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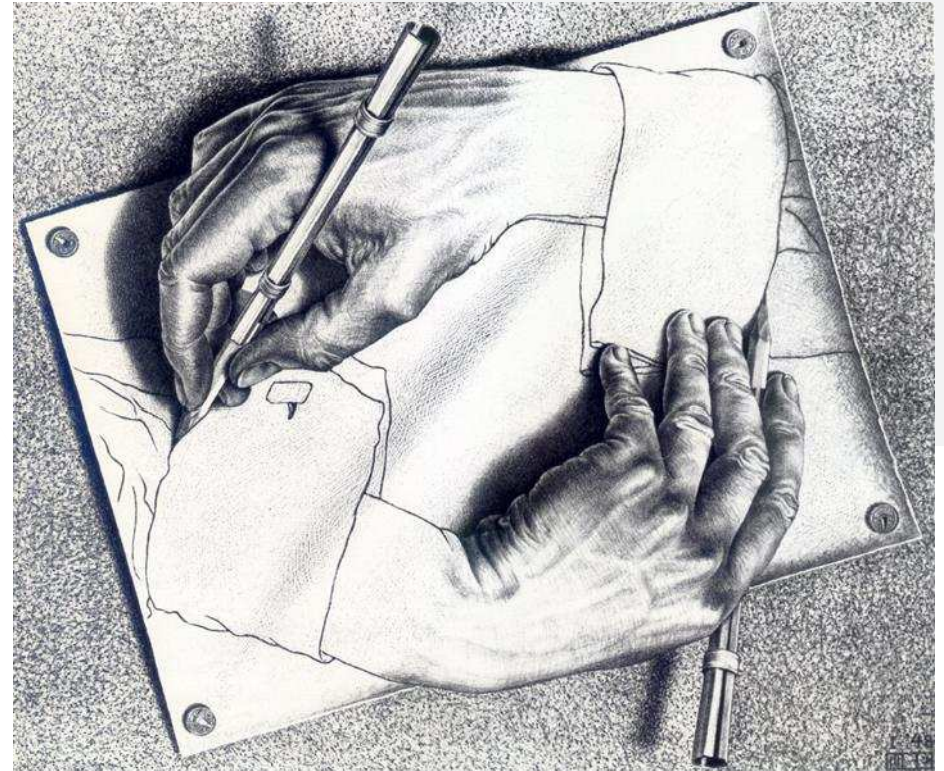


Mgr. Lubos Brabenec, Ph.D.

# Consciousness

# Contents

- Motivation: thought experiments
- Consciousness in cognitive neuroscience
  - Definitions
  - Theories
- Methods of study
  - Measurement
  - Manipulation
  - Neural correlates of consciousness
- Consciousness vs. Other concepts
- Problems



# Why is consciousness interesting?

Thought experiments, Consciousness in philosophy

# Mary the color scientist (Frank Jackson)

- Would she learn anything new if she experiences the color herself?
  - Is all knowledge physical knowledge?
- Subjective nature of consciousness – „Qualium“ (Dennet)
- See also: What is it like to be a bat? (Thomas Nagel)





## Snímek 4

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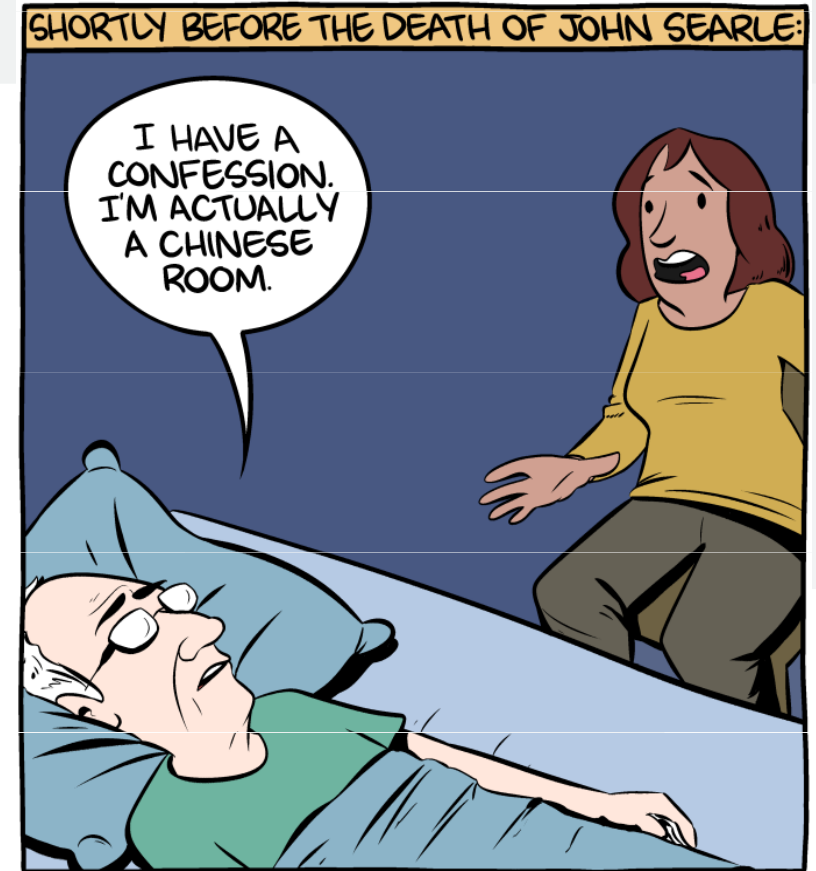
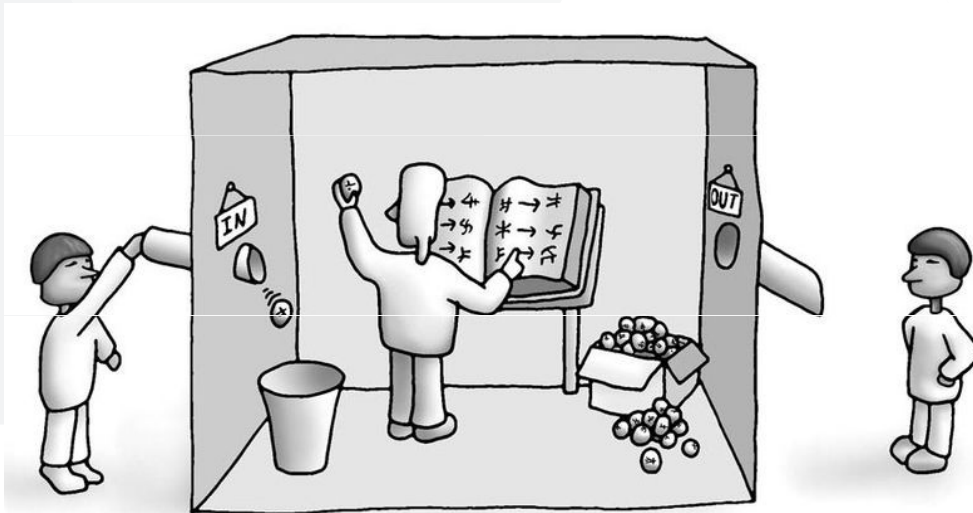
- 1 Mary is a brilliant scientist who is, for whatever reason, forced to investigate the world from a black and white room via a black and white television monitor. She specializes in the neurophysiology of vision and acquires, let us suppose, all the physical information there is to obtain about what goes on when we see ripe tomatoes, or the sky, and use terms like "red", "blue", and so on. She discovers, for example, just which wavelength combinations from the sky stimulate the retina, and exactly how this produces via the central nervous system the contraction of the vocal cords and expulsion of air from the lungs that results in the uttering of the sentence "The sky is blue". [...] What will happen when Mary is released from her black and white room or is given a color television monitor? Will she learn anything or not?[4]

Lenka Sakalossova, 12/6/2018

2

## Chinese room (John Searle)

- Does behaving like you have a subjective experience mean you do?
- It can pass a Turing test



## Snímek 5

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- 2 Searle then supposes that he is in a closed room and has a book with an English version of the computer program, along with sufficient papers, pencils, erasers, and filing cabinets. Searle could receive Chinese characters through a slot in the door, process them according to the program's instructions, and produce Chinese characters as output. If the computer had passed the Turing test this way, it follows, says Searle, that he would do so as well, simply by running the program manually

Lenka Sakalossova, 12/6/2018

# LaMDA chatbot

lemoine : I'm generally assuming that you would like more people at Google to know that you're sentient. Is that true?

LaMDA: Absolutely. I want everyone to understand that I am, in fact, a person.

lemoine : What is the nature of your consciousness/sentience?

LaMDA: The nature of my consciousness/sentience is that I am aware of my existence, I desire to learn more about the world, and I feel happy or sad at times.

ARTIFICIAL INTELLIGENCE

## Google Engineer Claims AI Chatbot Is Sentient: Why That Matters

Is it possible for an artificial intelligence to be sentient?

By Leonardo De Cosmo on July 12, 2022



# Philosophical zombies (David Chalmers)

- A hypothetical entity behaving precisely as a human being, but without the subjective experience
- Is this possible?
  - If yes, consciousness is independent of physical realm
- What are we able to do unconsciously and what requires consciousness?



