# Psychedelics, brain complexity, and consciousness

GIGA-Consciousness Day

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***Promoters:***

***Pr. Olivia Gosseries***
***Dr. Charlotte Martial***

# Psychedelics: what are they?

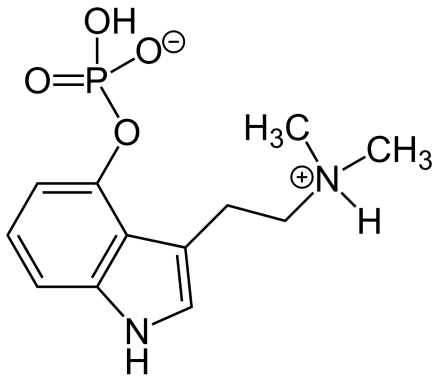
Credits: Lunae Parracho, Reuters

- "Mind-manifesting" drugs
- Millennial use for religious and shamanic purposes
- Good safety profile
- Neuroplastic effects

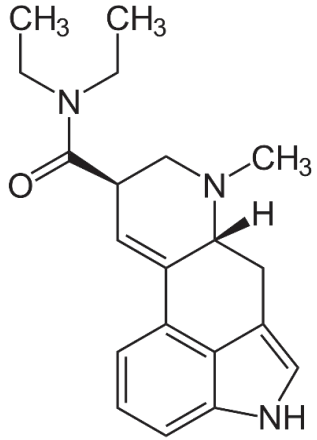
Nutt et al., *Lancet* 2010
Ly et al., *Cell Rep.*, 2018

# Two classes of psychedelics

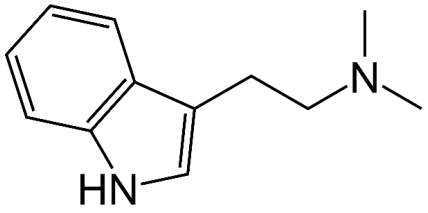
Typical psychedelics → **5HT2A agonists**



