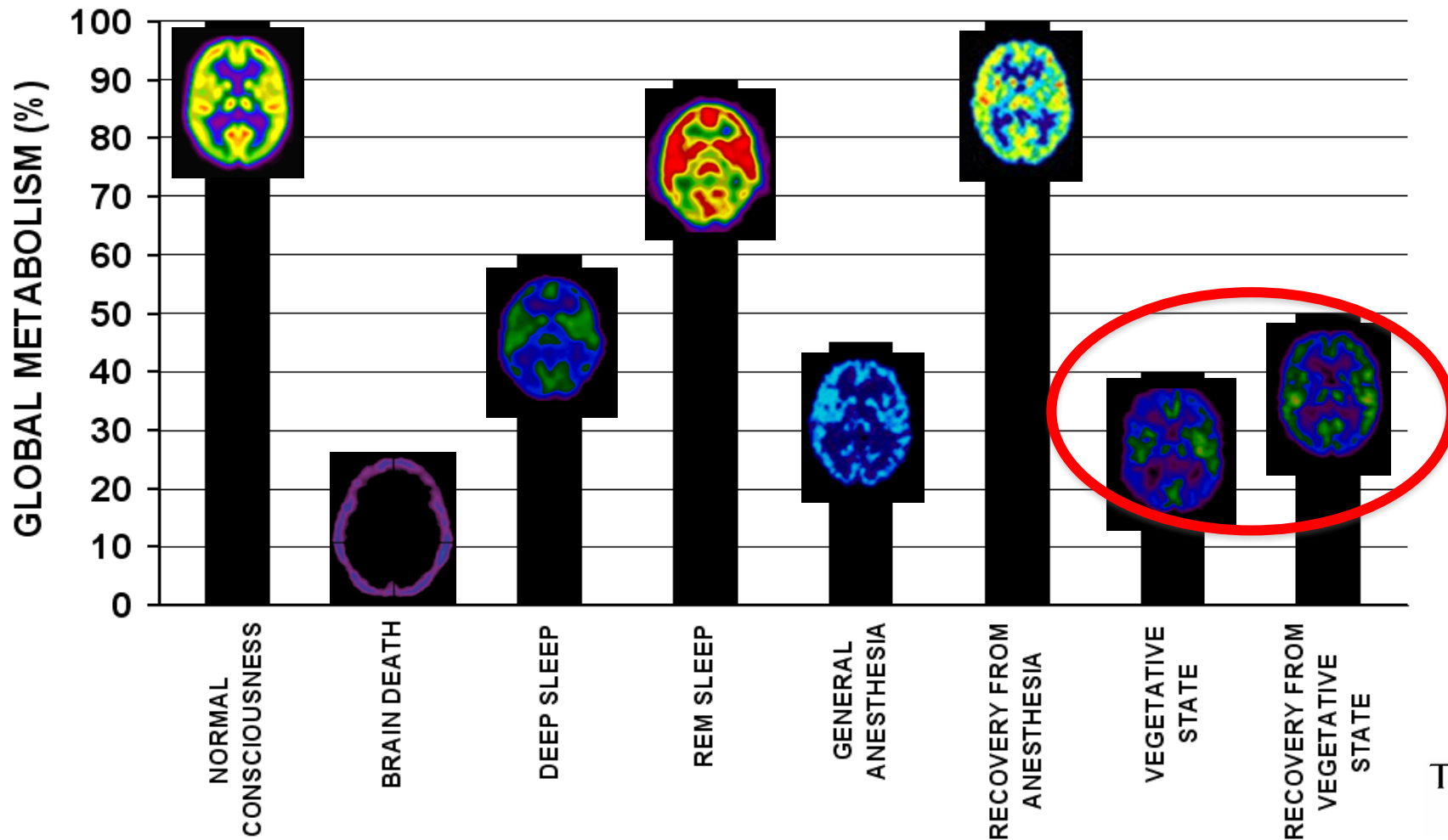
Prefrontal tDCS
best area to target

Thibaut et al, 2014, 2017

Huang et al, 2017

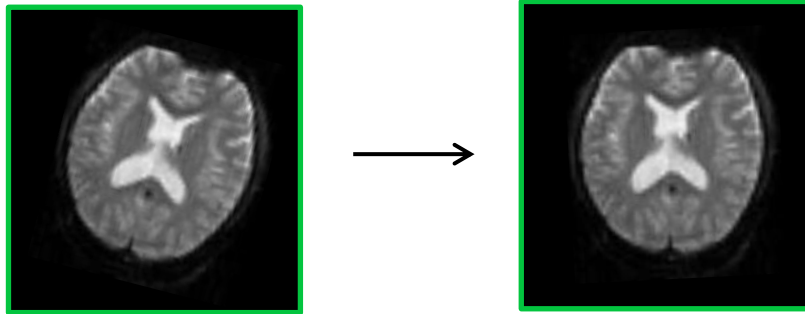
Martens et al, submitted, Thibaut et al, submitted

Consciousness $\neq$ global brain function



Reorientation

Correction head position

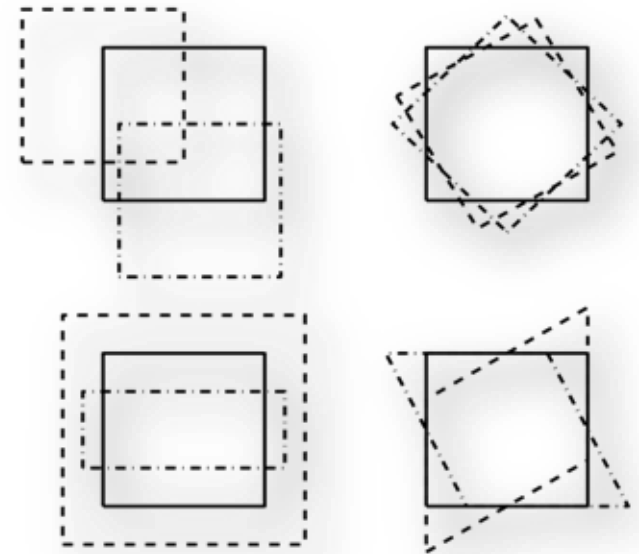


Normalization

Distord the images → each individual brain regions are the same among all subjects and controls
→ Template

Transformation:

- 3 translations