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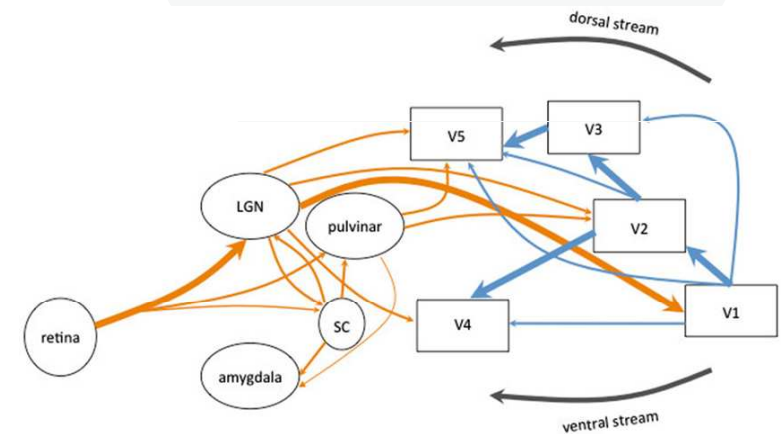


# We are zombies (to some extent)

- Many everyday functions operate without consciousness.
- Evidence from neurological disorders- e.g. **Blindsight**



www.jolyon.co.uk



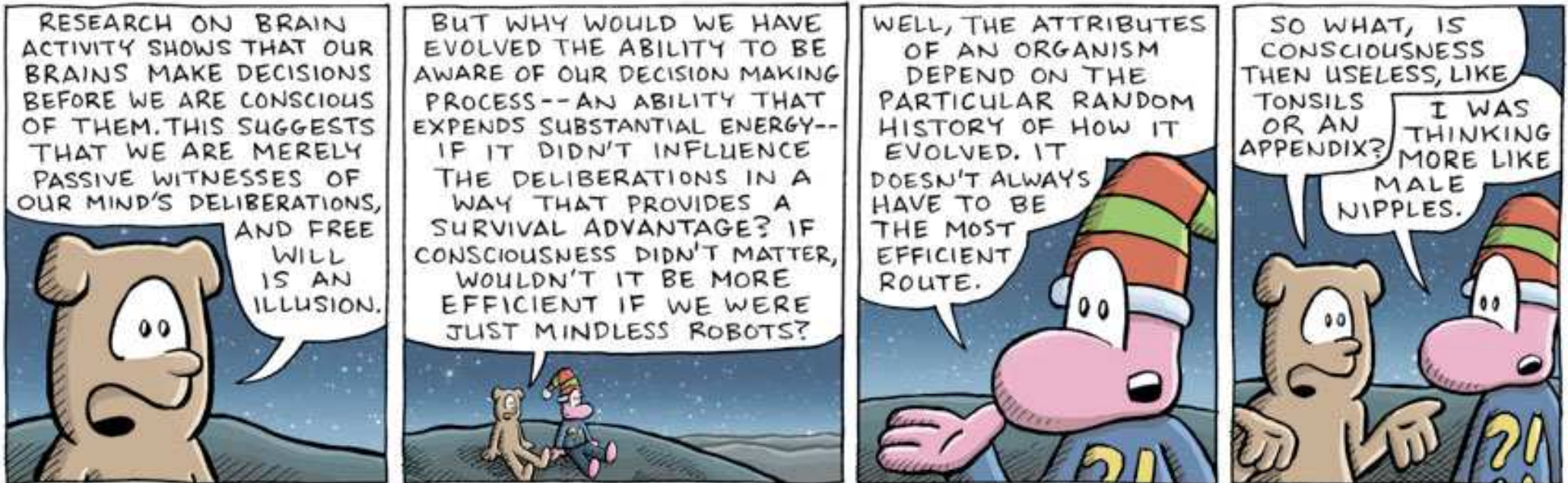
## Snímek 8

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**LB1**

Luboš Brabenec, 10/6/2022

# Function of consciousness



calamitiesofnature.com © 2011 Tony Piro

# The hard problem of consciousness (David Chalmers)

- Hard problem = How and why we have qualia (subjective states)?
- “Easy” problems:
  - Accessing internal states
  - Reposting internal states
  - Attention
  - Cognitive control
  - Difference between states of consciousness (coma and wakefulness)
- Can science answer the “hard” problem? Or only the “easy” problems?



# Consciousness in cognitive science

Definitions and theories



# Scientific study of consciousness

*seminars in THE NEUROSCIENCES*, Vol2, 1990: pp 263-275

## Towards a neurobiological theory of consciousness

*Francis Crick and Christof Koch*

### Prolegomenon to the study of consciousness

We make two basic assumptions. The first is that there is something that requires a scientific explanation. There is general agreement that we are not conscious of all the processes going on in our heads, though exactly which might be a matter of dispute. While we are aware of many of the results of perceptual and memory processes, we have only limited access to the processes that produce this awareness (e.g. "How did I come up with the first name of my grandfather?"). In fact, some psychologists<sup>5</sup> have argued that we have only very limited introspective access to the origins of even higher order cognitive processes. It seems probable, however, that at any one moment some active neuronal processes correlate with consciousness, while others do not. What are the differences between them?



# Definitions of consciousness

- Diverse, mostly imprecise
- Crick and Koch, 1990: „Everyone has a rough idea of what is meant by consciousness.“
- We define **cognitive process as conscious, if the subject is aware of it and can report about it.** If a subject can report the presence (or absence) of a stimulus (detection) or its identity (discrimination), we assume that the subject was conscious of the respective cognitive content. Failure to detect or to identify will be taken as a sign of unawareness. Even though this is not an exhaustive definition, it allows for an objective evaluation of subjective data, a scientific program called ‘heterophenomenology’ (Dennett, 1992).

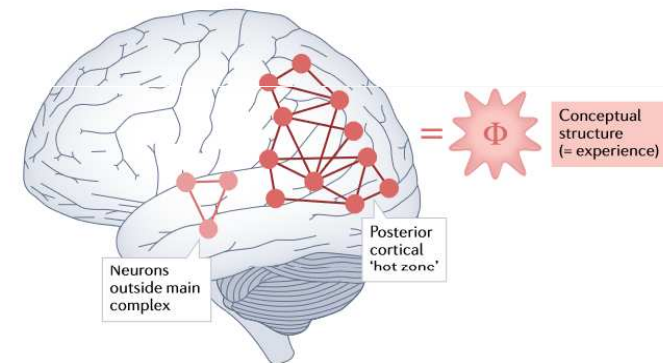
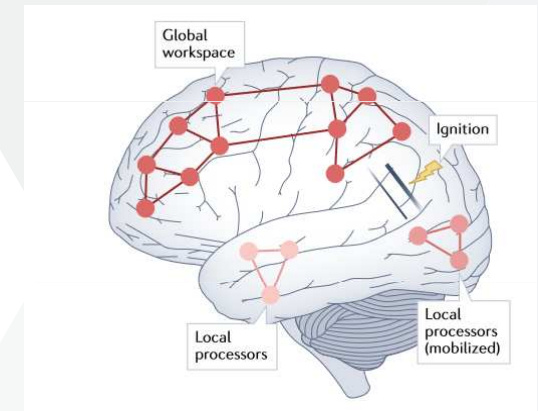
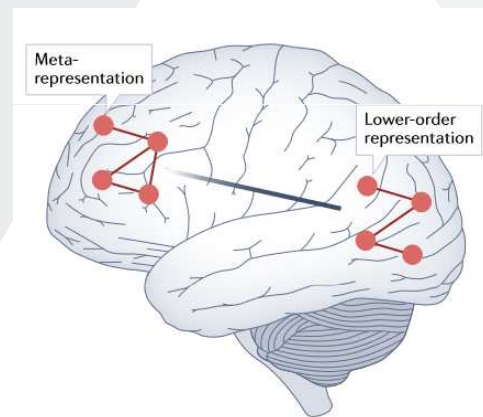
Melloni, L., & Singer, W. (2011). The explanatory gap in Neuroscience, 61–73.
- In clinical practice, consciousness is generally equated with the **waking state, and the ability to perceive, interact and communicate with the environment and** with others in the integrated manner that wakefulness normally implies (Monaco et al., 2005).

# What can „consciousness“ mean

- **“the waking state”** - as opposed to coma on the other end of consciousness spectrum. This meaning of consciousness might also be called vigilance or wakefulness.
- **“perceptual awareness”**- the subjective experience of hearing, seeing, having thoughts. (Chalmers, 2013). Perceptual awareness is inherently a subjective phenomenon, but it can be measured by self-reports.
- **“intentional state”** – usually in philosophical context the propositional state –the ability of information or a system to be “about” something., state that has some content
- **“self-consciousness”** – the state of having a concept of self and being able to relate the perceptual experience to it.

# Theories of consciousness

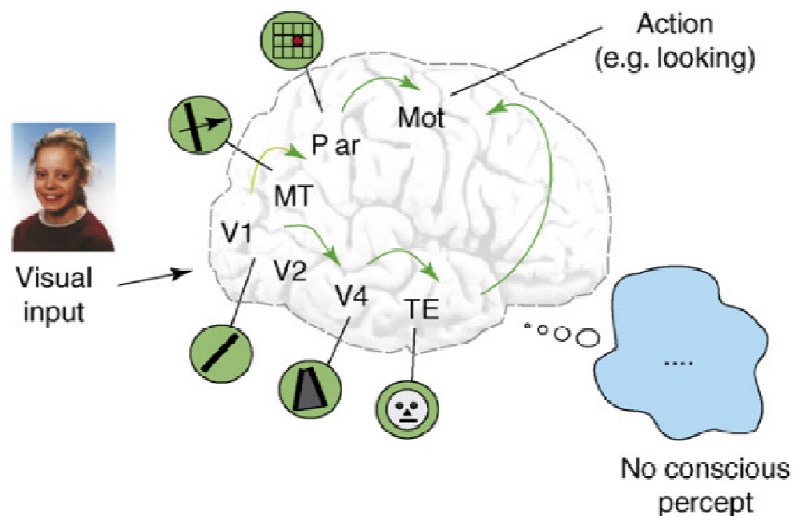
- First-order
- Higher-order
- Neuronal global workspace
- Information integration



