Exploration of consciousness: Disorders of consciousness & near-death experiences

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COMA SCIENCE GROUP

13th June 2016

Université de Liège

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Academic career

- Charlotte Martial
  - Master in psychology
  - Neuroscience
  - PhD student – 2nd year
  - FNRS grant
- Charlène Aubinet
  - Master in clinical neuropsychology
  - Master in speech therapy
  - Language neuropsychology
  - PhD student – 1st year

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Pr Steven Laureys

Content

PART 1

Disorders of consciousness & language impairment

- Definition of consciousness
- Coma recovery
- Diagnosis of disorders of consciousness (DOC)
- Language comprehension impairment in DOC patients

PART 2

Near-Death Experience

- What is a Near-Death Experience (NDE)?
- Characteristics of NDEs memories
- Cognitive characteristics of NDE experiencers
- Reproducing NDEs

PART 1:
Disorders of consciousness & language impairment

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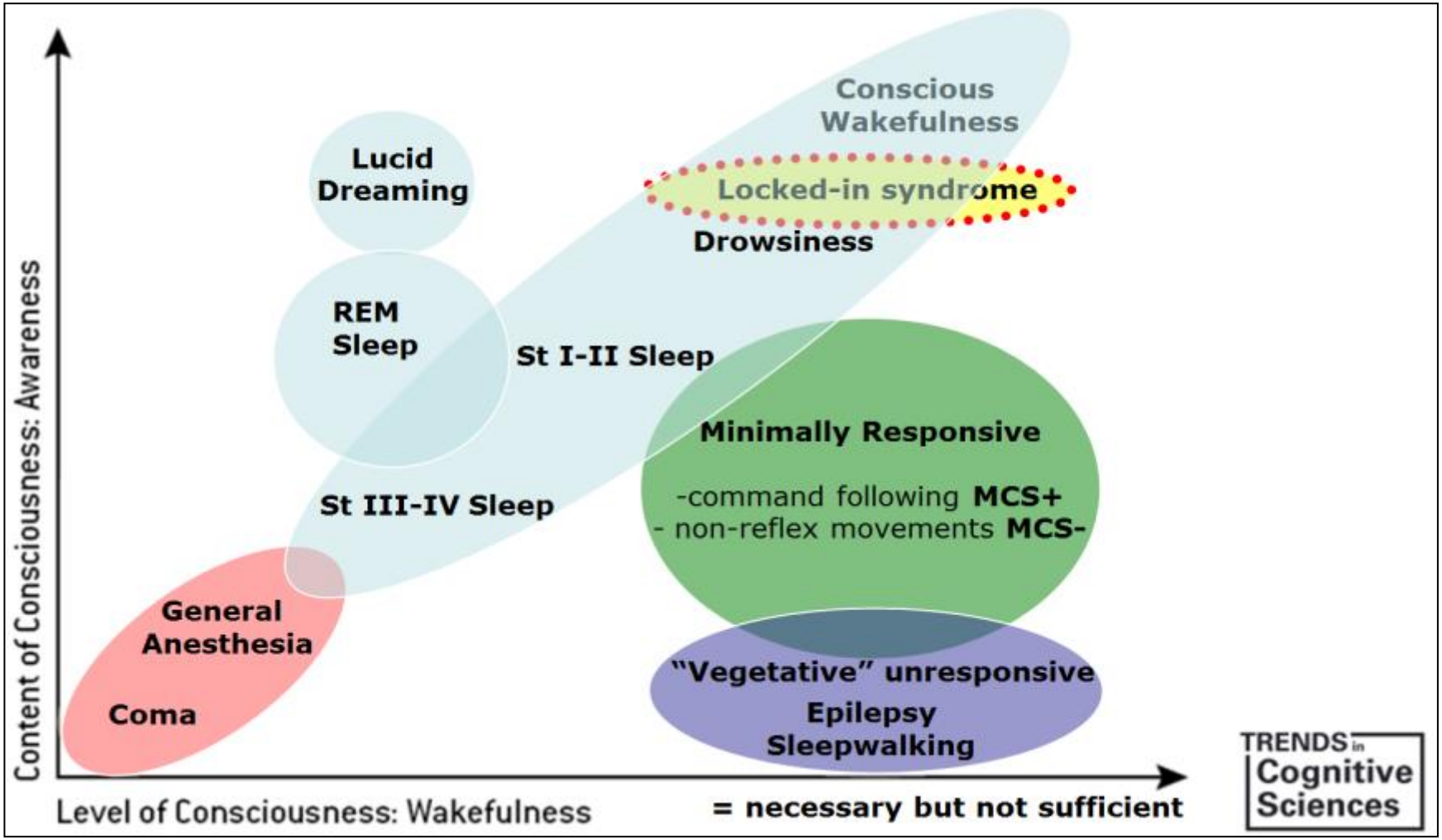
Question 1

How to define « consciousness »?

Un si brillant cerveau – Editions Odile Jacob, 2015

Reducing consciousness in 2D



Laureys, *Trends in Cognitive Sciences*, 2005
Laureys et al, *Nature Clinical Medicine*, 2008

Possible causes of coma

Car Accident

Aggression

Stroke

Hypoglycemia

Cerebral hypoxia

Hypothermia

Encephalopathy

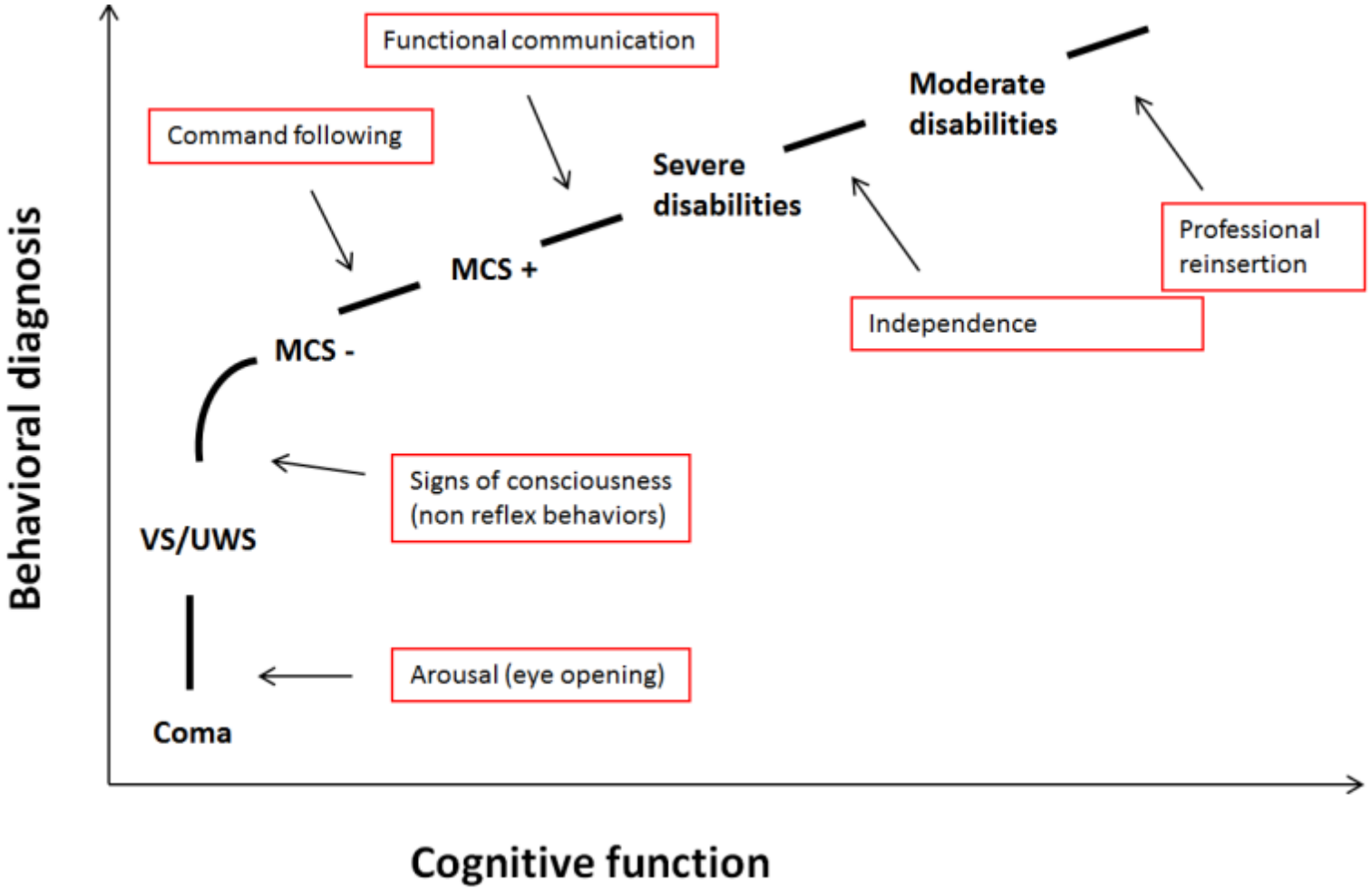
Hemorrhage

Intoxication

Question 2

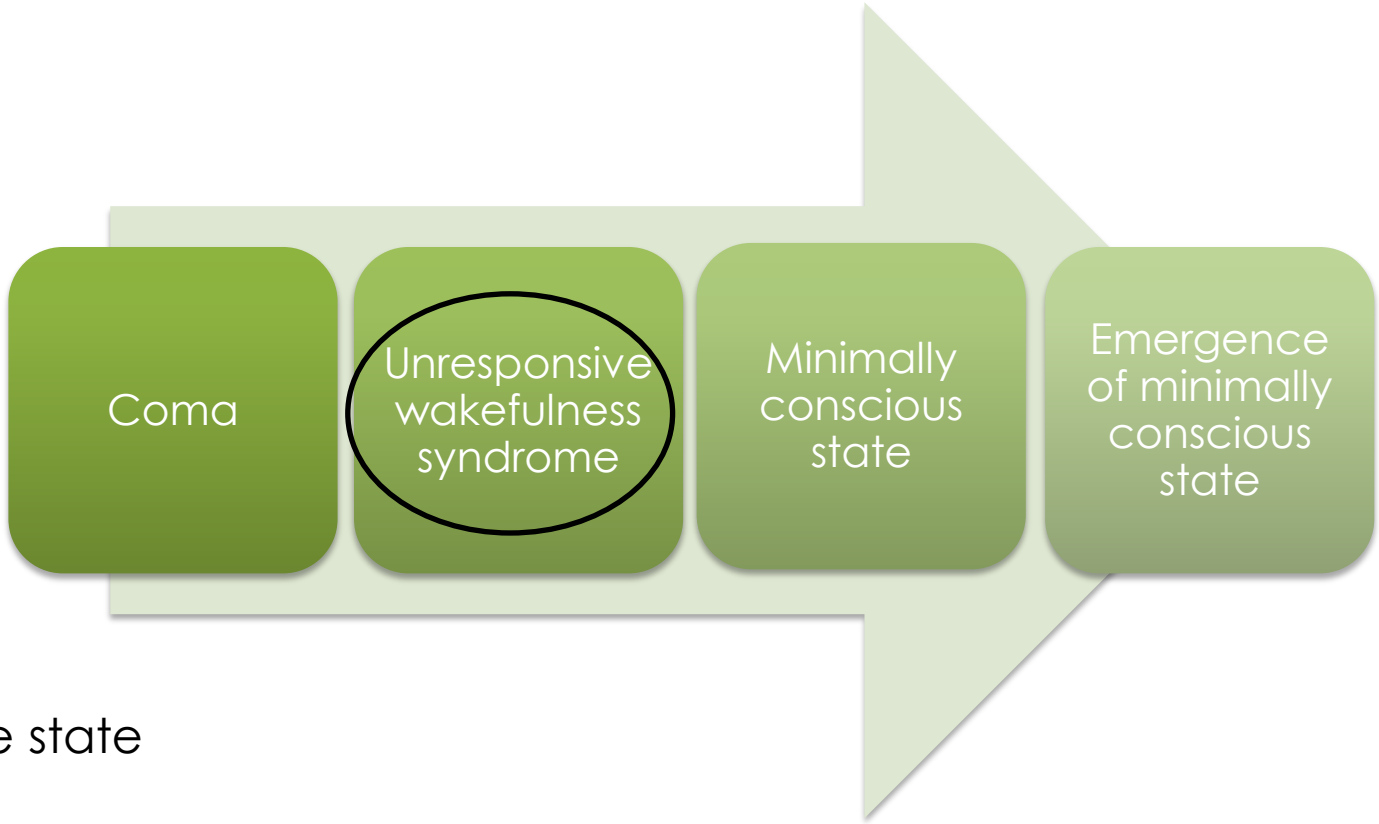
How do patients in coma (partially) recover consciousness?