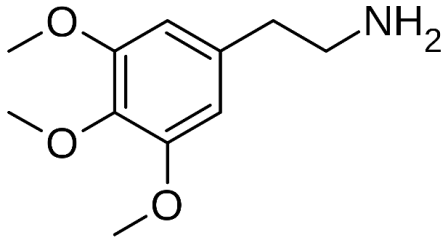

Psilocybin




LSD

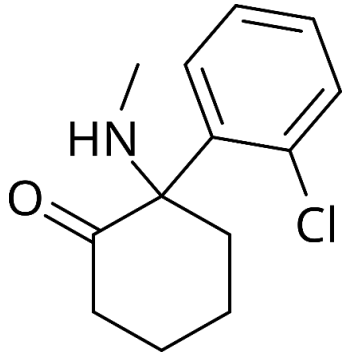



DMT

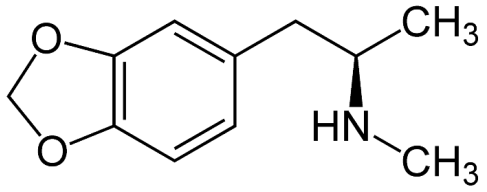



Mescaline

Atypical psychedelics

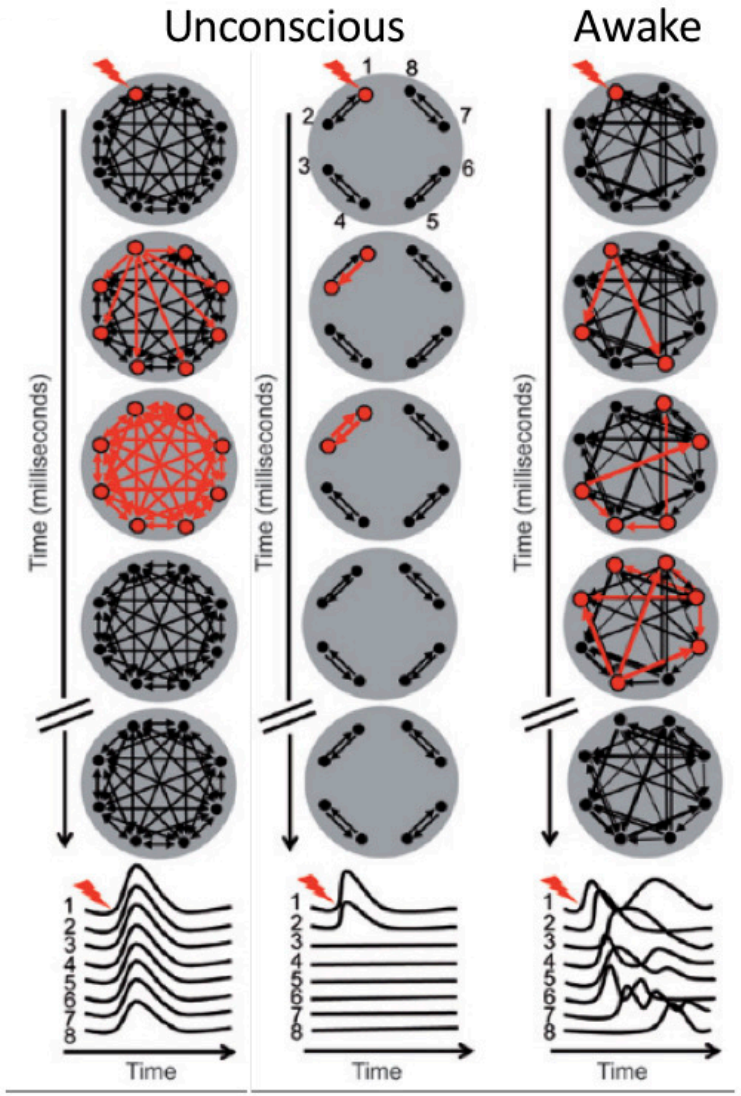



Ketamine




MDMA

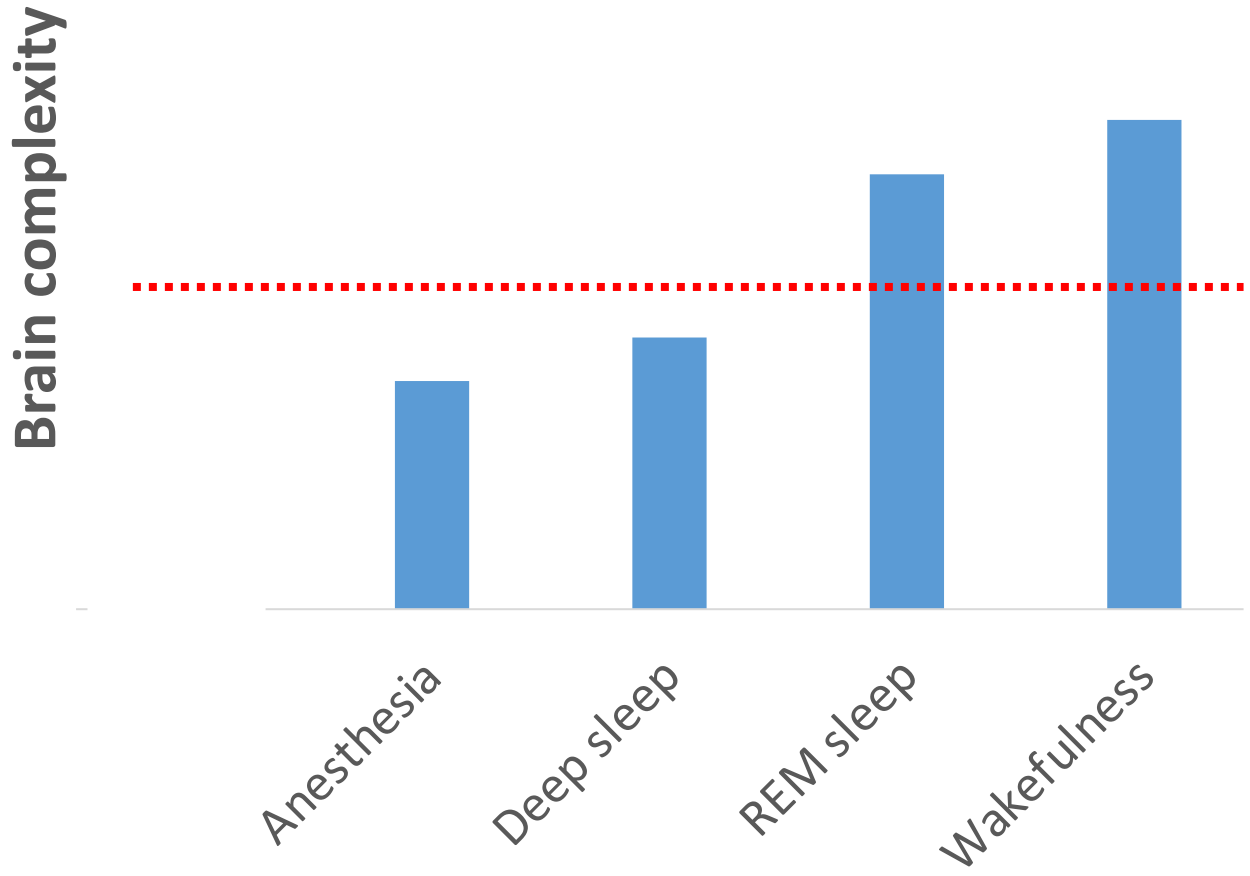