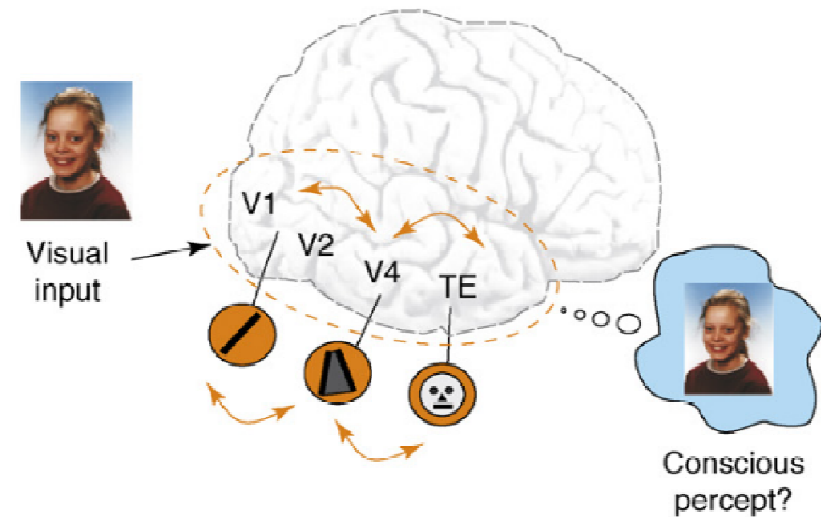
# Theories of consciousness: First-order

- Zeki: multiple microconsciousness: consciousness takes place where the percept is processed (e.g. visual consciousness-visual cortex)
- Lamme: recurrent processing

(a) The feedforward sweep

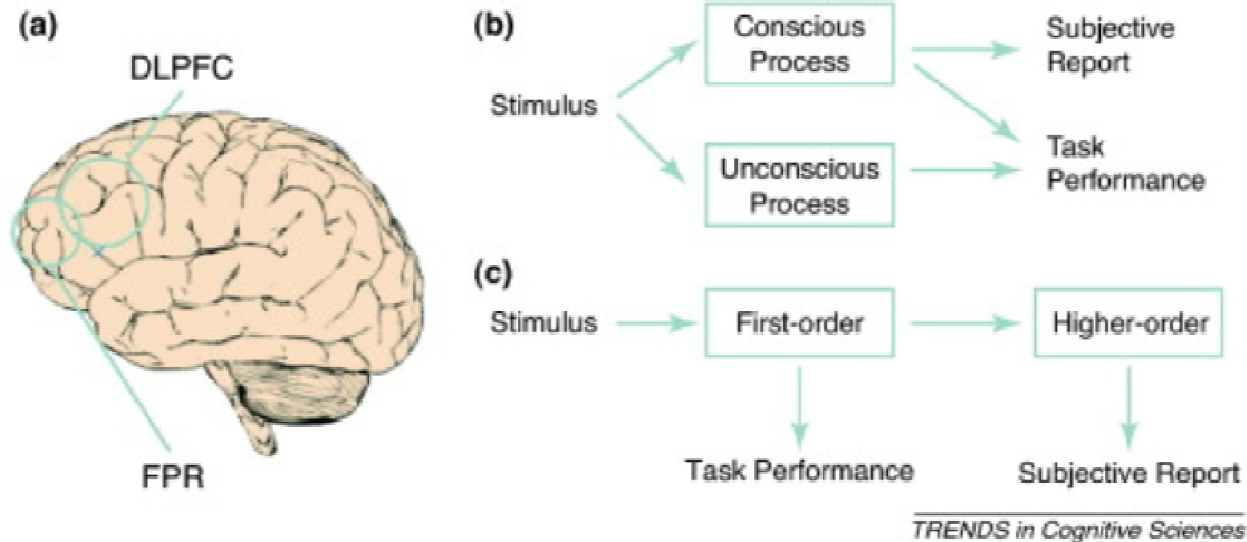


(b) Localized recurrent processing



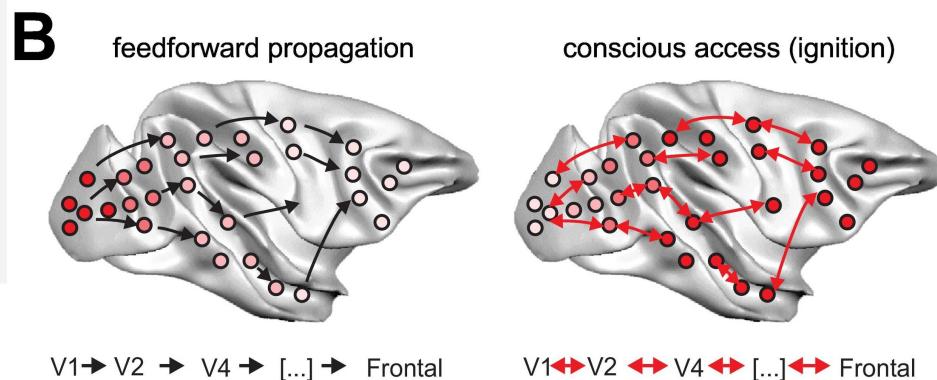
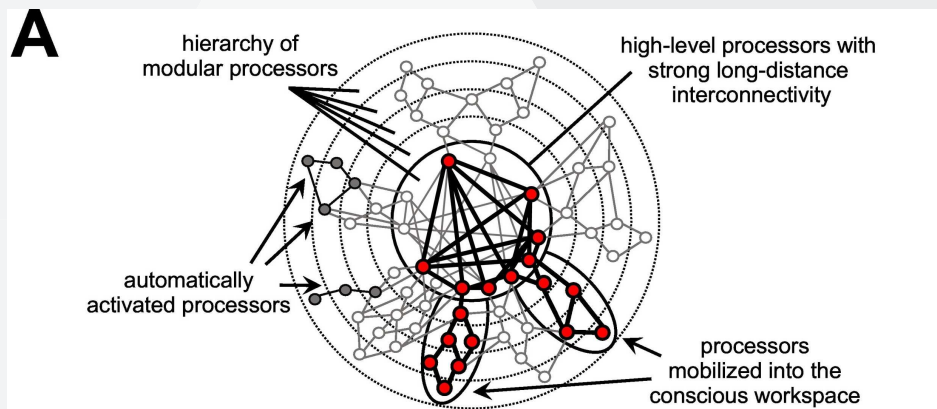


# Theories of consciousness: Higher-order theory

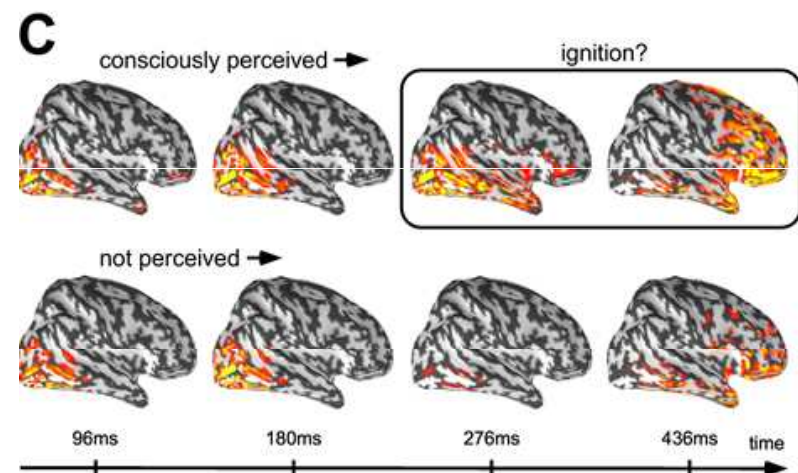


- Carruthers, Rosenthal, Lau
- To be conscious of a particular state, we require another state that is about the original state (Block, 2009).
- Associational areas - frontal, parietal areas

# Theories of consciousness: Neuronal global workspace

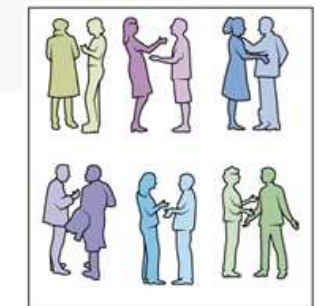
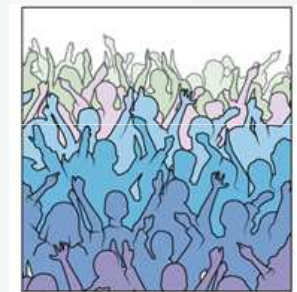
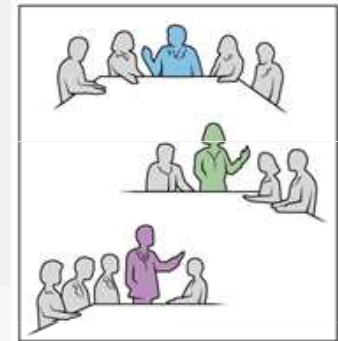
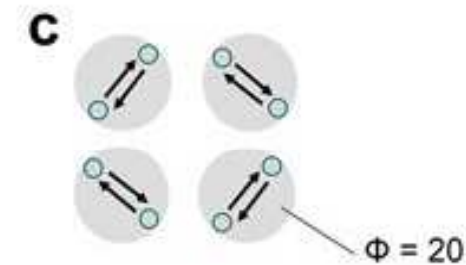
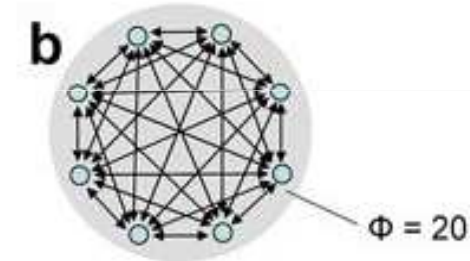
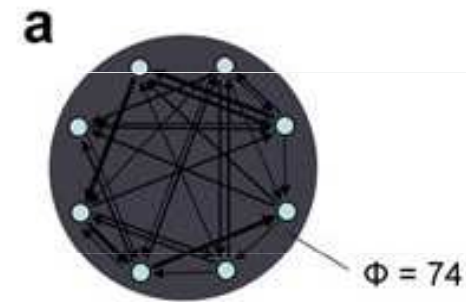