Consciousness is spread on a continuum



Vanhaudenhuyse, Boly, Laureys. *Scholarpedia* (2009)

Disorders of consciousness

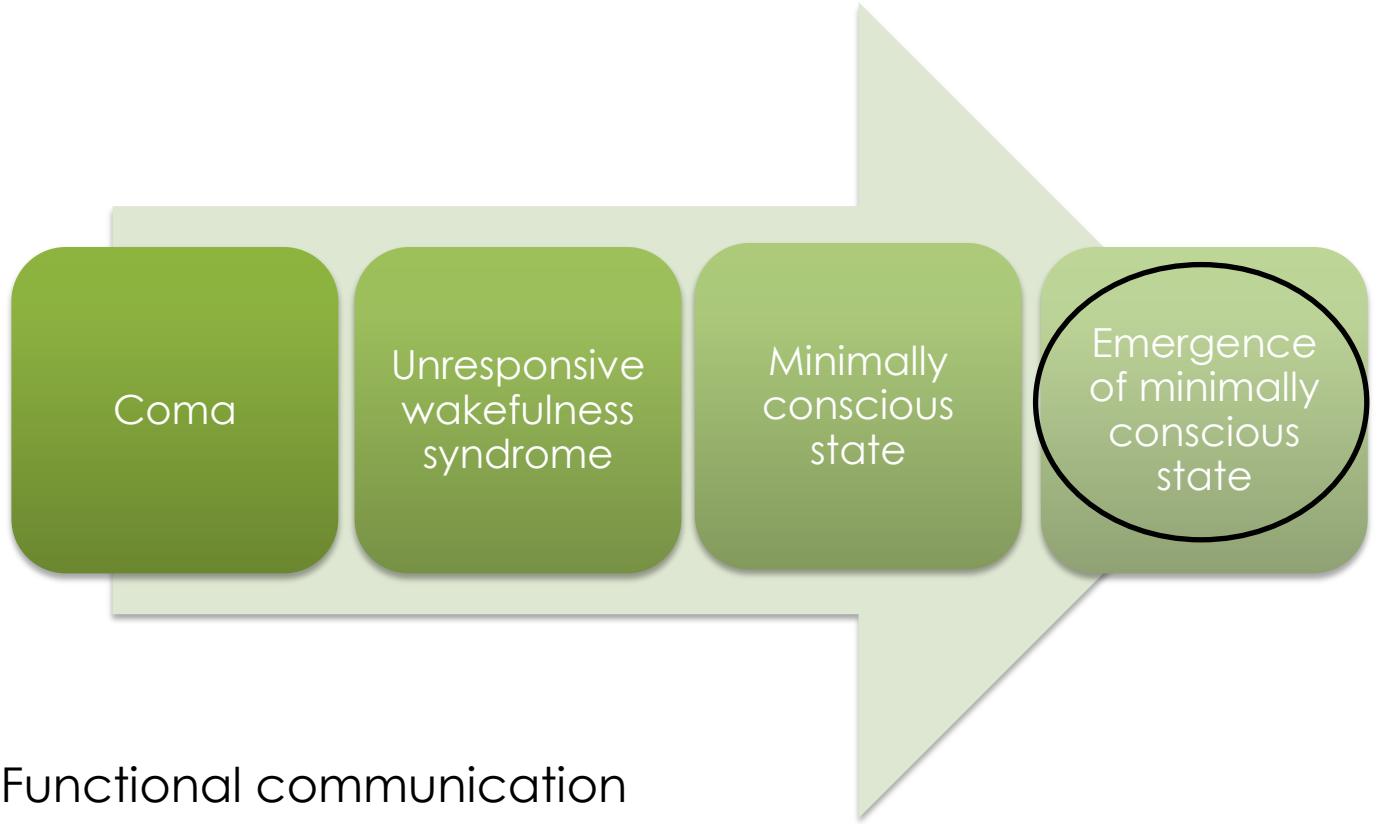


~ Vegetative state

- Partially preserved sleep-wake cycles
- Absence of purposeful behaviors
- Absence of language
- Preserved hypothalamic and brainstem autonomic functions

Laureys, S. (2006). Les degrés de la conscience. *Pour la science*, *350*, 100-105.
Multi-Society Task Force on Persistent Vegetative State guidelines, 1994; Laureys et al., *BMC Med*, 2010

Disorders of consciousness



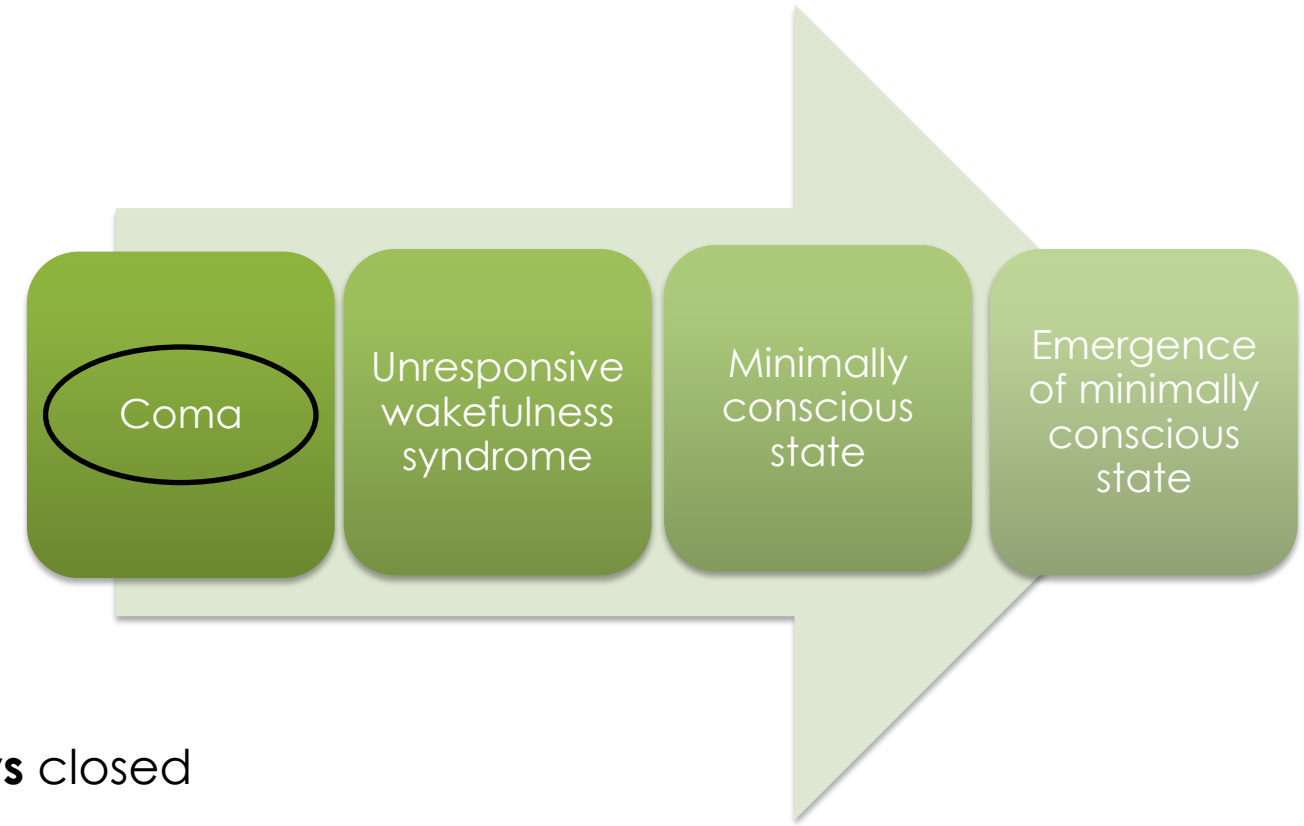
Functional communication

AND/OR

Functional object use

Giacino et al., *Neurology,* 2002
Laureys, S. (2006). Les degrés de la conscience. *Pour la science*, *350*, 100-105.

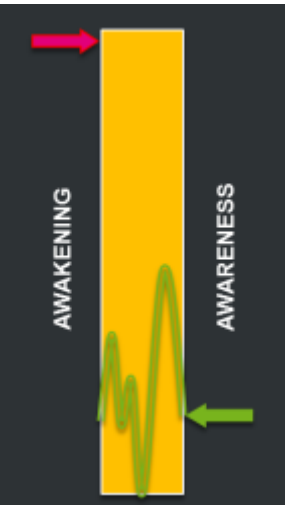
Disorders of consciousness

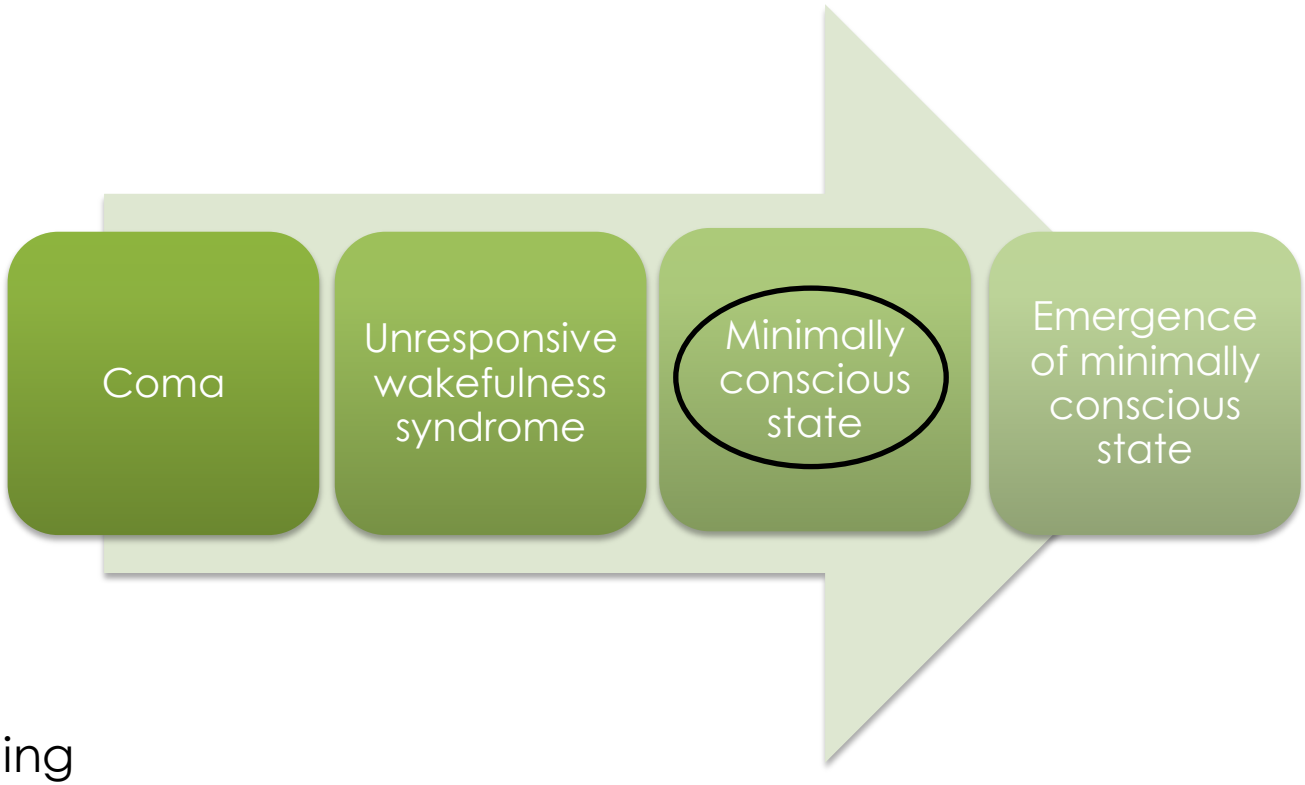


- Eyes **always** closed
- Duration: > 1h
- Recovery from coma: few hours to 4 weeks