# The case of complexity




Modified by Sarasso et al, *Clin EEG Neurosci.*, 2014

- Degree of integration and information
  - Graph theory representation
- Wakefulness is complex over **time** and **space**
- Various measures (e.g. LZC, PCI)

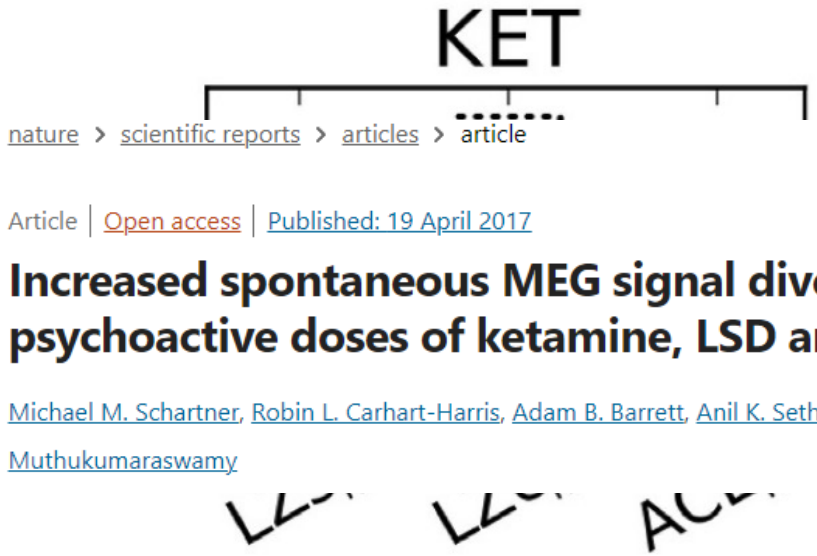
# Complexity and global conscious states