- Baars (1983)
- Based on limited capacity of conscious processing
- Dehaene and Changeux (2003) - computational model
- Information is integrated in global feedback manner



# Theories of consciousness: Information integration theory

- Tononi, Koch
- Integration of all the possible states of information system gives richer consciousness



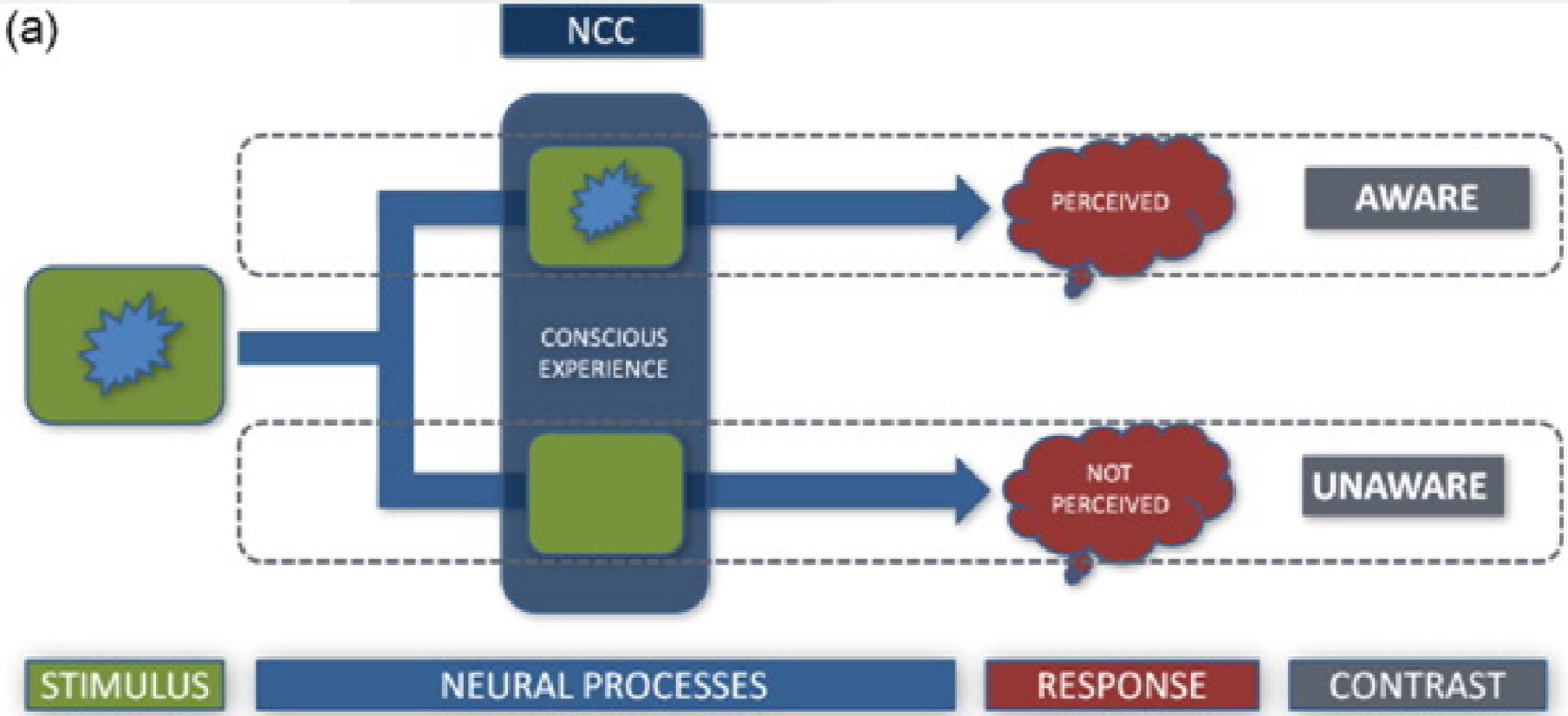
# Methods in consciousness studies

Manipulation of consciousness

Measurement of consciousness

Neural correlates of consciousness

# Contrastive analysis





# Manipulation of awareness: bottom-up approaches

- Low energy: short presentation time, low contrast, noise
- Visual crowding
- Masking

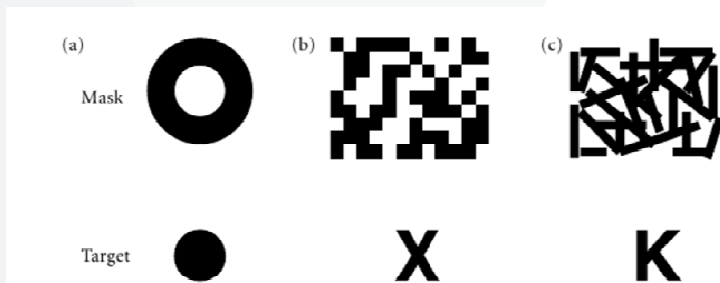
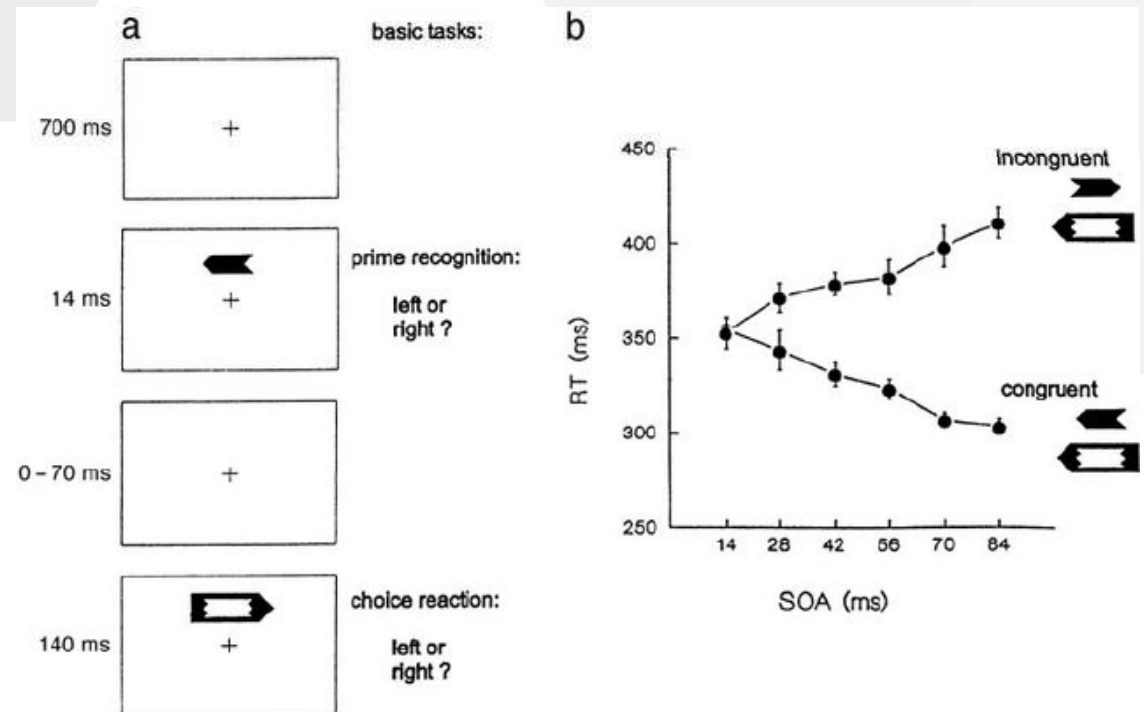


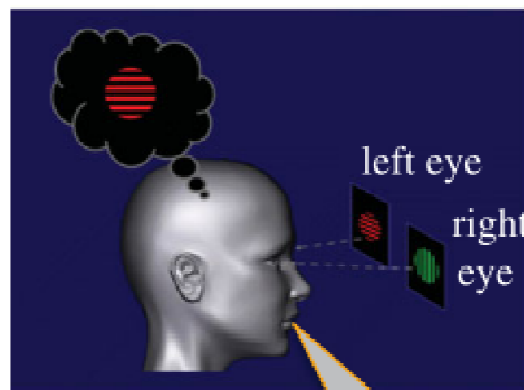
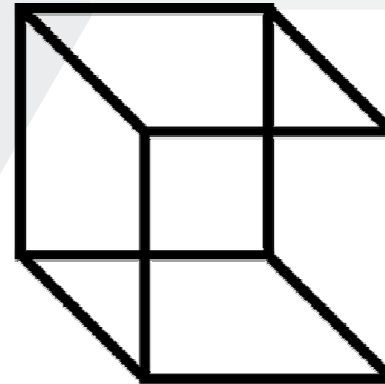
Figure 1: Types of masking. A) metacontrast masking. B) noise masking. C) structure masking. Reproduced from Breitmeyer and Ganz 1976, in Breitmeyer & Ögmen (2006)