Laureys, S. (2006). Les degrés de la conscience. *Pour la science*, *350*, 100-105.
Laureys et al., *Lancet Neurology*, 2004. Posner et al, 2007

Disorders of consciousness





- Eye opening
- Preserved sleep-wake cycles
- Clear signs of reproducible purposeful behaviors
- Emotionally contingent behaviors
- Challenge: fluctuation +++

Giacino et al, *Neurology,* 2002; Laureys et al., *Lancet Neurology*, 2004; Bruno & Vanhaudenhuyse et al., 2011
Laureys, S. (2006). Les degrés de la conscience. *Pour la science*, *350*, 100-105.

Clinical subcategorization of MCS patients

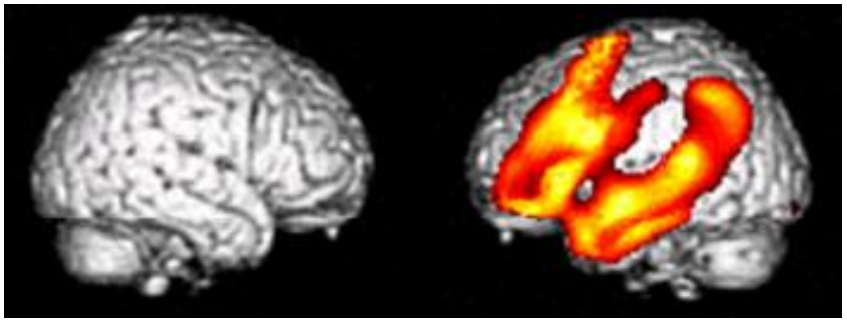
MCS -

- Oriented (contextualized) behaviors
- Visual pursuit or fixation
- Orientation to noxious stimulation
- Reaching for objects
- Contingent behaviors (emotional)

MCS +

- Following simple commands
- Intentional communication
- Intelligible verbalization

MCS- < MCS+



Bruno, Vanhaudenhuyse et al., *J Neurol,* 2011; Bruno et al., *J Neurol,* 2012

Question 3

How to diagnose patients with DOC?

1. Behavioral assessments

JFK COMA RECOVERY SCALE - REVISED ©2004
Record Form

Patient: Date:								
AUDITORY FUNCTION SCALE								
4 - Consistent Movement to Command *								
3 - Reproducible Movement to Command *								
2 - Localization to Sound								
1 - Auditory Startle								
0 - None								
VISUAL FUNCTION SCALE								
5 - Object Recognition *								
4 - Object Localization: Reaching *								
3 - Visual Pursuit *								
2 - Fixation *								
1 - Visual Startle								
0 - None								
MOTOR FUNCTION SCALE								
6 - Functional Object Use †								
5 - Automatic Motor Response *								
4 - Object Manipulation *								
3 - Localization to Noxious Stimulation *								
2 - Flexion Withdrawal								
1 - Abnormal Posturing								
0 - None/Flaccid								
OROMOTOR/VERBAL FUNCTION SCALE								
3 - Intelligible Verbalization *								
2 - Vocalization/Oral Movement								
1 - Oral Reflexive Movement								
0 - None								
COMMUNICATION SCALE								
2 - Functional: Accurate ‡								
1 - Non-Functional: Intentional *								
0 - None								
AROUSAL SCALE								
3 - Attention								
2 - Eye Opening w/o Stimulation								
1 - Eye Opening with Stimulation								
0 - Unarousable								
TOTAL SCORE								

103 post-comatose patients

- 45 clinical consensus diagnosis 'vegetative state'
- 18 showed signs of awareness

→40% potential misdiagnosis

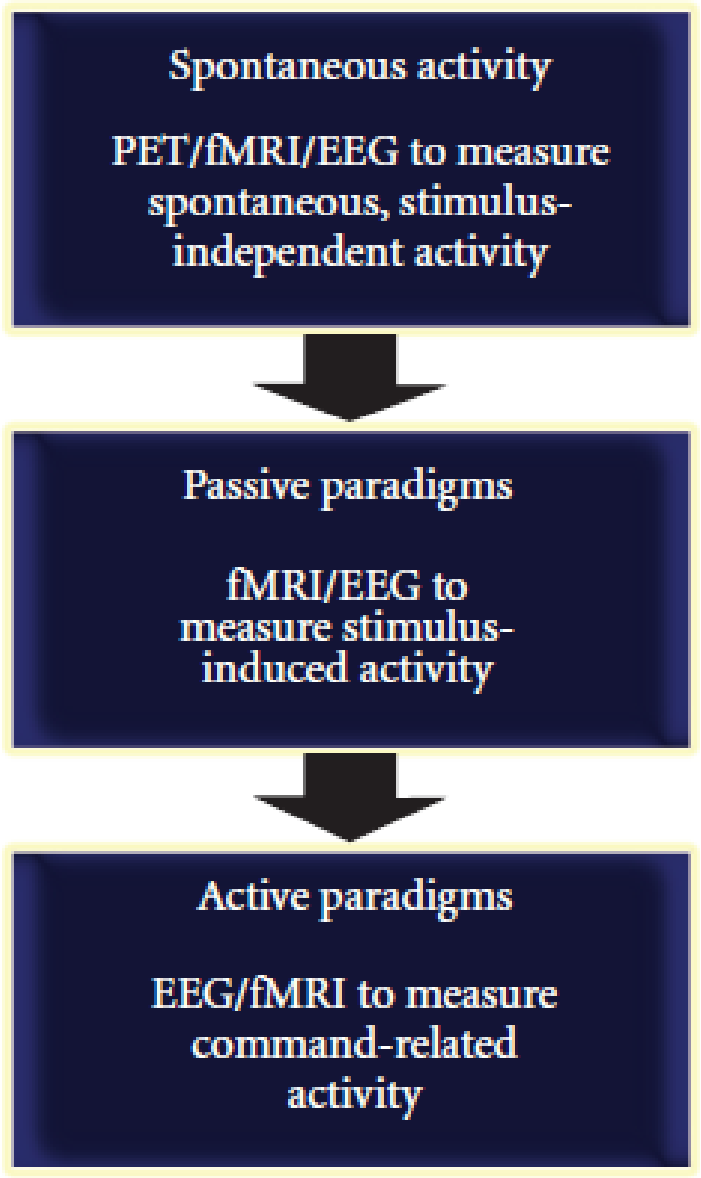
Solution: Coma Recovery Scale Revised (CRS-R)

Limitations of the CRS-R:

- Patients suffering from aphasia or lack of motivation on of the patient
- Motor abilities
- When using only 1 CRS-R assessment ~ 34% chance of false negatives
  → Perform at least 5 assessments

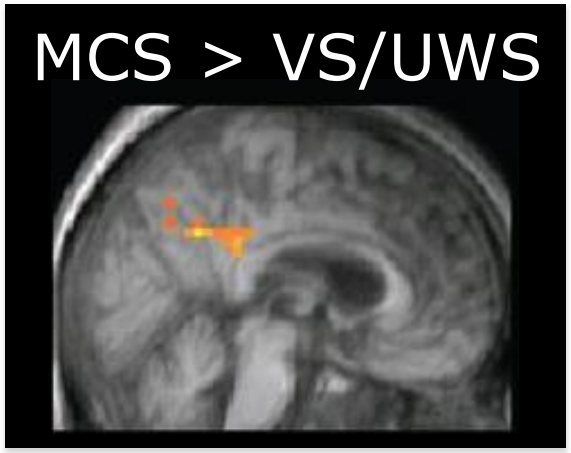
Schnakers et al, *BMC Neurology* 2009; Wannez & al., submitted

2. Neuroimaging



2. Neuroimaging - Spontaneous activity

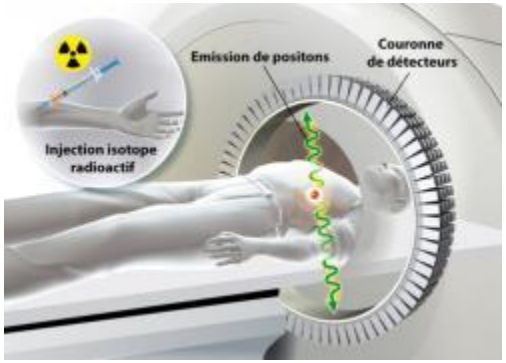
Magnetic Resonance Imagery (MRI)

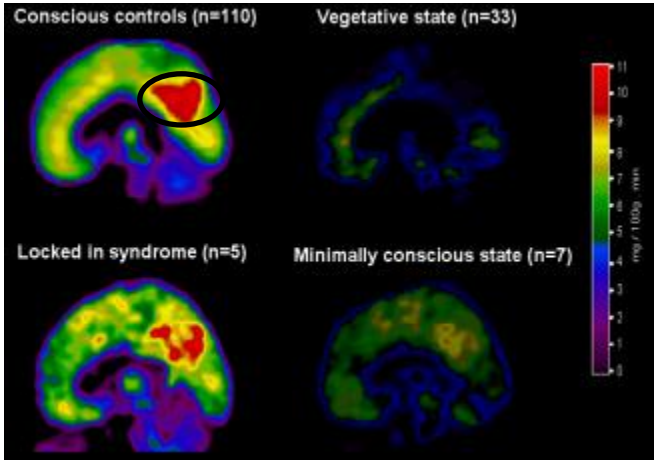


Precuneus connectivity

Vanhaudenhuyse et al, *Brain* 2010

Positon Emission Tomography (PET)