- High complexity in conscious states; low in unconscious ones

Sarasso et al., *Clin EEG Neurosci.* 2014

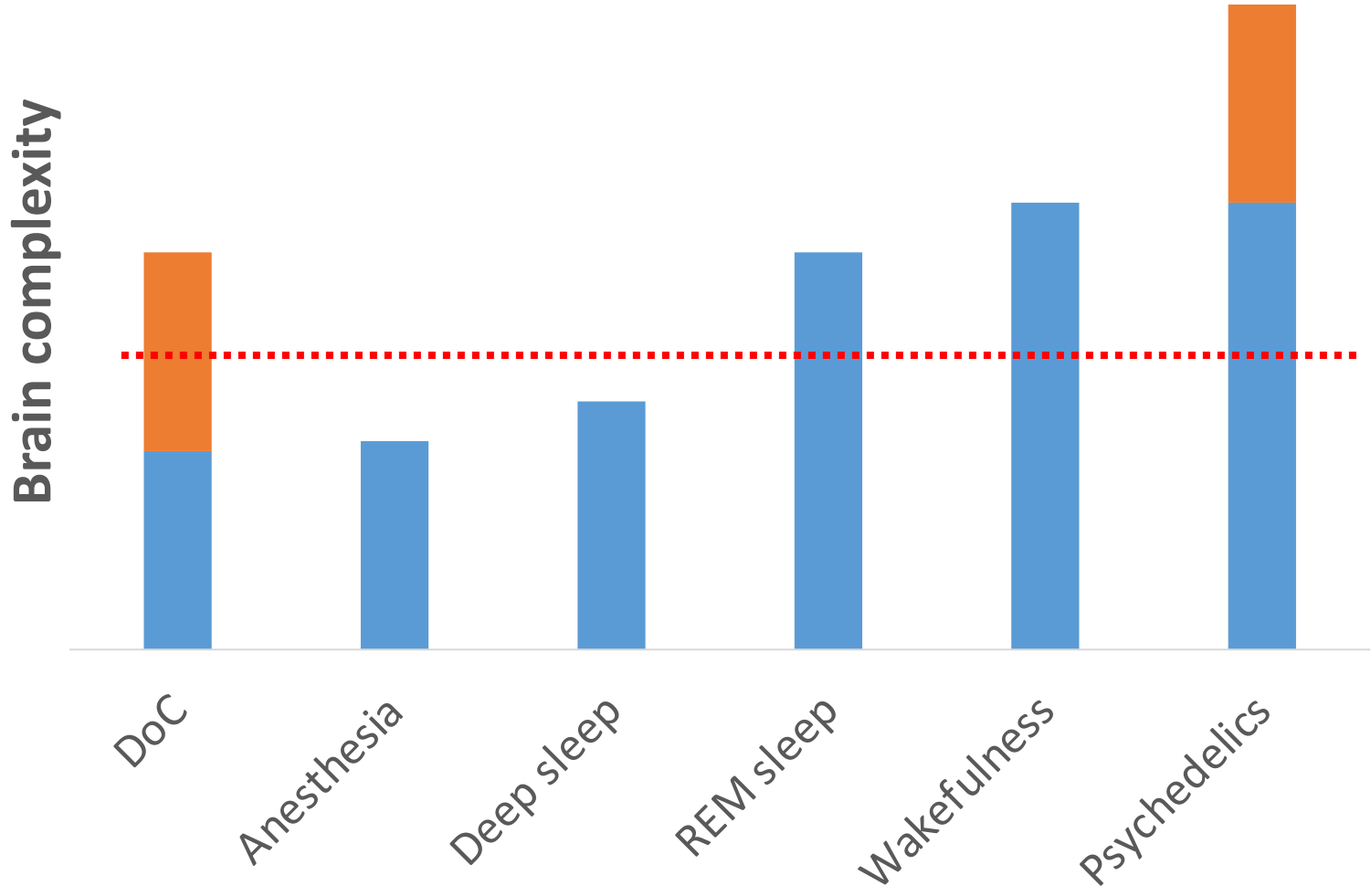
# Could we increase complexity?




- In healthy participants psychedelics increase complexity
  - Different techniques: fMRI, EEG, MEG
  - Several studies, with some differencies

Schartner et al. ,*Sci. Rep.,* 2017
Luppi et al.. *Comm. Biol.,* 2023
Farnes et al.. *PLoS ONE*, 2020
Ort et al.. *iScience*, 2023

# The case of DoC




- High complexity in conscious states; low in unconscious ones
- Psychedelics increase brain complexity