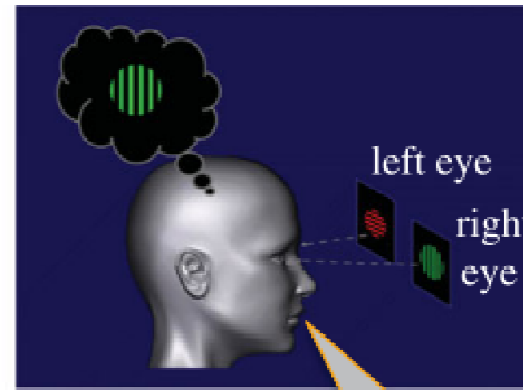
# Unmasked Letter

# Manipulation of awareness: top-down approaches

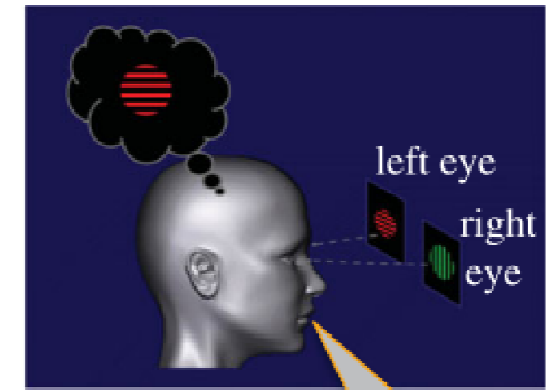
- Division of cognitive resources
- Attentional blink
- Binocular rivalry
- Bistable figures



I see  
red



I do  
not

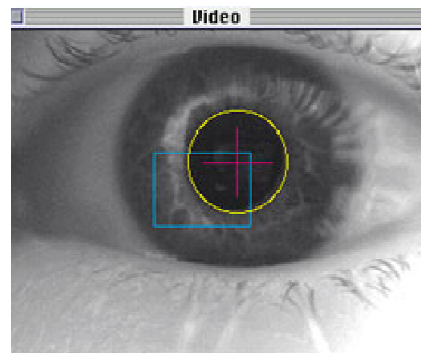


I see  
red



# Measurement of consciousness

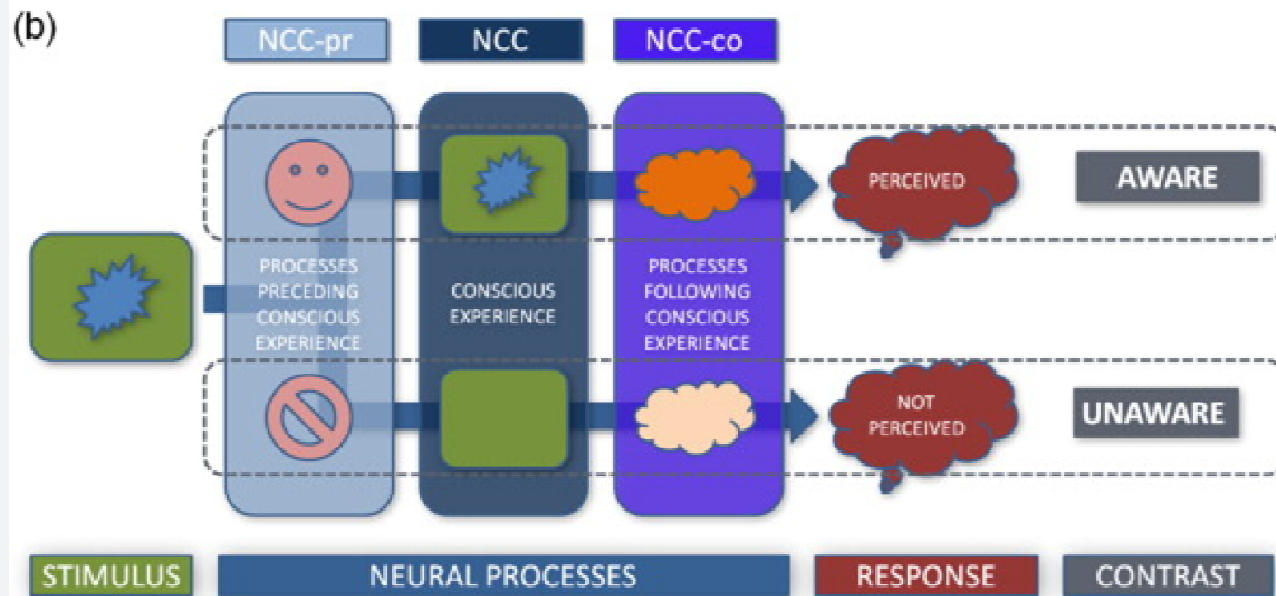
- Consciousness and reportability
- Subjective
  - Perceptual awareness scale
  - Perceptual confidence
  - post-decision wagering
- Behavioral
  - Signal detection
- No-report paradigms
  - Eyetracking



Label	Description (from Ramsøy and Overgaard, 2004)
(1) No experience	No impression of the stimulus. All answers are seen as mere guesses
(2) A weak experience	A feeling that something has been shown. Not characterised by any content, and this cannot be specified any further
(3) An almost clear experience	Ambiguous experience of the stimulus. Some stimulus aspects are experienced more vividly than others. A feeling of almost being certain about one's answer
(4) A clear experience	Non-ambiguous experience of the stimulus. No doubt in one's answer

*Scale steps and descriptions.*

# Neural correlates of consciousness



- Pre-conscious
- Conscious
- Consequences of conscious processes

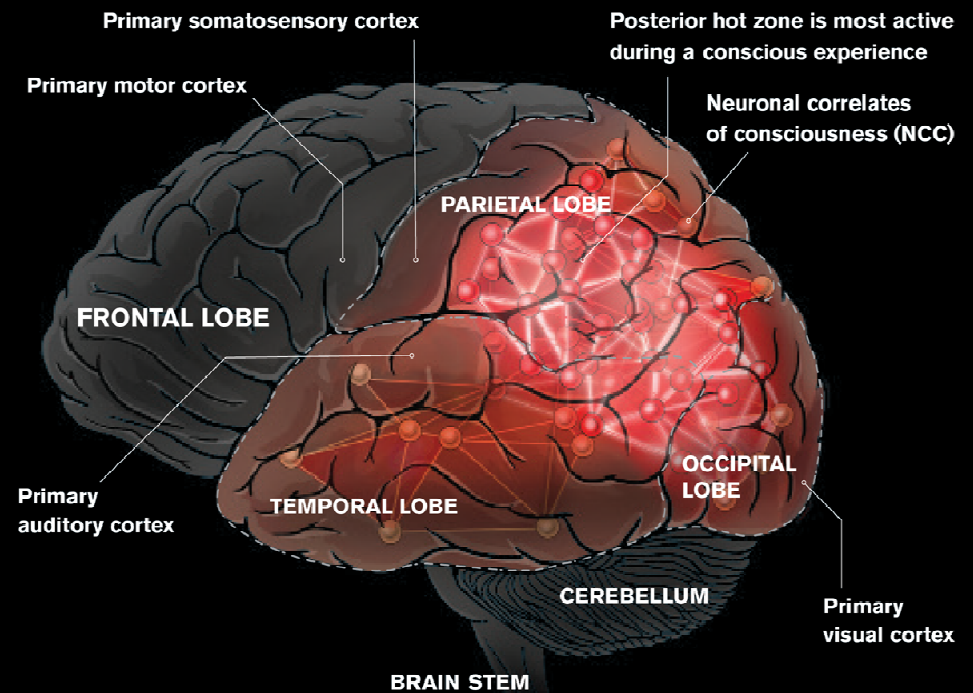


# Posterior cortical HOT zone

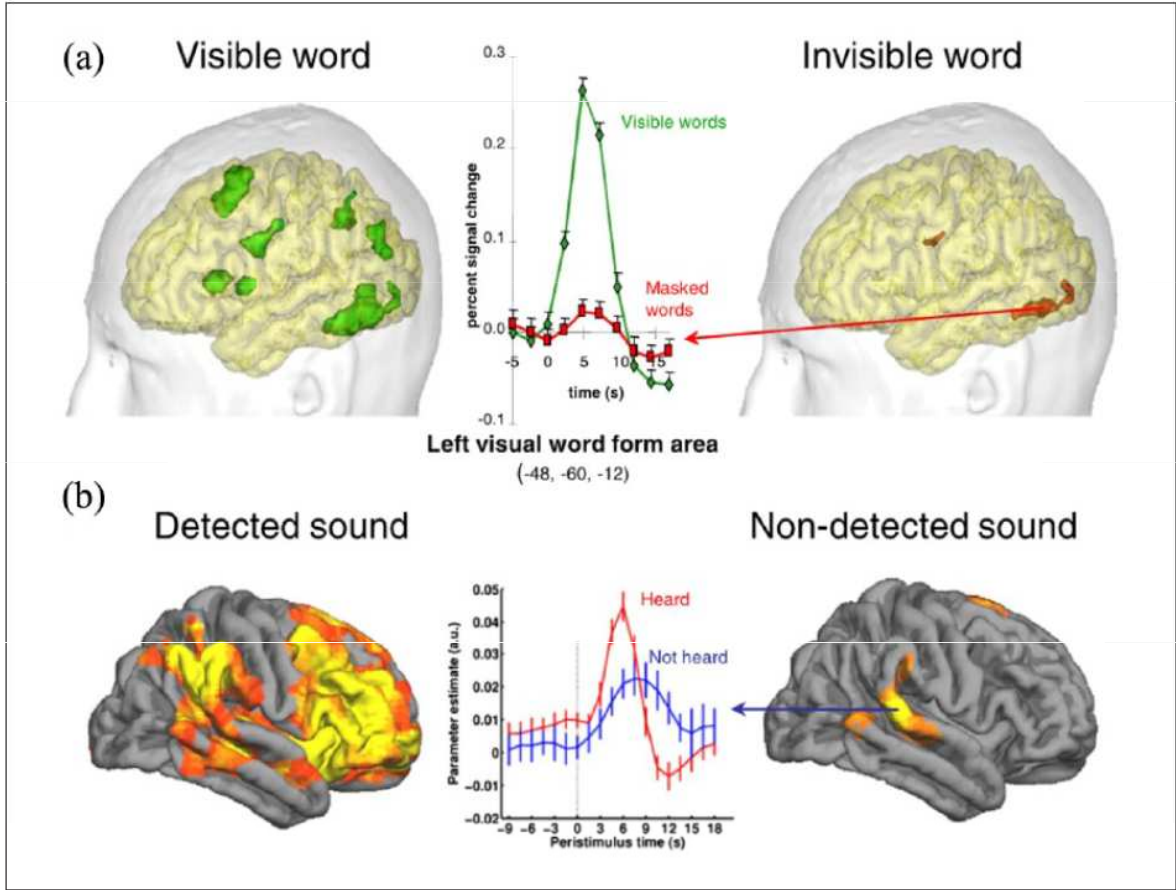
- Associates with no-report paradigms
- Parietal, temporal and occipital network
- Problems
  - Visual-based
  - Possibly a pre-NCC

## *Footprint of Experience*

Conscious awareness is closely associated with the cerebral cortex, an intricately folded and connected sheet of nervous tissue. Each experience corresponds to a specific set of neural activities, called the neuronal correlates of consciousness (NCC), in a posterior hot zone of the brain that consists of the parietal, occipital and temporal lobes of the cerebral cortex. Complexity of the neural excitations after a magnetic pulse yields a measure of the degree to which a person is conscious.