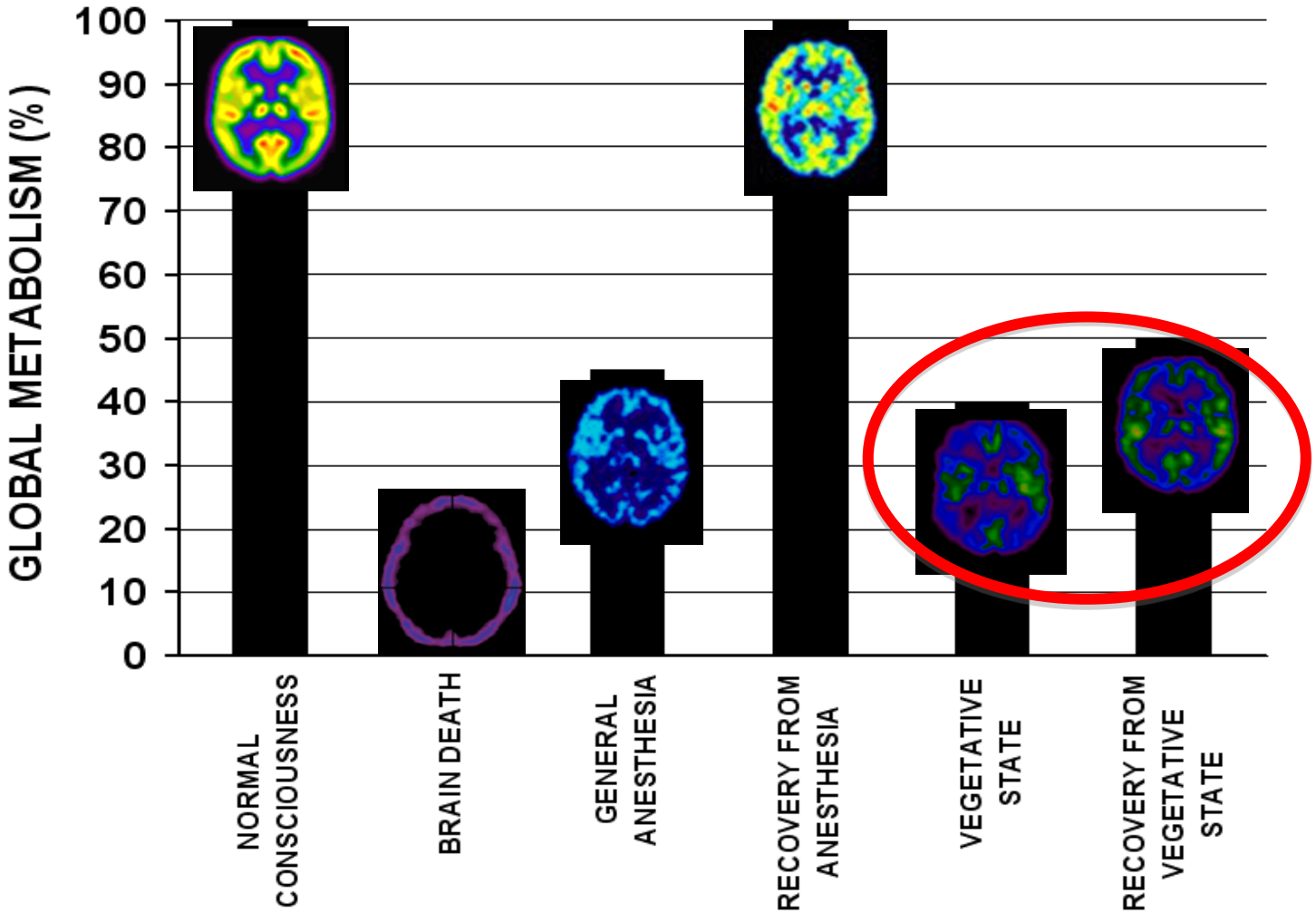




Precuneus metabolism

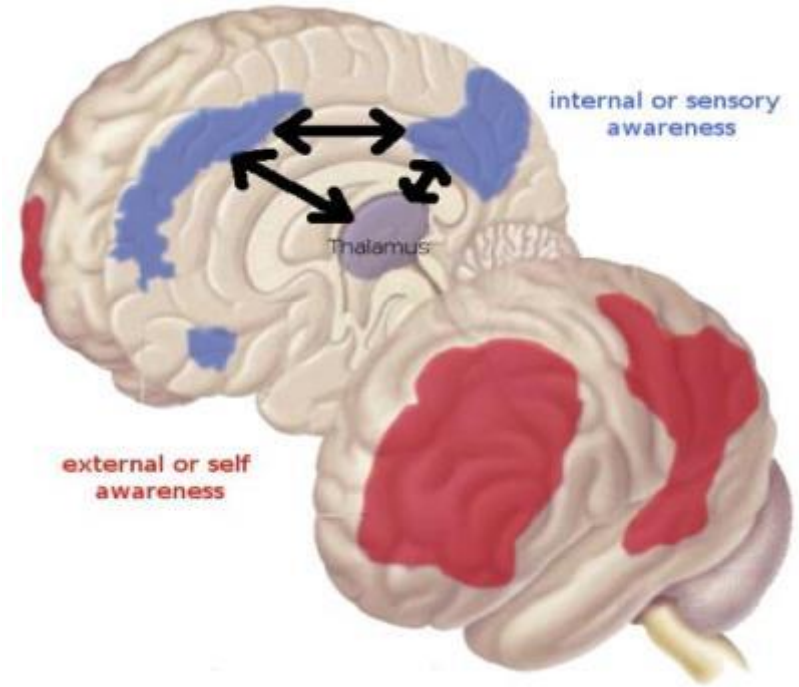
Laureys et al, *Lancet Neurology*, 2004

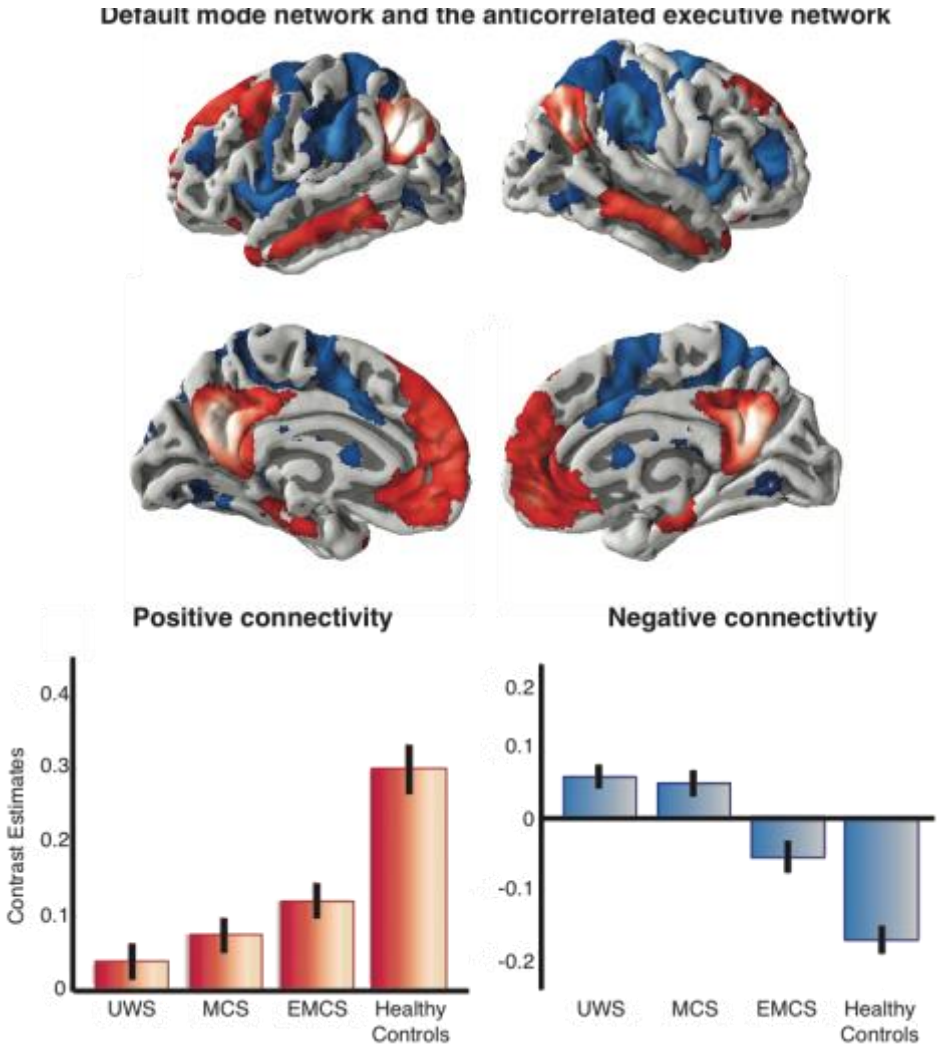
Consciousness ≠ global brain function



Laureys et al., *Lancet Neurology*, 2004

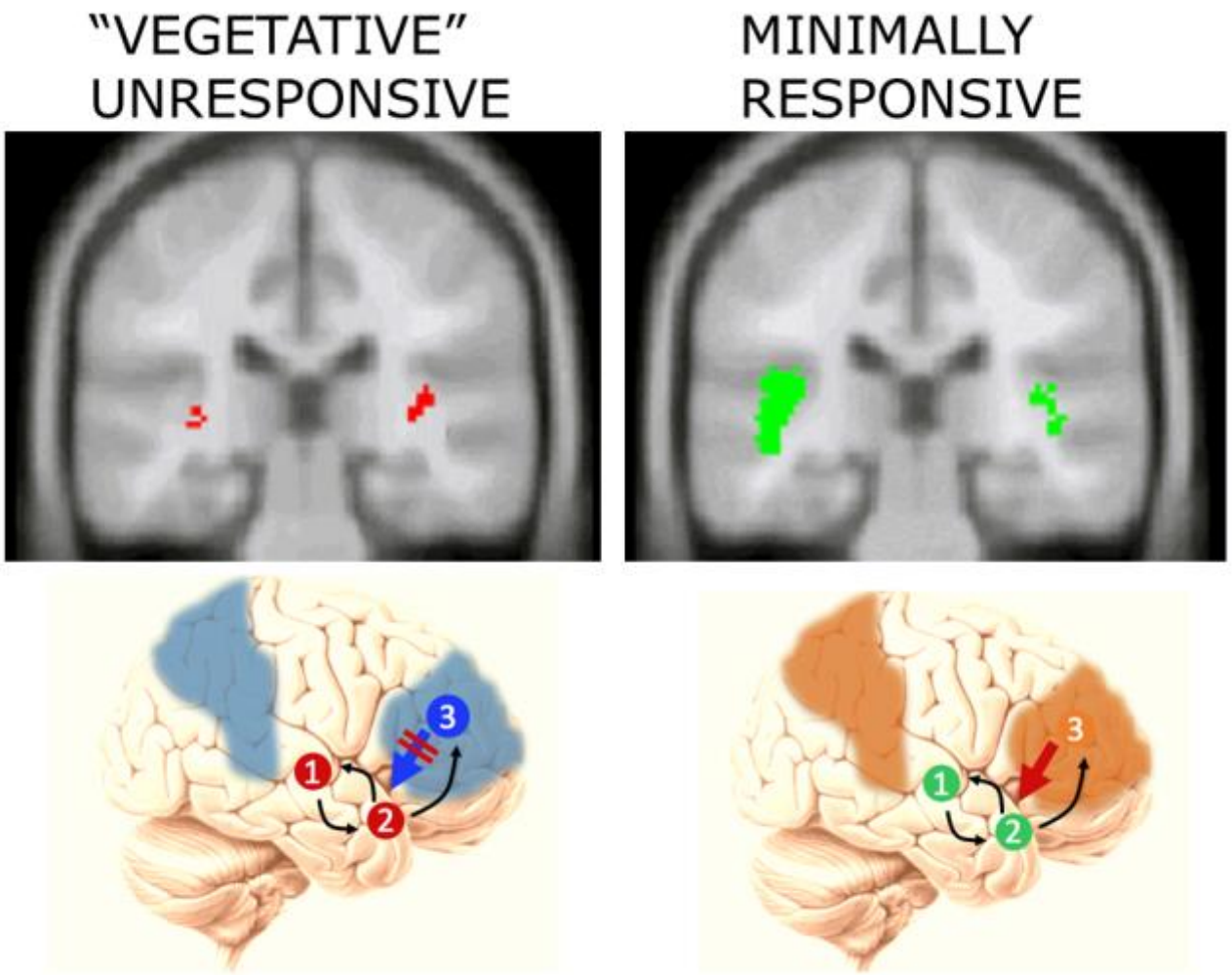
Two awareness networks



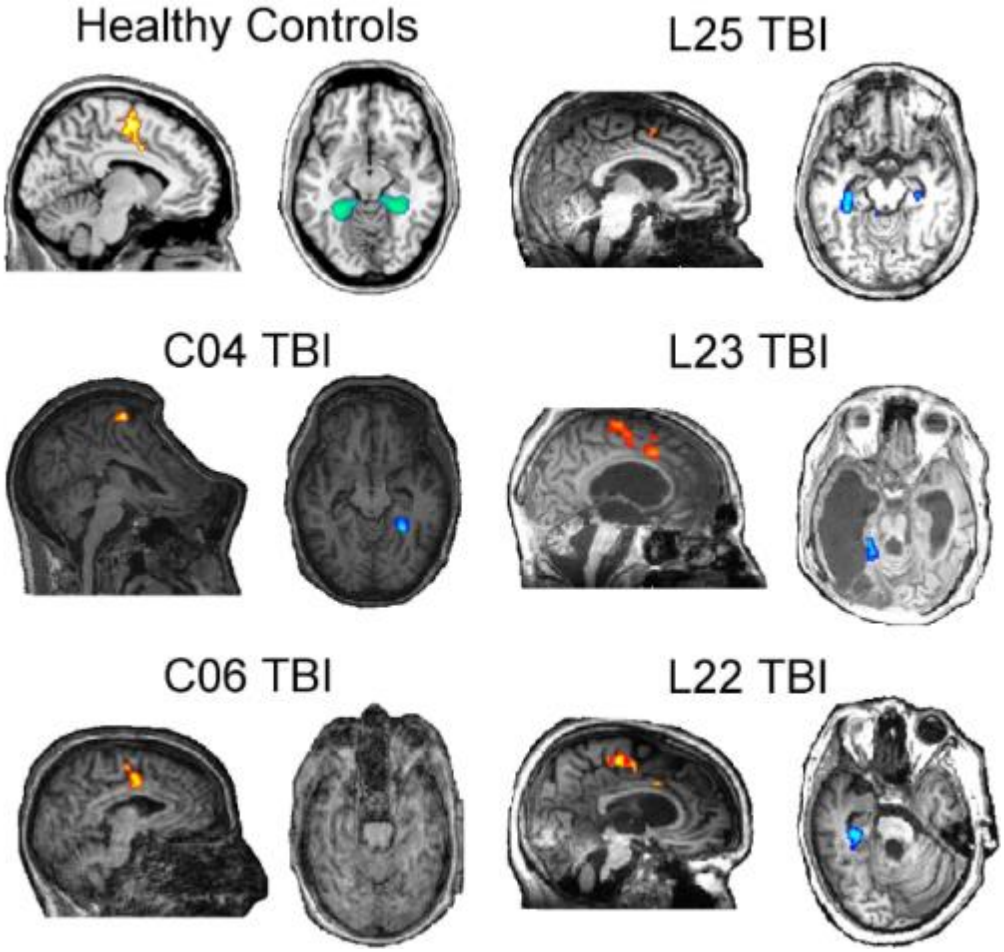


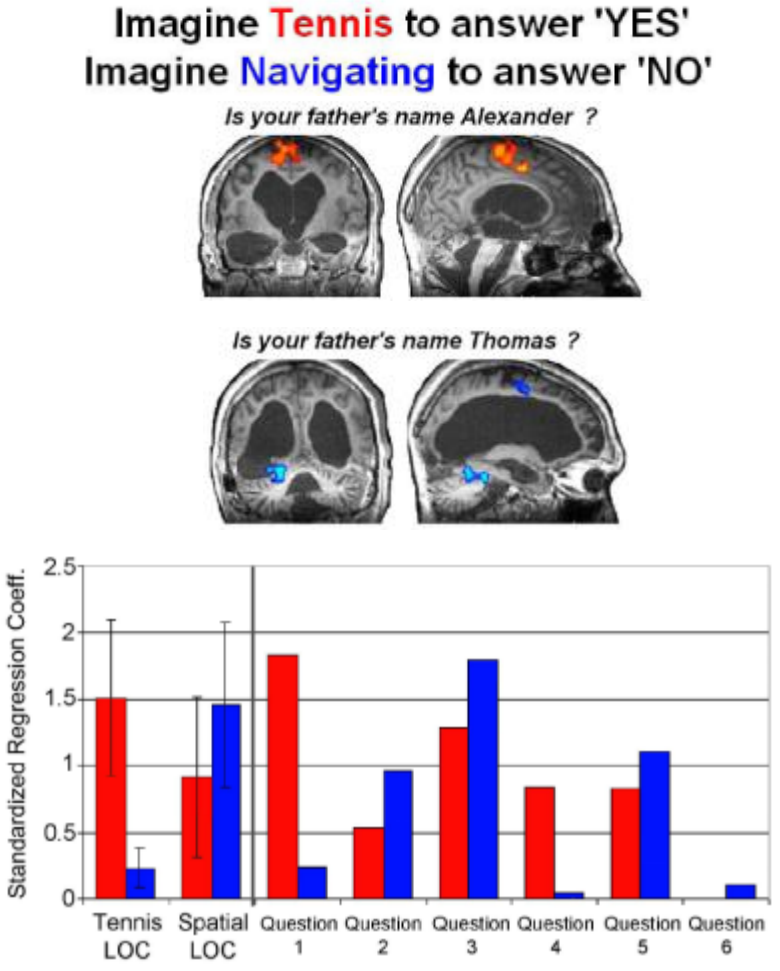
Laureys, *Scientific American* 2007; Vanhaudenhuyse, Demertzi et al, *J Cogn Neurosci* 2011; Di Perri et al., *Lancet Neurology, 2016*

2. Neuroimaging – Passive paradigm



2. Neuroimaging – Active paradigm