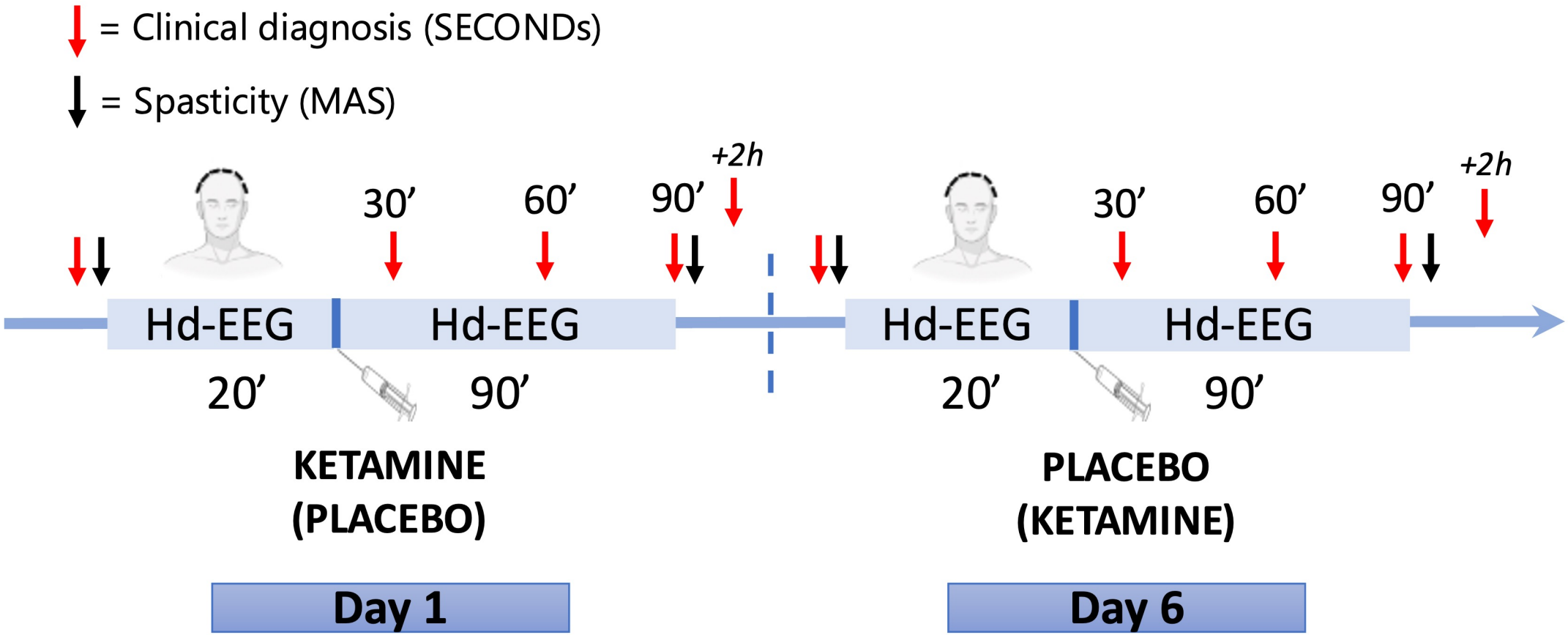
  →Could psychedelics boost complexity in patients with DoC?

Sarasso et al., *Clin EEG Neurosci.* 2014
Scott & Carhart-Harris, *Neurosci Conscious.* 2019

# Aims of the project

- Psychedelics as treatment
  - Can ketamine ameliorate conscious state in DoC patients?
- Look for baseline biomarkers of efficacy
  - Future predictions on responsiveness?