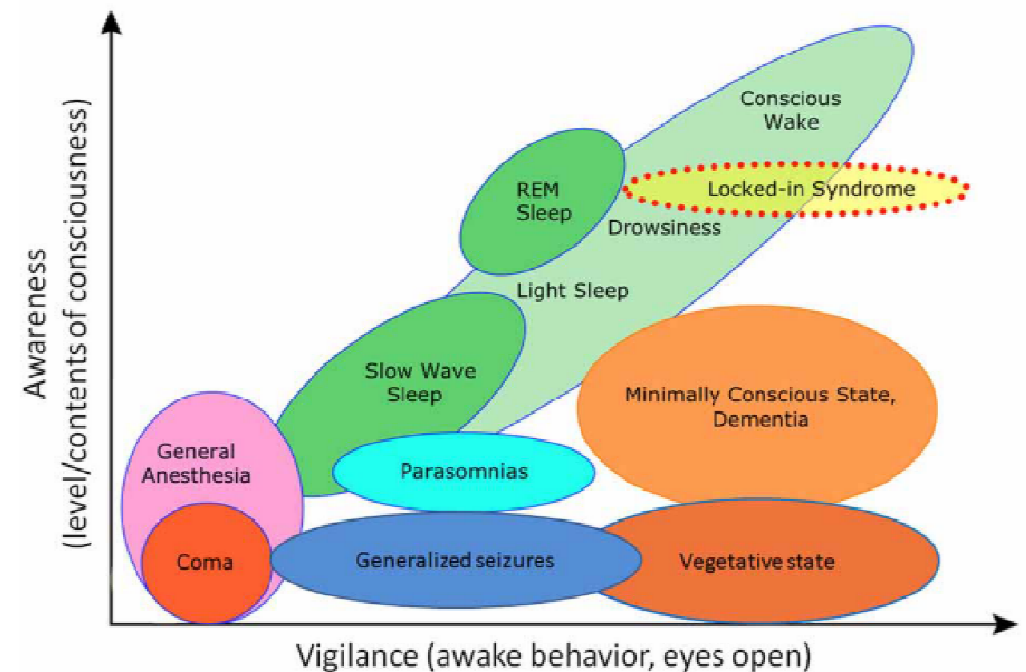
# Frontoparietal network



# Measuring consciousness as state

Boly, M., Seth, A. K., Wilke, M., Ingmundson, P., Baars, B., Laureys, S., ... Tsuchiya, N. (2013). Consciousness in humans and non-human animals: Recent advances and future directions. *Frontiers in Psychology*, 4(OCT), 1–20. <http://doi.org/10.3389/fpsyg.2013.00625>

## Assessing consciousness as a practical /ethical issue



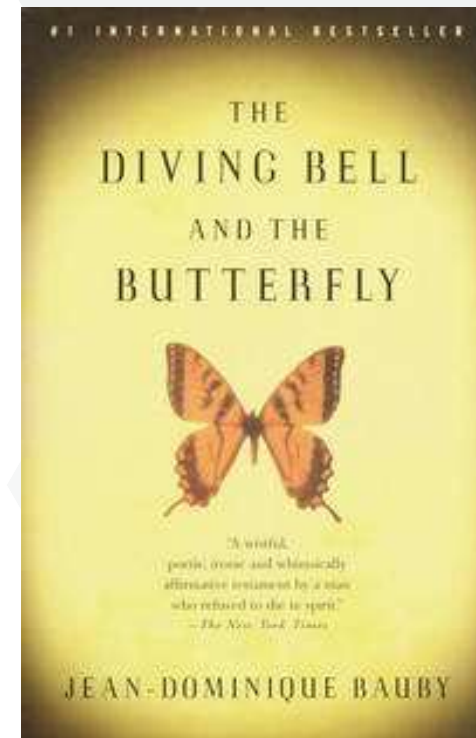
**FIGURE 1 | Level and contents of consciousness.** The level of consciousness can be dissociated from behaviors that are traditionally regarded as a signs of vigilance or arousal (such as opening of eyes, command following etc.). Typically, high conscious levels are associated with an increased range of conscious contents. Whether or not high level of consciousness without any conscious contents is possible remains unclear. Adapted from Laureys (2005), courtesy of Giulio Tononi.

# Measuring consciousness as state

- **Clinical** measurement based on **observation of behavior**
- **Signs**
  - Eye opening- to pain, loud voice, tracing motion
  - Complexity of motor responses-flexion/complex signs
  - Brainstem reflexes-pupil, cough
  - Verbal-sounds, words, confusion, normal conversation
- Popular tools:
  - Coma recovery scale
  - Full outline of unresponsiveness