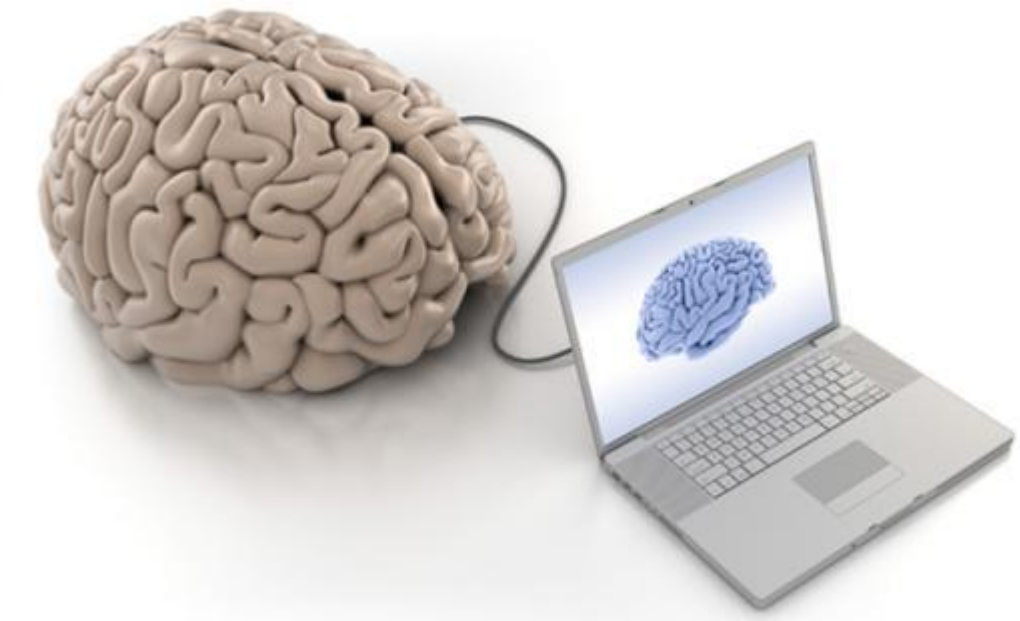




Monti & Vanhaudenhuyse, Coleman, Boly, Pickard, Tshibanda, Owen, Laureys. *New England J Med* 2010

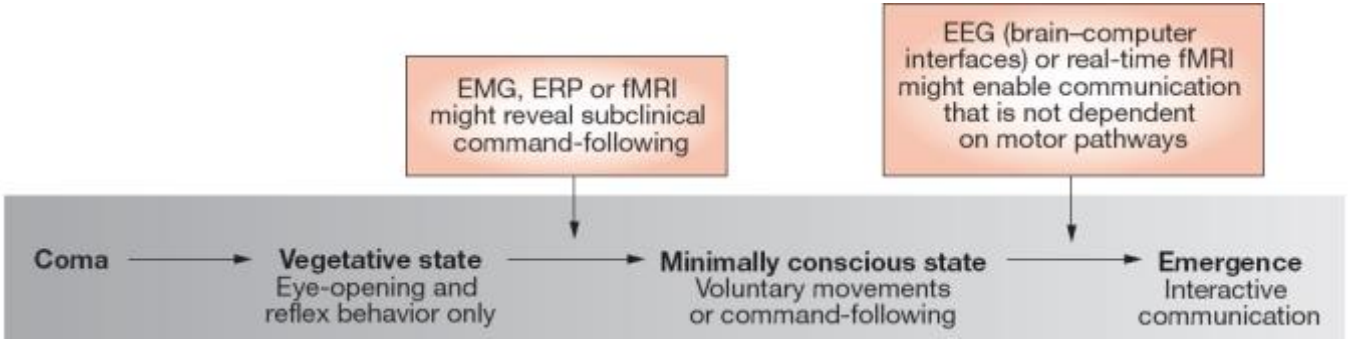
3. Brain Computer Interfaces

Allows a communication system between a computer and a person without the need of muscular intervention



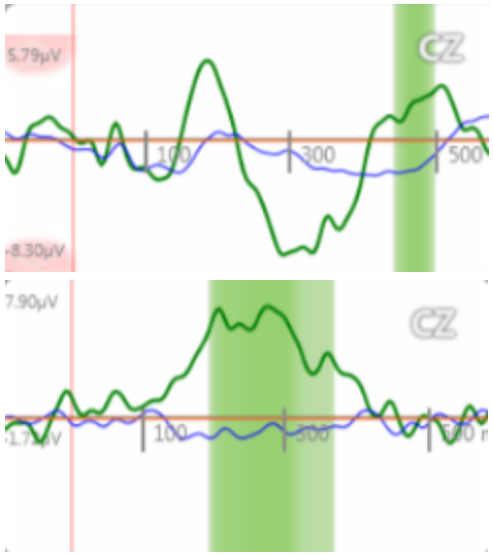
3. Brain Computer Interfaces

- *MindBeagle*

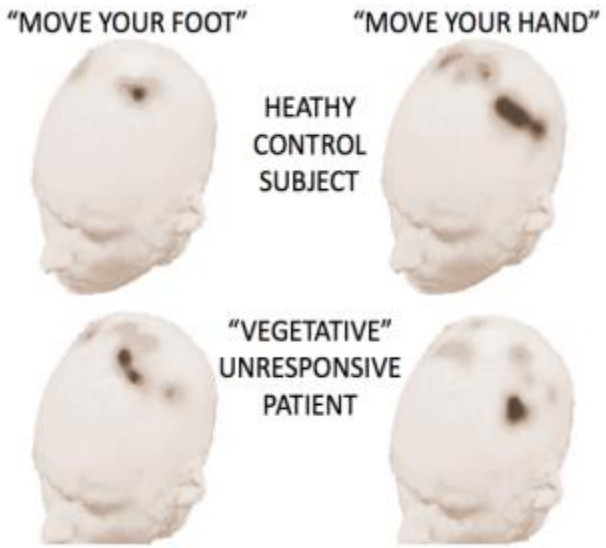


Laureys & Boly, *Nature Clinical Practice*, 2008

- Assessment of awareness
  - P300 auditory oddball paradigm
- Assessment of command following
  - P300 vibrotactile oddball paradigm
- Communication
  - Motor imagery