- 3 rotations
- 3 zooms
- 3 shears



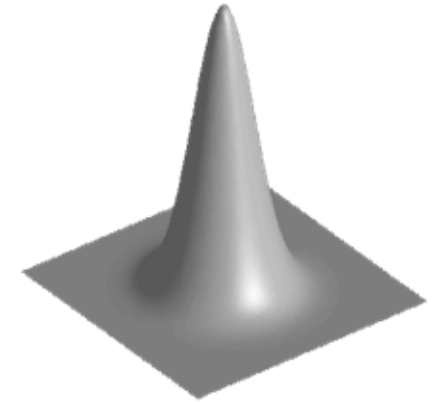
Smoothing

Increase sensitivity

Inter-subject mean

GLM (general linear model)

→ gaussian distribution



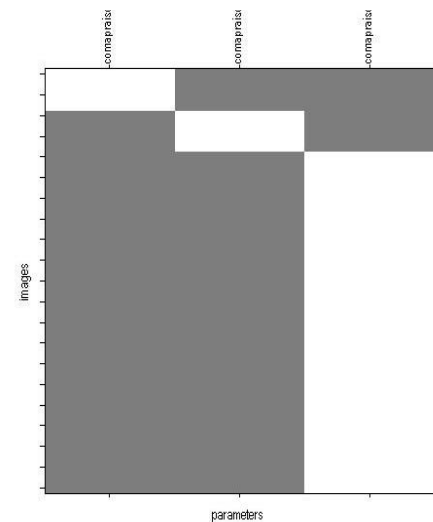
Convolution (par cercle ou Gaussienne)

Statistique

Statistical test: intersujet comparison

Or with controls

Statistical analysis: Design



20minutes of incubation

Acquisition = 12 min (PET-FDG)

1. 90 slices => 1 image

2. Reorientation

3. Normalization

4. Smoothing (14mm FWHM)