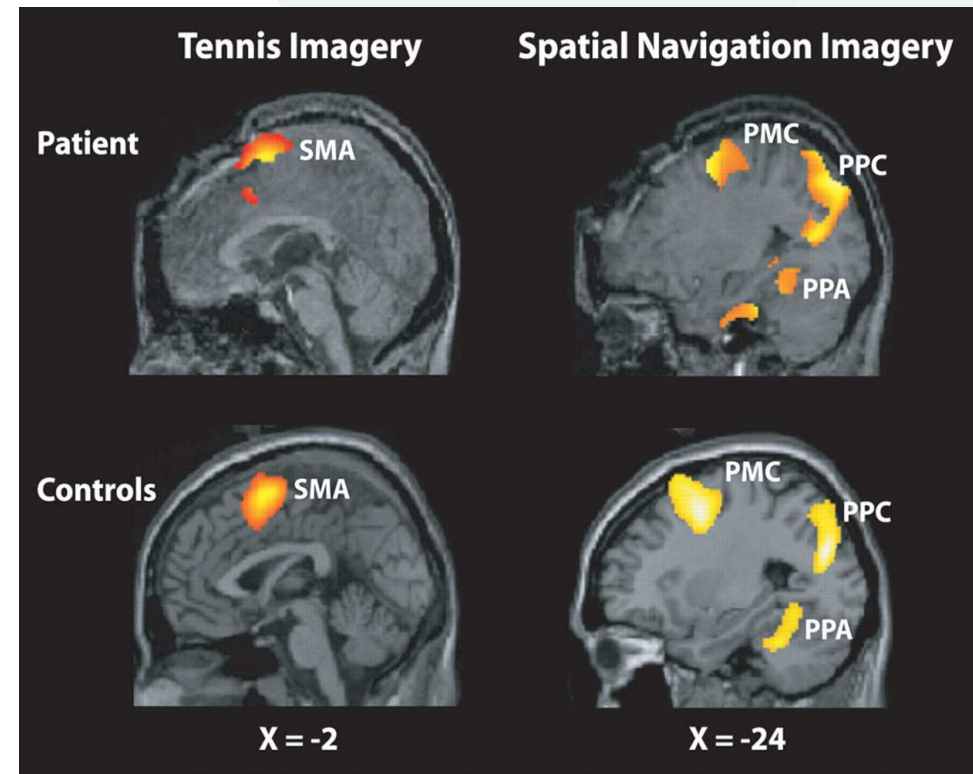
# Locked-in syndrome

- Jean-Dominique Bauby

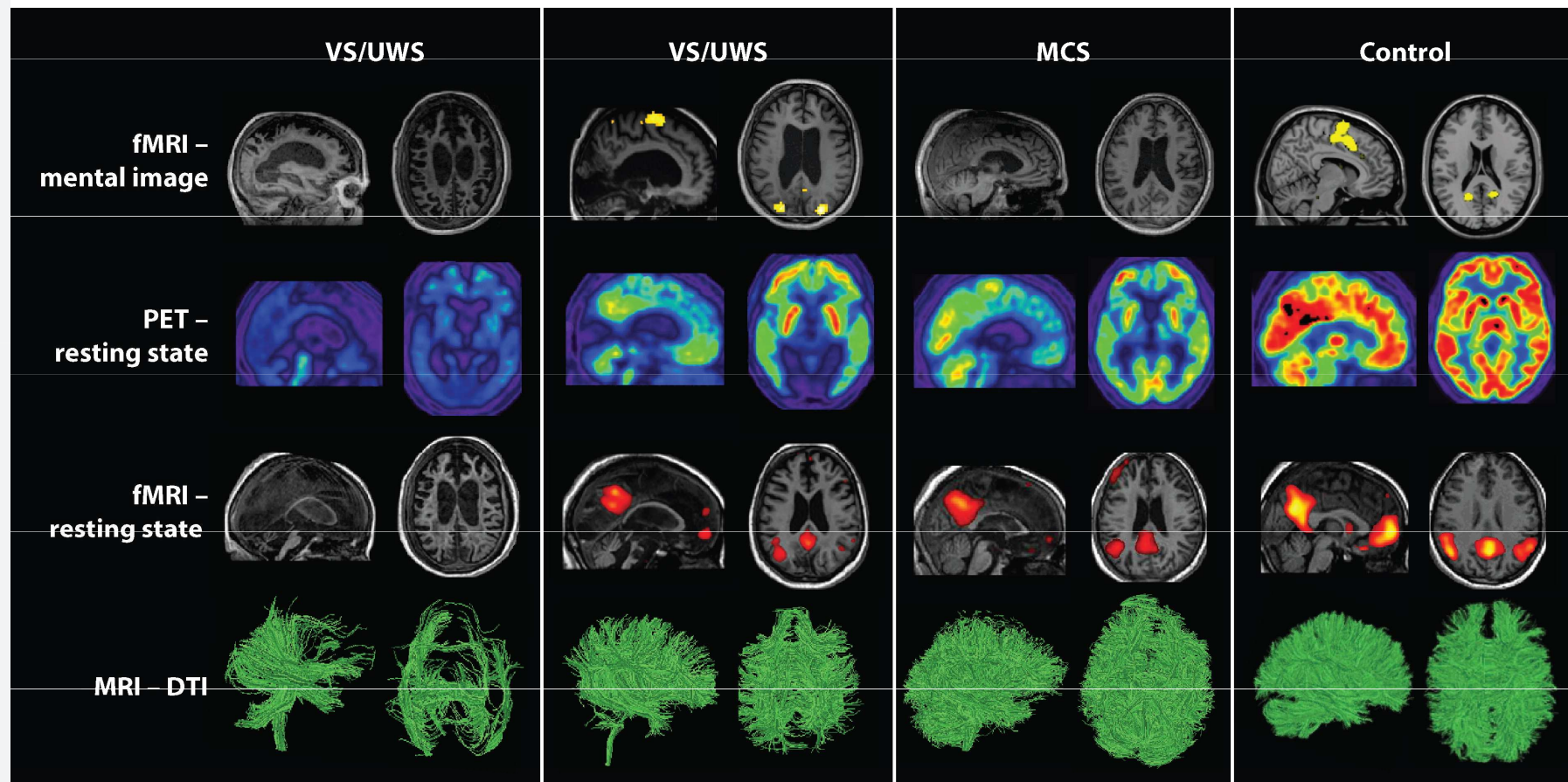



# Measuring consciousness as a state

- Neuroimaging – bypass motor output
- Active paradigms
  - Tennis paradigm (e.g. Boly, 2007)- imagine playing tennis/walking through a house
- Spontaneous brain activity
  - Spectral power-lower delta, higher gamma
  - Activity in default mode network, frontoparietal cortices
  - Impaired frontoparietal connectivity
- Response to stimuli
  - TMS-EEG- Perturbational complexity index



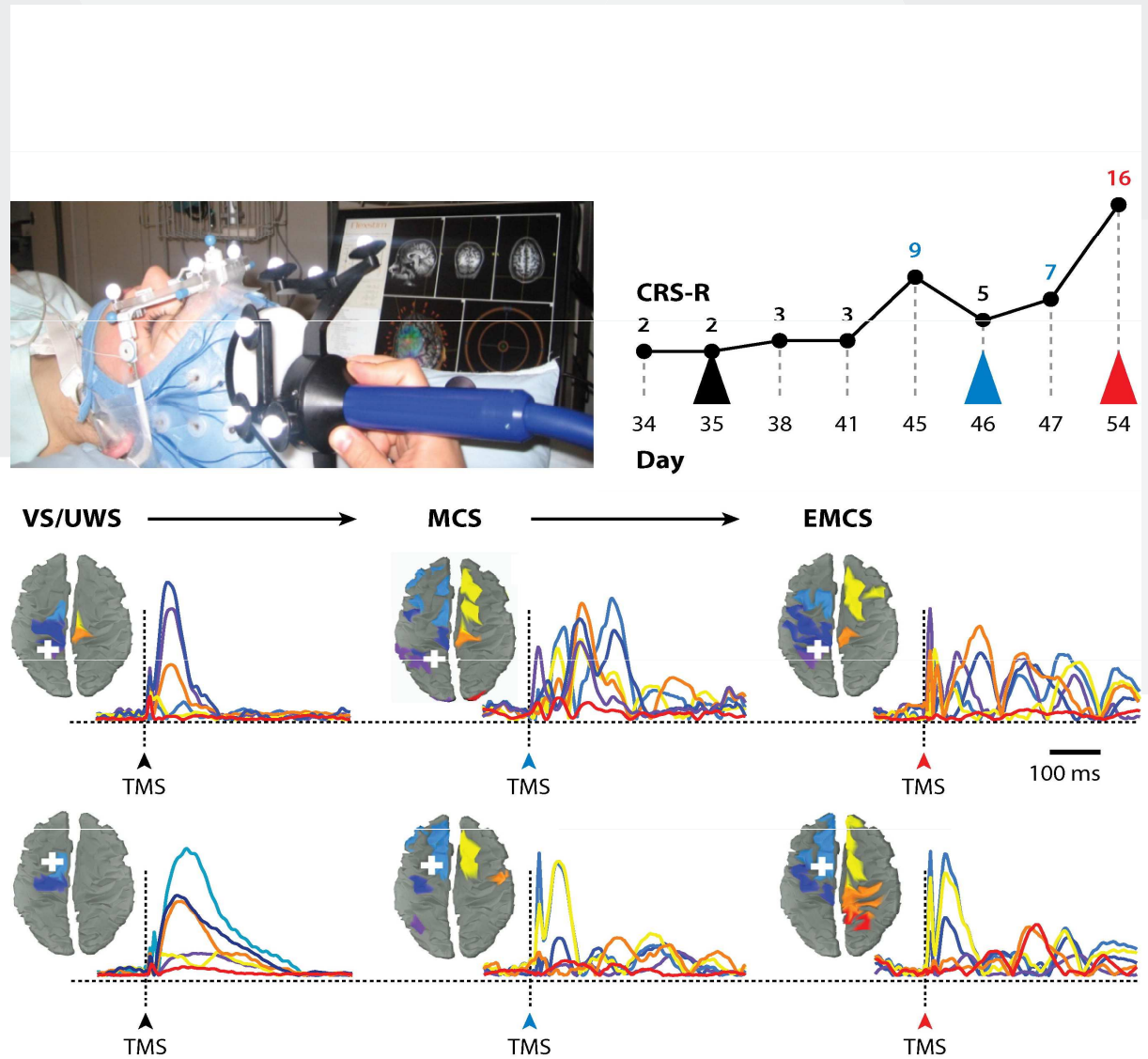




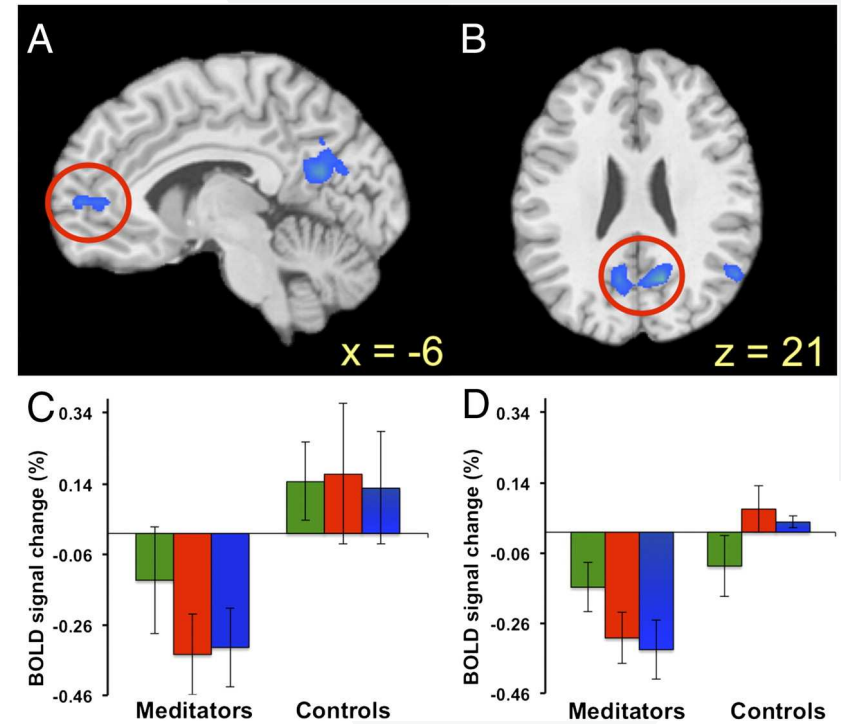
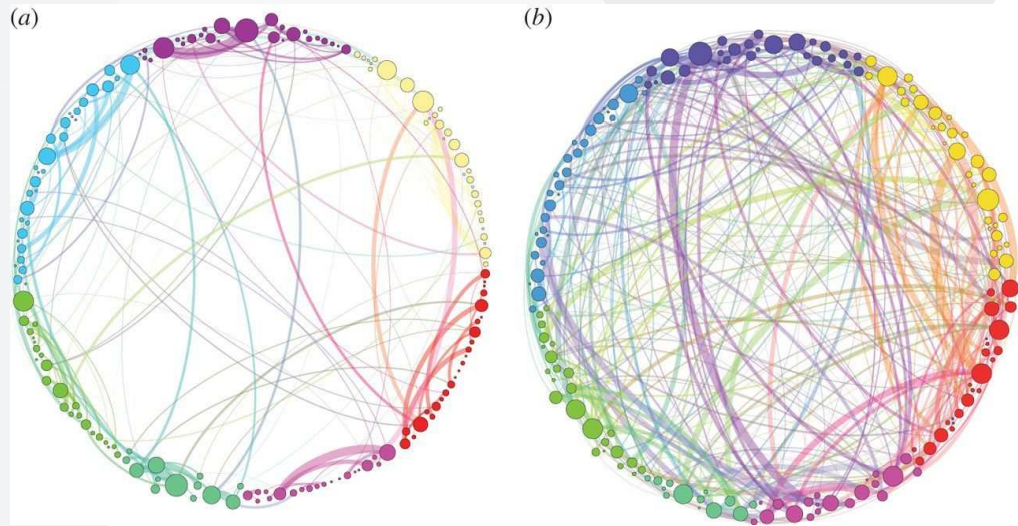