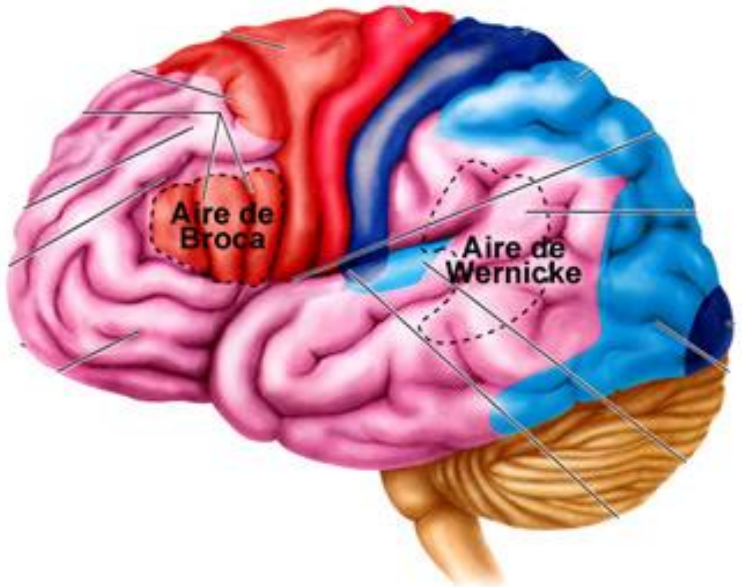
MindBeagle by Gtec, Graz, Austria



Cruse et al., *Lancet* 2012 & Cruse et al., *Neurology* 2012

Question 4

How to know that DOC patients understand language?



1. Bedside assessment

MCS LANGUAGE COMPREHENSION TEST
Administration Guidelines

Administration:

- Choose two (2) non-object related commands to be administered across the three first subtests ("a" to "c") and two (2) object-related commands to be administered across the three last subtests ("d" to "f"), in the command list set below. For the non-object related commands, choose one non-limb related command and one limb related command.
- In each subtest, each command is presented on 4 occasions (i.e., 4 trials) with an interval of time of 10 seconds between each trial.
- Each command has two levels of complexity, with Level 1 commands to be administered only in the event of Level 2 task failure (i.e., less than 3 of 4 trials succeeded) within individual subtests.
- For all subtests, stand direct in front of patient in a quiet environment. Provided arousal facilitation via deep pressure stimulation if applicable at any point during test administration.

Command List Set:

Non-Object Related Commands: Pick two (2)		
	Level 2	**Level 1**
Non-limb Movement	Show me how you close your eyes.	Close your eyes.
	Show me how you open / close your mouth.	Open / close your mouth.
Limb Movement	Show me how you move your arm / leg.	Move your arm / leg.
	Show me how you wiggle your fingers / toes.	Move your fingers / toes.

Object Related Commands: Pick two (2)	
Level 2	**Level 1**
Show me how you comb your hair.	Comb your hair
Show me how to drink from a cup.	Drink from a cup
Show me how write with a pen.	Write with a pen
Show me how to eat with a fork.	Eat with a fork
Show me how to brush your teeth.	Brush your teeth

Scoring Instructions:

Score responses noted across subtests, as follows:

- 3 Points: Accurate to Level 2 commands (Motor movement accurately matches command on at least 3 out of 4 trials)
- 2 Points: Accurate to Level 1 commands (Motor movement accurately matches command on at least 3 out of 4 trials)
- 1 Point: Inaccurate to both Level 2 & 1 (Motor movement does not match command)
- 0 Points: No response to both Level 2 & 1

- 24 post-stroke aphasic but conscious patients
  - Complex vs simple commands
  - Oral vs written commands
  - Gestural cueing vs no gesture

Bedside assessment

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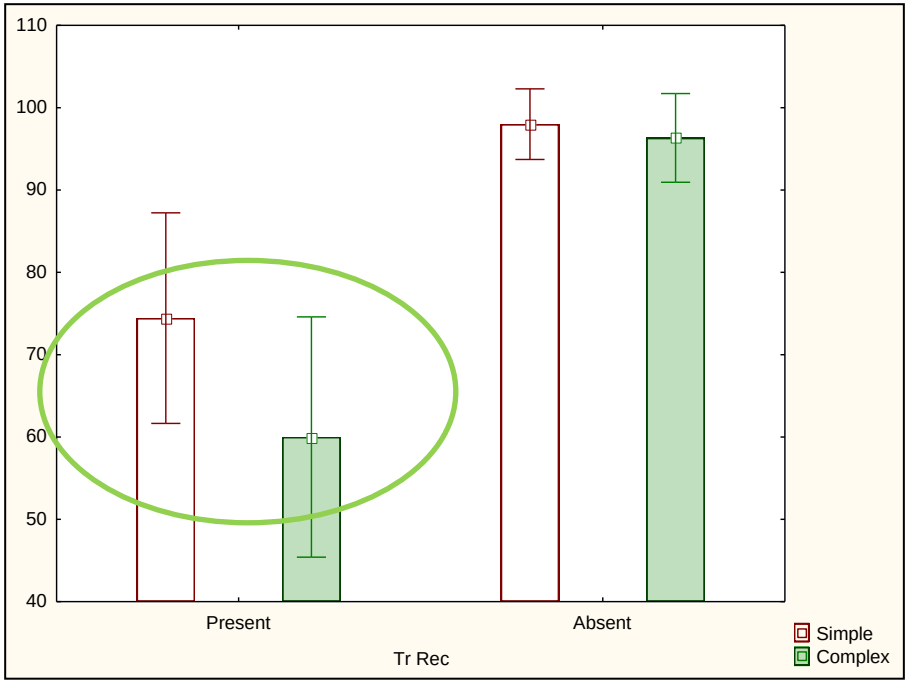

Aubinet, C. & al (in preparation)

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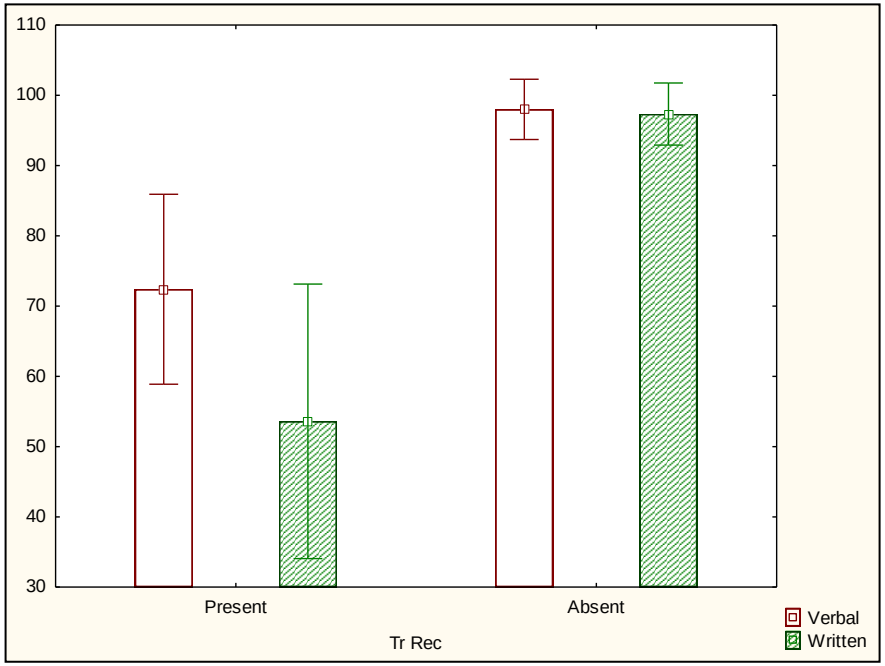

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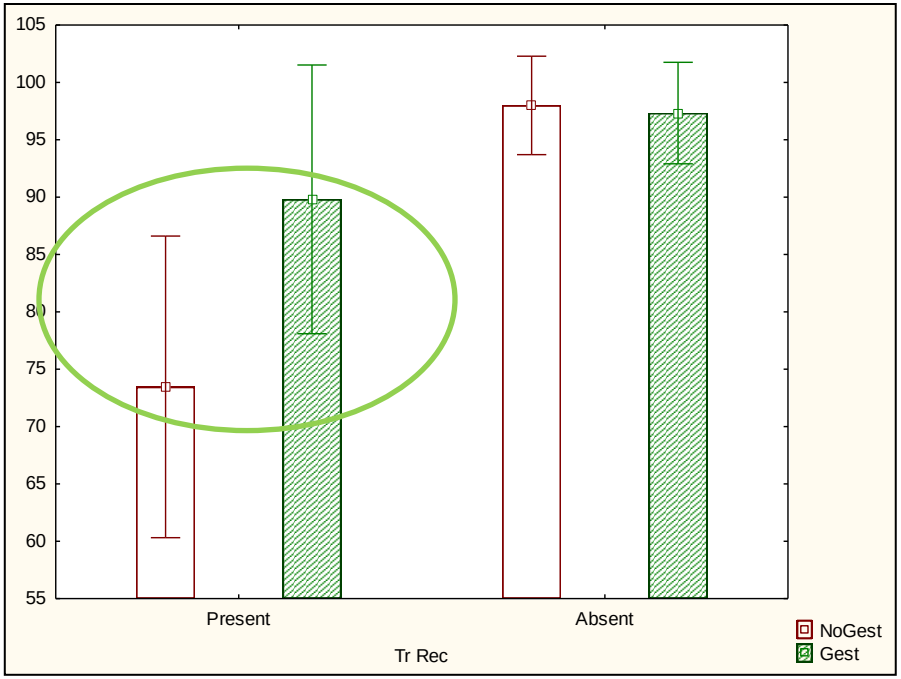


Aubinet, C. & al (in preparation)