# Feasibility study using ketamine

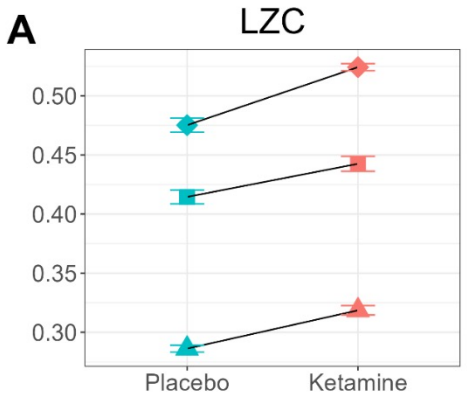


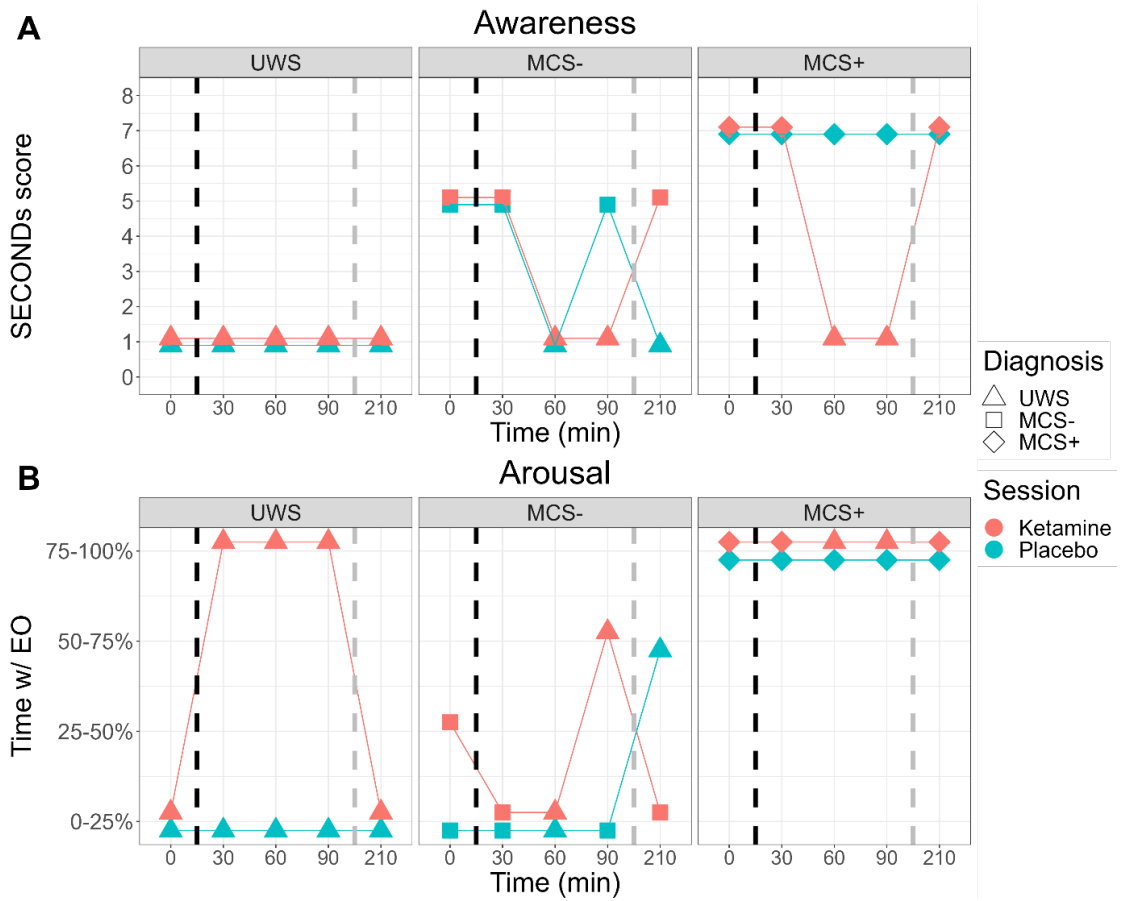

- 3 patients with DoC: 1 UWS, 1 MCS-, 1 MCS+
- IV subanesthetic concentration of ketamine (max: 0.75 ng/ml)

- Psychedelic guides and anesthesiologist present

Cardone et al., in submission

# Results from feasibility study




- Increased brain complexity measured as LZC
- More time awake, but no new overt behaviour

Cardone et al., in submission

# Take-home messages

- Psychedelics drugs change transiently consciousness
- Brain complexity seems tightly linked with consciousness
- Proved effects for psychiatric disorders, not yet for neurological ones

# Acknowledgments

Pr. Olivia Gosseries

Dr. Charlotte Martial

Patients & families!

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