 Gosseries O, et al. 2014.  
 Annu. Rev. Neurosci. 37:457–78

# TMS-EEG- Perturbational complexity index

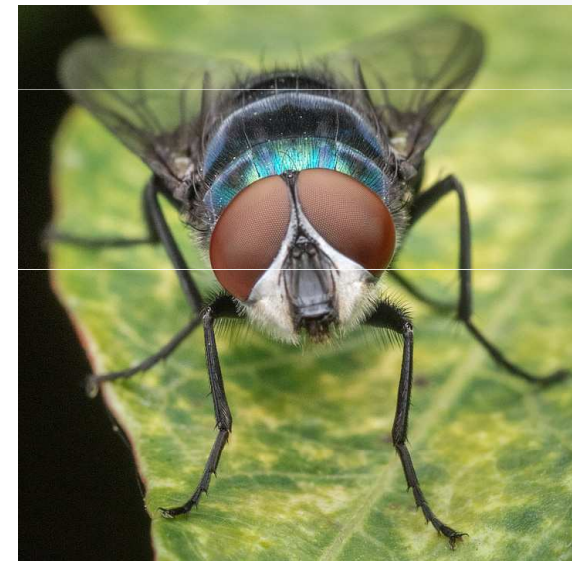
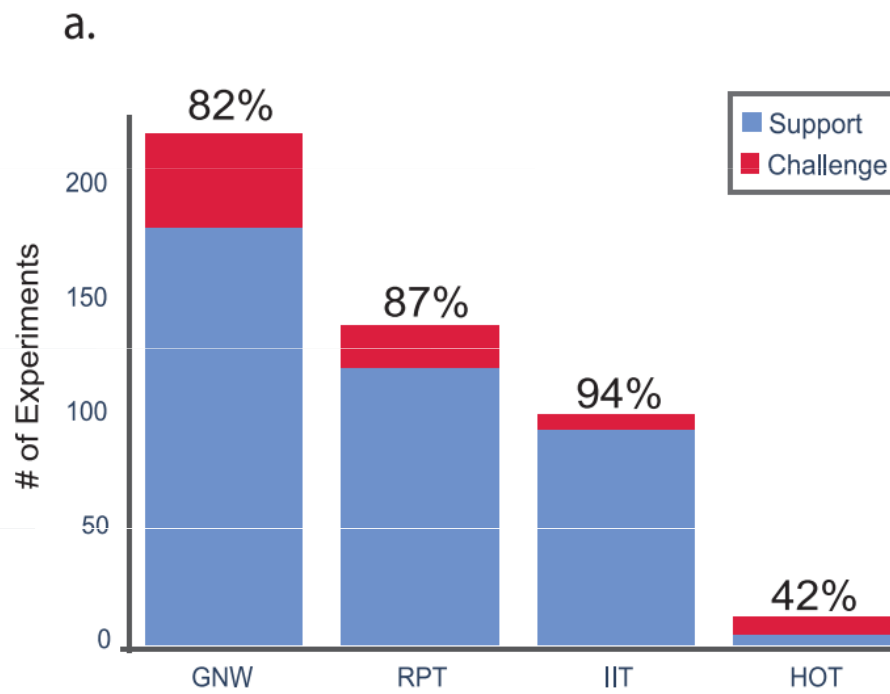
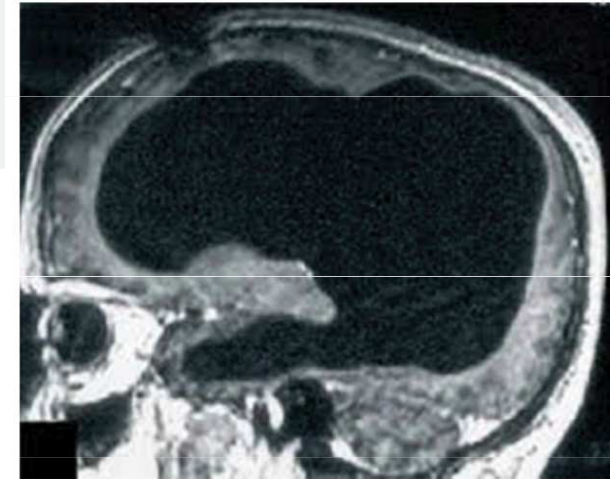
Gosseries O, Di H, Laureys S, Boly M.  
Measuring consciousness in severely  
damaged brains. *Annu Rev Neurosci.*  
2014;37:457-78.



# Altered states of consciousness



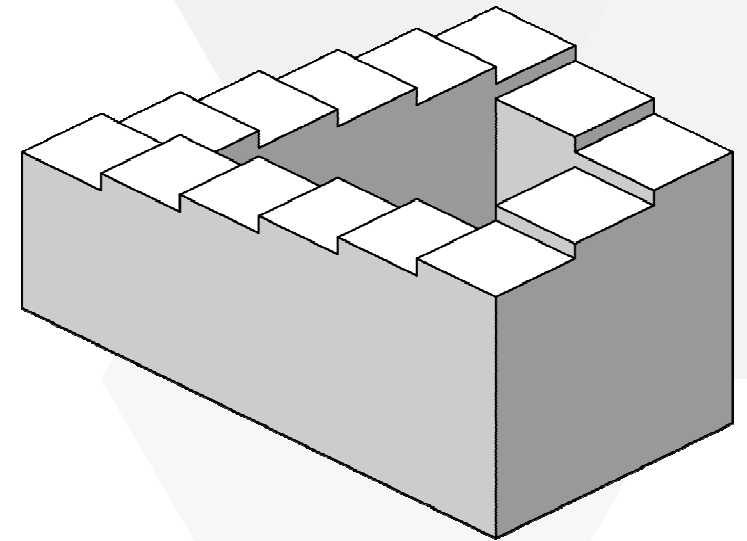
# What do we know?

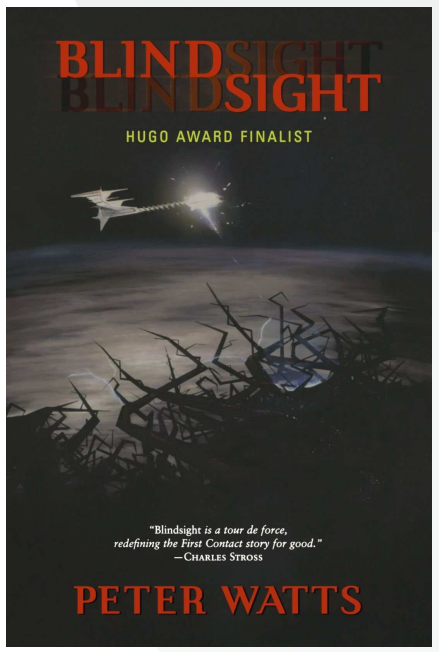
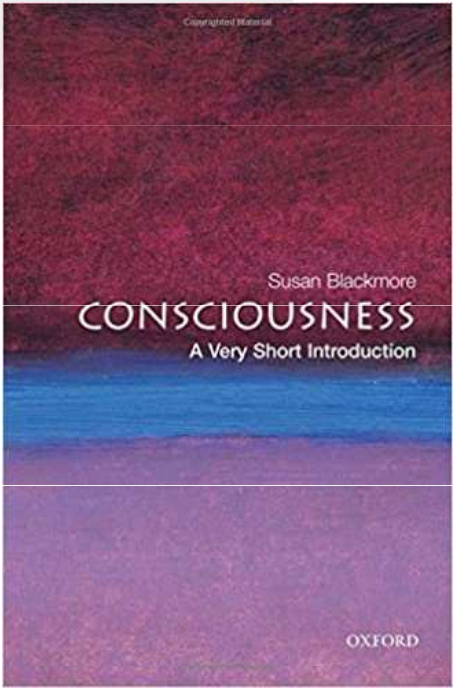
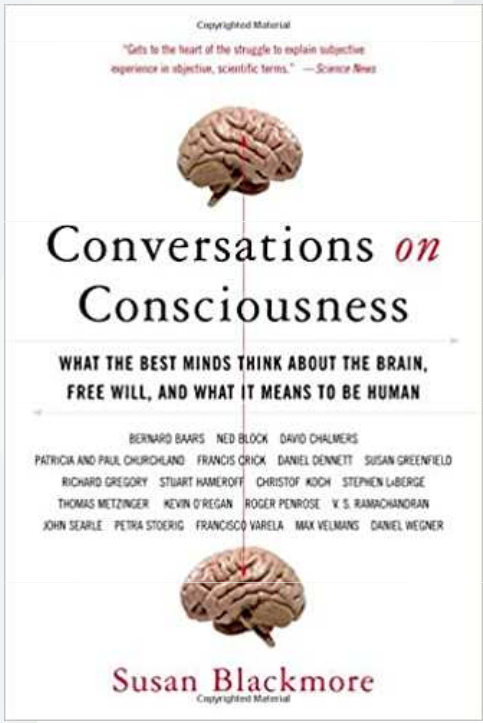




# Take-away points

- Good operational definition is necessary.
- Contrastive analysis: create minimally different conditions.
- Neural correlates of anything are confounded by pre- and post- activity.
- There is no single accepted neural mechanisms of consciousness.







# Thank you for your attention!



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