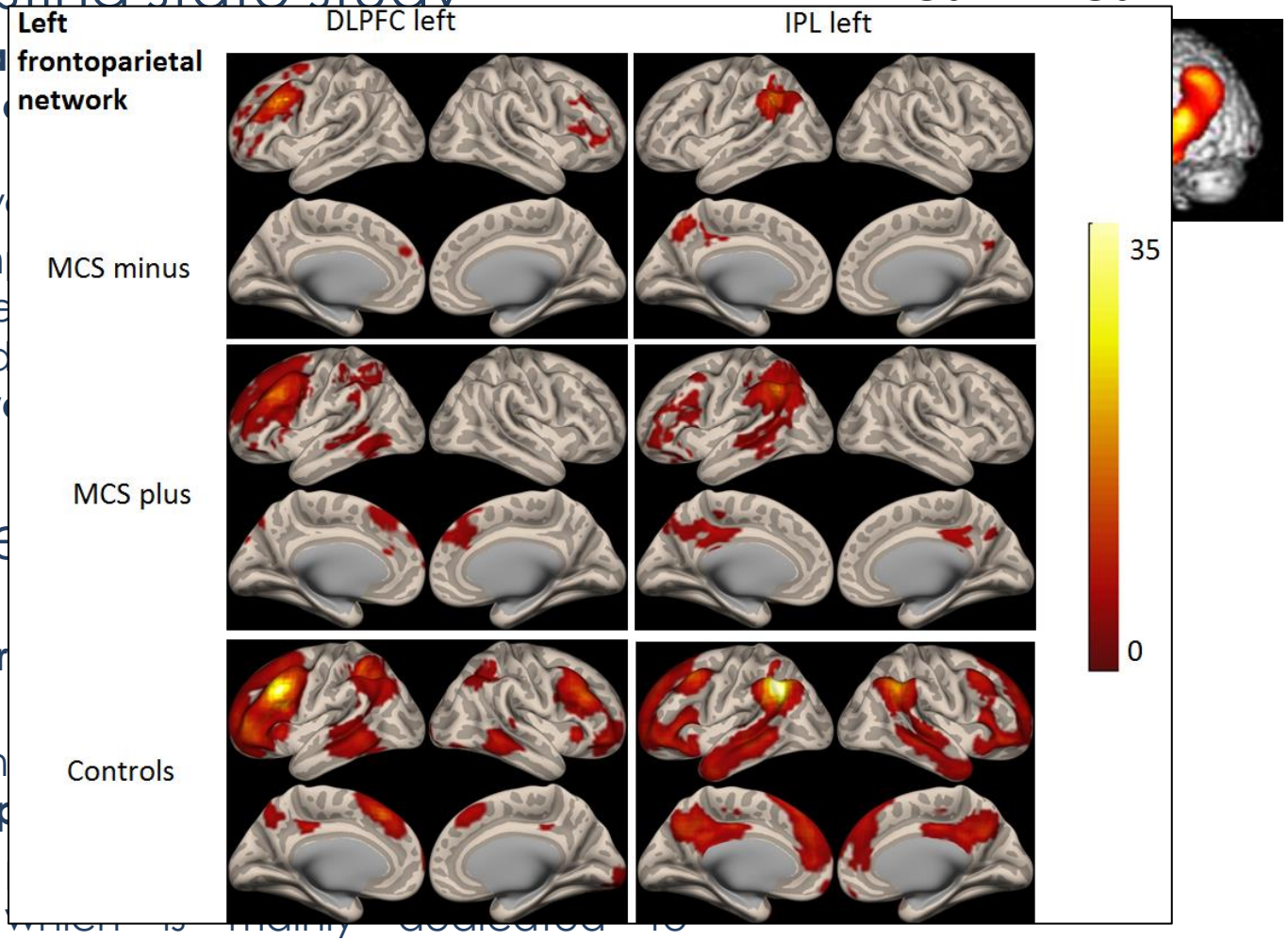
2. Neuroimaging

- PET resting state study

  – **Meta**
  subc
  and
  netw

  – Com
  prese
  sided
  netw

MCS- < MCS+



- fMRI re

  – **Left**
  contr

  – This
  conn
  occip

  → It is
  area" which is mainly dedicated to
  comprehension abilities

Bruno & al. (2012); Aubinet, C. & al. (in preparation)

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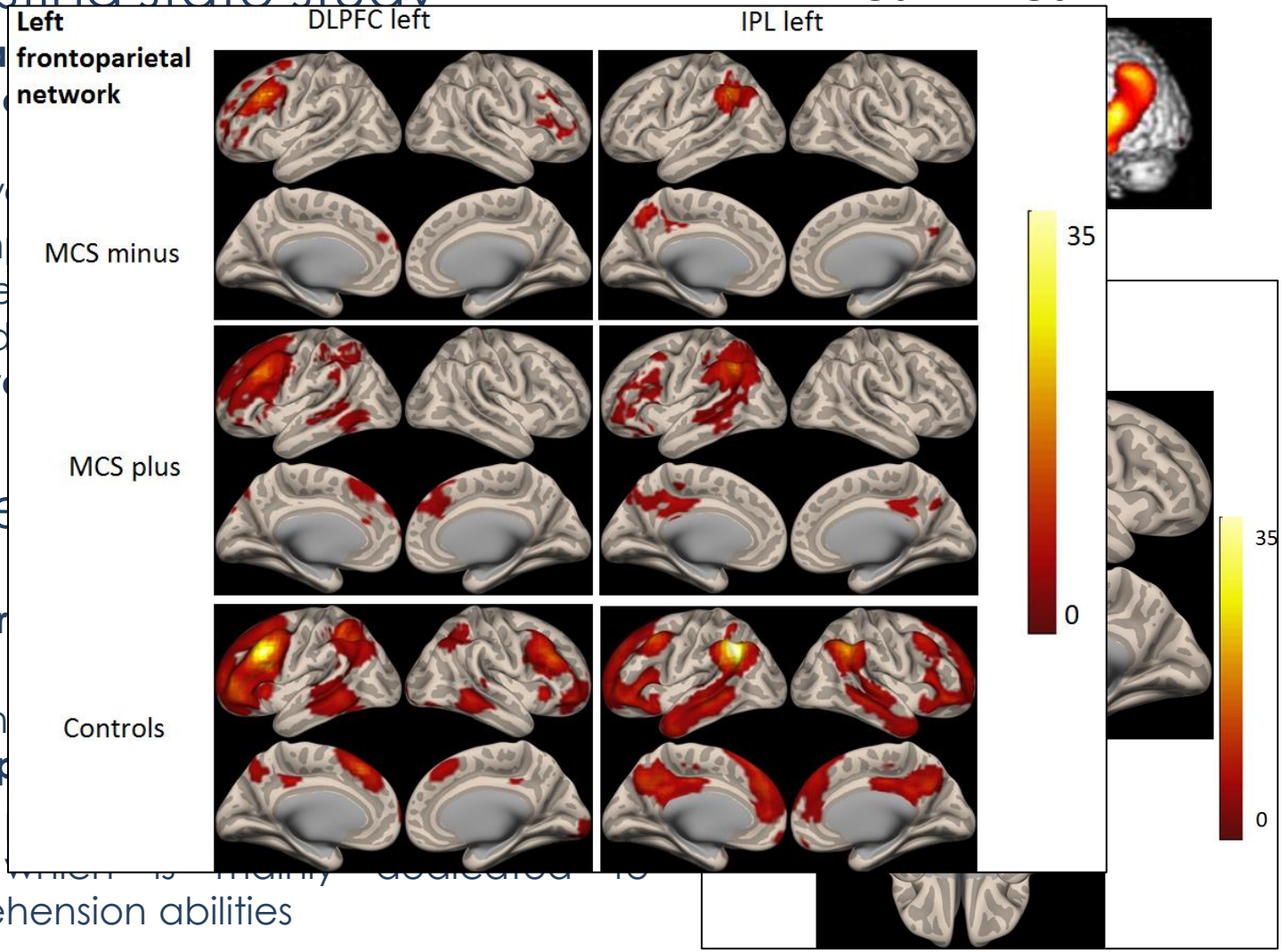

Aubinet, C. & al (in preparation)

PART 2:
Near-Death Experience (NDE)

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University of Liège, Belgium

13th June 2016

Université de Liège

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What is a Near-Death Experience (NDE)?

- **NDE** = memories reported by some individuals who had recovered consciousness after coma

- No consensus on NDE definition !

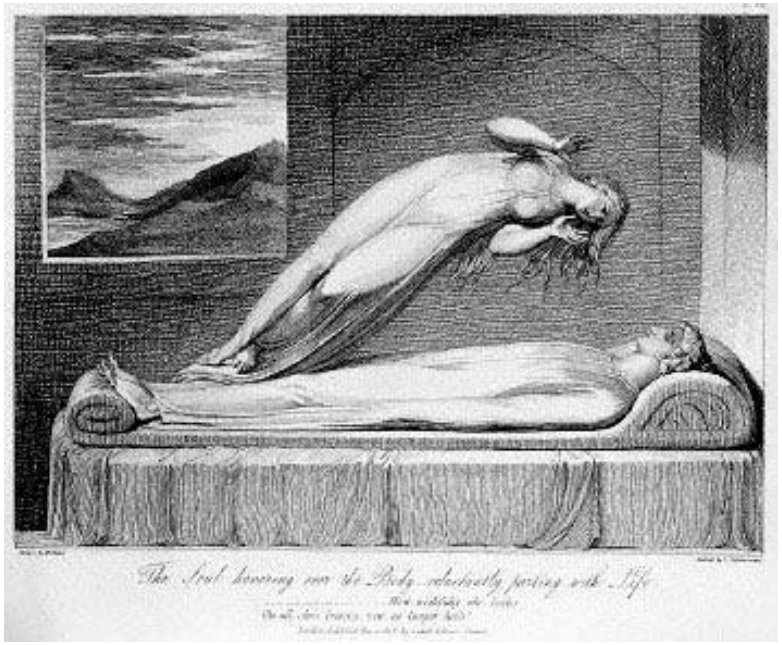
- BUT propositions :

NDEs = "*profound psychological events with transcendental and mystical elements typically occurring to individuals close to death or in situations of intense physical or emotional danger*"

- Decreased of brain activity, but not stopped !

Greyson, 2000; Charland-Verville et al., 2014

What is a Near-Death Experience (NDE)?



‘Out-of-Body Experience’ (OBE)
⟶ temporo-parietal junction

Seeing a bright light
⟶ occipital lobe
Seeing a tunnel

Encounter with spirits

Harmony

What is a Near-Death Experience (NDE)?

Greyson NDE scale: Scores ≥7 = NDE experiencer

Cognitive

(1) Did time seem to speed up or slow down?
- 0 = No
- 1 = Time seemed to go faster or slower than usual
- 2 = Everything seemed to be happening at once; or time stopped or lost all meaning

(2) Were your thoughts speeded up?
- 0 = No
- 1 = Faster than usual
- 2 = Incredibly fast

(3) Did scenes from your past come back to you?
- 0 = No
- 1 = I remembered many past events
- 2 = My past flashed before me, out of my control

(4) Did you suddenly seem to understand everything?
- 0 = No
- 1 = Everything about myself or others
- 2 = Everything about the universe

Affective

(5) Did you have a feeling of peace or pleasantness?
- 0 = No
- 1 = Relief or calmness
- 2 = Incredible peace or pleasantness

(6) Did you have a feeling of joy?
- 0 = No
- 1 = Happiness
- 2 = Incredible joy

(7) Did you feel a sense of harmony or unity with the universe?
- 0 = No
- 1 = I felt no longer in conflict with nature
- 2 = I felt united or one with the world

(8) Did you see, or feel surrounded by, a brilliant light?
- 0 = No
- 1 = An unusually bright light
- 2 = A light clearly of mystical or other-worldly origin

Greyson, 1983

What is a Near-Death Experience (NDE)?

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Paranormal

(9) Were your senses more vivid than usual?
- 0 = No
- 1 = More vivid than usual
- 2 = Incredibly more vivid

(10) Did you seem to be aware of things going on elsewhere, as if by ESP?
- 0 = No
- 1 = Yes, but the facts have not been checked out
- 2 = Yes, and the facts have been checked out

(11) Did scenes from the future come to you?
- 0 = No
- 1 = Scenes from my personal future
- 2 = Scenes from the world's future

(12) Did you feel separated from your body?
- 0 = No
- 1 = I lost awareness of my body
- 2 = I clearly left my body and existed ou

Transcendental

(13) Did you seem to enter some other, unearthly world?
- 0 = No
- 1 = Some unfamiliar and strange place
- 2 = A clearly mystical or unearthly realm

(14) Did you seem to encounter a mystical being or presence, or hear an unidentifiable voice?
- 0 = No
- 1 = I heard a voice I could not identify
- 2 = I encountered a definite being, or a voice clearly of mystical or unearthly origin

(15) Did you see deceased or religious spirits?
- 0 = No
- 1 = I sensed their presence
- 2 = I actually saw them

(16) Did you come to a border or point of no return?
- 0 = No
- 1 = I came to a definite conscious decision to return to life
- 2 = I came to a barrier that I was not permitted to cross; or was sent back against my will

Greyson, 1983

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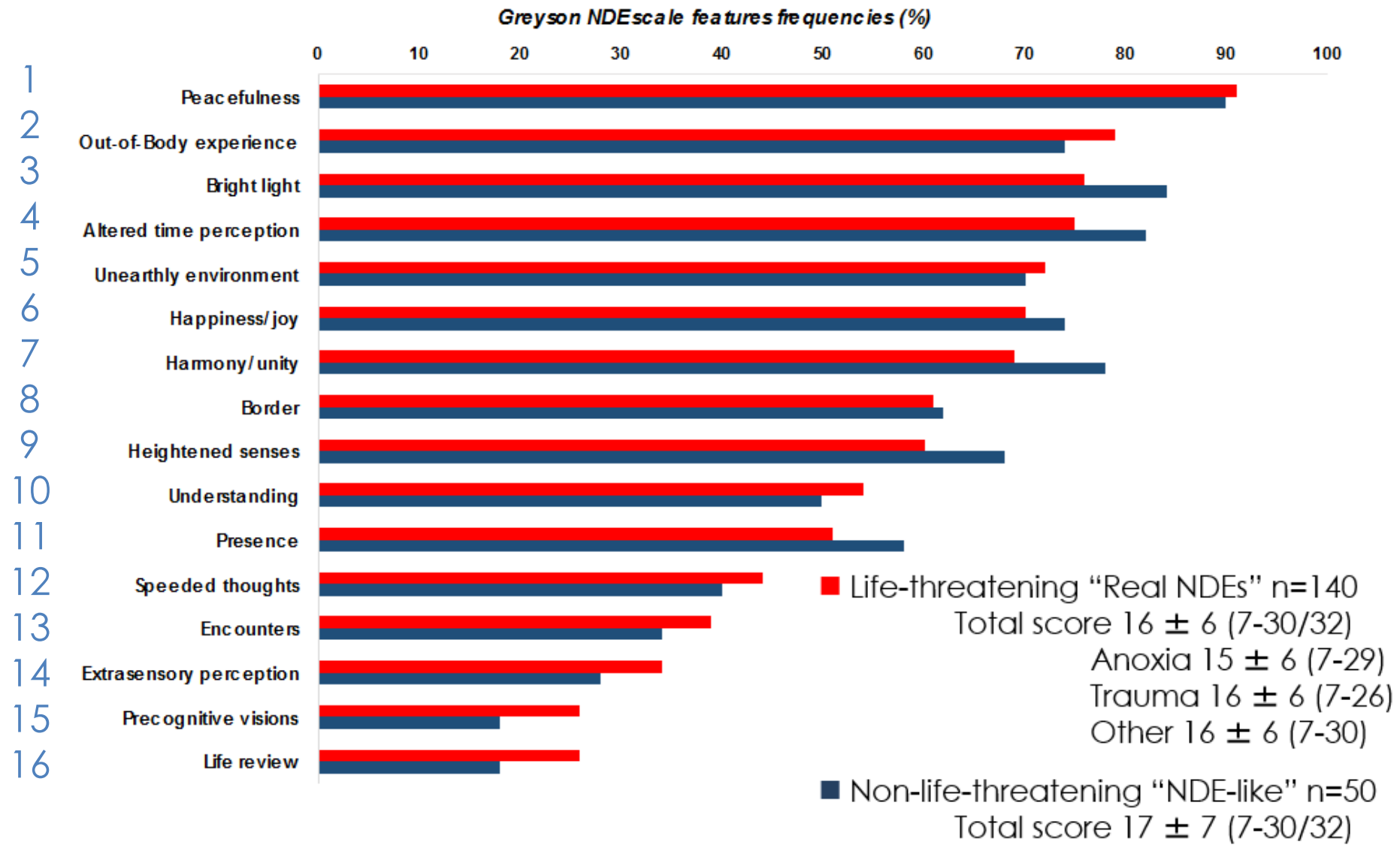
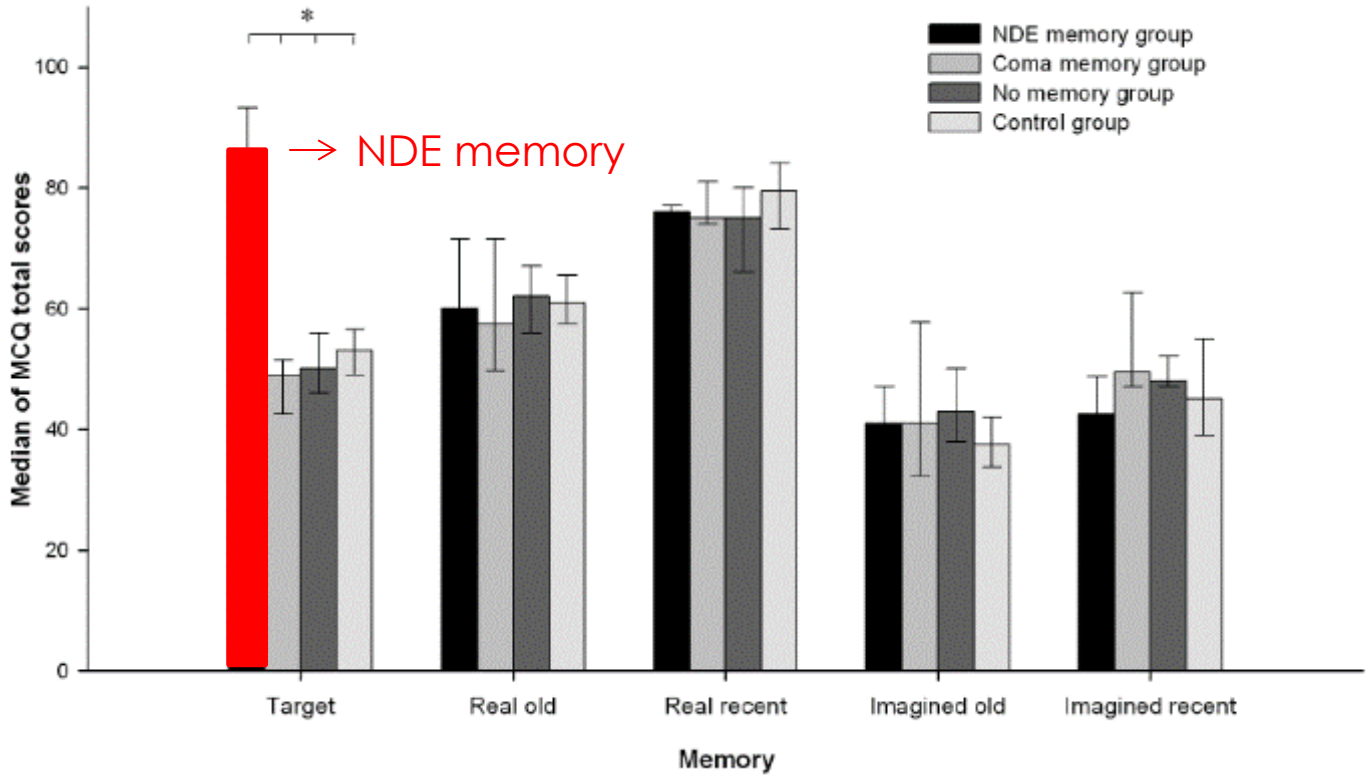


Charland et al., 2014

Characteristics of NDEs memories

Memory Characteristics Questionnaire (MCQ; Johnson et al.,1988) total scores for each assessed memory



Thonnard & Charland et al., 2013

Characteristics of NDEs memories

Correlation between MCQ and Greyson total scores.

	Greyson total score	MCQ total score
Demography		
Age at interview	-.11 (.167)	.007 (.925)
Age at NDE	-.14 (.079)	.009 (.911)
Time since NDE	.06 (.448)	-.001 (.984)
Greyson total score	-	**.26 (.0014)**
MCQ total score	**.26 (.0014)**	-

Data are Pearson's correlations (*p*).

NDE experiencers who described more intense NDEs
→ also reported more phenomenological characteristics of NDE

Martial et al., submitted

Cognitive characteristics of NDE experiencers

From the experiencer's point of view:

- **NDE memories**

→ a sense of "*phenomenological certainty*"

(Dell'Olio, 2010)

→ seem unrivalled memories due to its associated rich phenomenology

(Thonnard & Charland-Verville et al., 2013)

… while we do not have any certainty that this experience was lived in reality!

- Investigation of false memory susceptibility

Martial et al., *submitted*

Cognitive characteristics of NDE experiencers

- Using the DRM paradigm

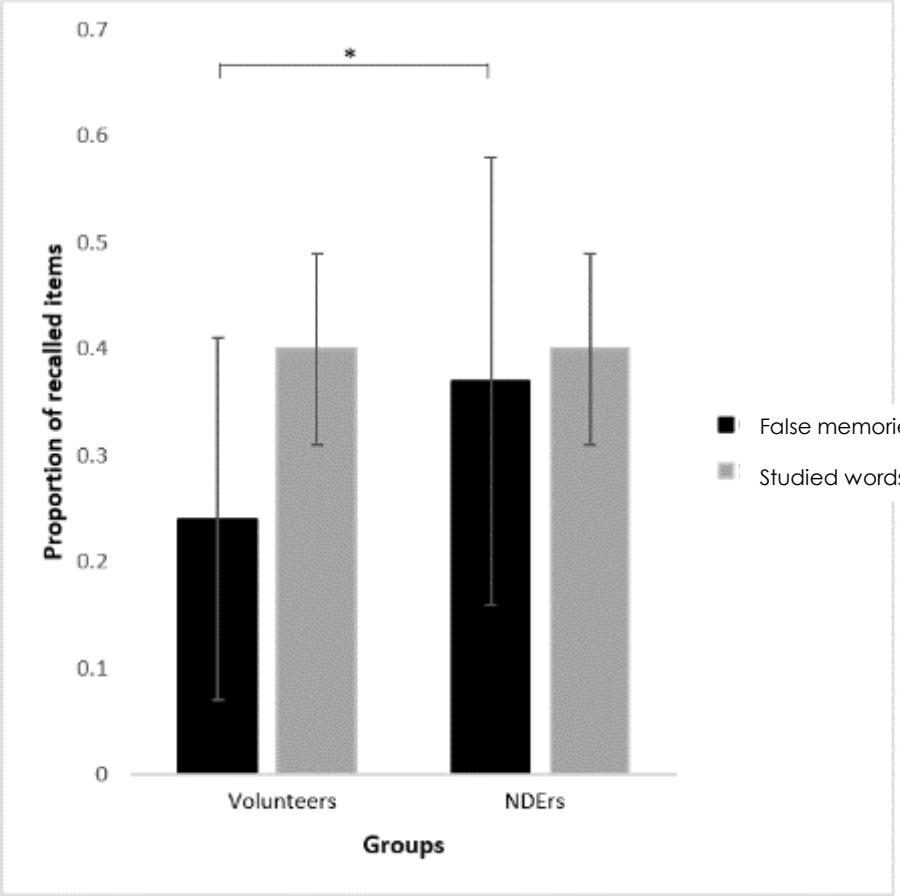
(Deese, 1959; Roediger & McDermott, 1995)

- NDE experiencers group VS control subjects group

Martial et al., *submitted*

Cognitive characteristics of NDE experiencers

Mean proportions of false memories & studied words recalled with certainty at free recall test in NDErs and matched volunteers.



Martial et al., *submitted*

Reproducing NDEs

- Reproducing NDEs in controlled laboratory setting, by inducing hypoxic loss of consciousness produces NDE like memories

- Identified NDE experiencers: 9/26 (35%)

Charland-Verville et al., submitted

Any questions?

THANKS FOR YOUR ATTENTION

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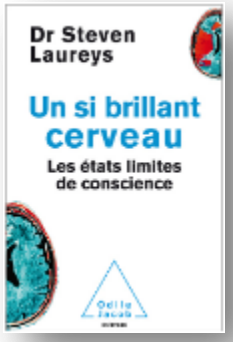
COMA SCIENCE GROUP



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Human Brain Project

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MIND SCIENCE FOUNDATION

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