MAY
25-26

Consciousness and language in disorders of consciousness after a coma

Aubinet Charlène, PhD

Psychologie & Neuroscience Cognitives
PsyNCog
Psychology & Neuroscience of Cognition

Faculté de Psychologie et des Sciences de l'Education

BAPS
BELGIAN ASSOCIATION FOR PSYCHOLOGICAL SCIENCES

UMONS
Université de Mons

Outline

- Disorders of consciousness (DoC)
- Language assessment in post-comatose patients
  - Neuroimaging
  - Electrophysiology
  - Behavioral tools
- Theoretical implications

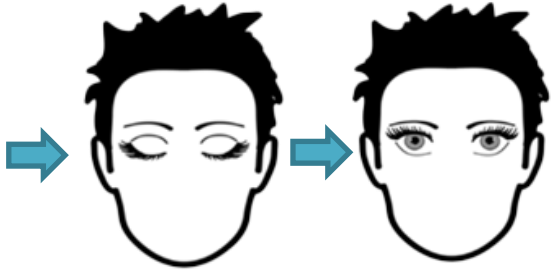
Consciousness disorders in post-comatose recovery

Trauma
Anoxia
Hemorrhage
Metabolic
Infection
Inflammation

Coma

Consciousness disorders in post-comatose recovery

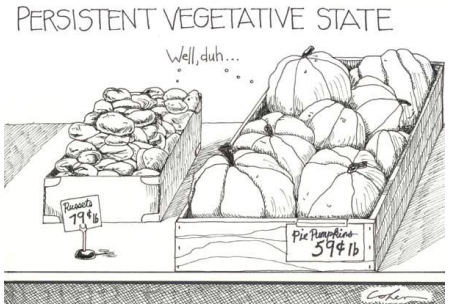
Trauma
Anoxia
Hemorrhage
Metabolic
Infection
Inflammation



Coma

Unresponsive Wakefulness Syndrome (UWS)

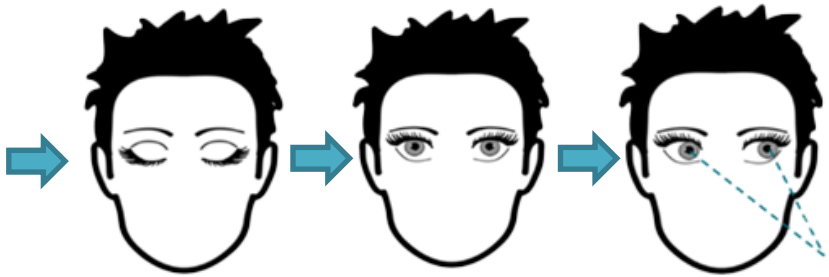
"There's nothing we can do… he'll always be a vegetable."



Laureys et al., *BMC Med*, 2010

Consciousness disorders in post-comatose recovery

Trauma
Anoxia
Hemorrhage
Metabolic
Infection
Inflammation



Coma

Unresponsive Wakefulness Syndrome (UWS)

Minimally Conscious State (MCS-)

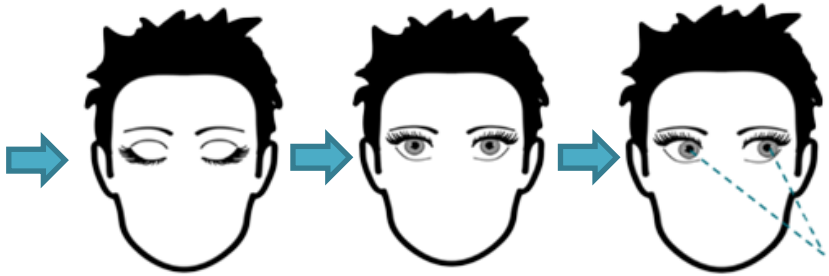
Reproducible signs of consciousness

Oriented behaviors
- **Visual**

Giacino et al., *Neurology*, 2002
Wannez et al., *Neuropsychol Rehabil*, 2017

Consciousness disorders in post-comatose recovery

Trauma
Anoxia
Hemorrhage
Metabolic
Infection
Inflammation



Coma

Unresponsive Wakefulness Syndrome (UWS)

Minimally Conscious State (MCS-)

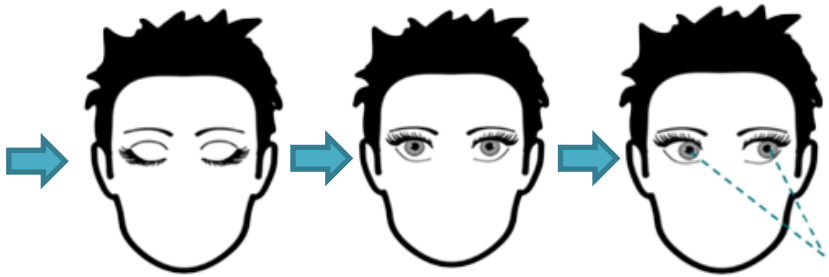
Oriented behaviors
- **Visual**
- **Motor**

Reproducible signs of consciousness

Giacino et al., *Neurology*, 2002
Wannez et al., *Neuropsychol Rehabil*, 2017

Consciousness disorders in post-comatose recovery

Trauma
Anoxia
Hemorrhage
Metabolic
Infection
Inflammation



Coma

Unresponsive Wakefulness Syndrome (UWS)

Minimally Conscious State (MCS-)

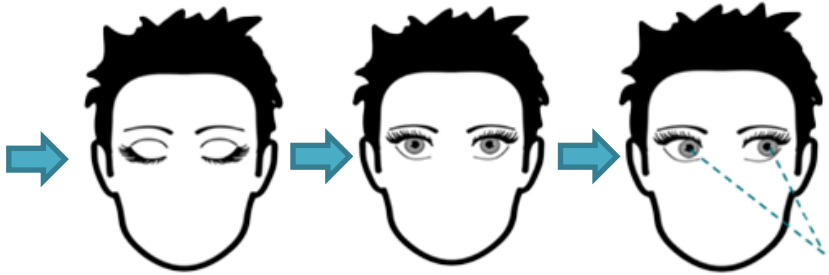
Reproducible signs of consciousness

Oriented behaviors
- **Visual**
- **Motor**
- **Auditory**

Carrière et al., *Brain Commun*, 2020
Mat et al., *Semin Neurol*, 2022

Consciousness disorders in post-comatose recovery

Trauma
Anoxia
Hemorrhage
Metabolic
Infection
Inflammation



Coma

Unresponsive Wakefulness Syndrome (UWS)

Minimally Conscious State (MCS-)

Oriented behaviors
- **Visual**
- **Motor**
- **Auditory**
- **Emotional**

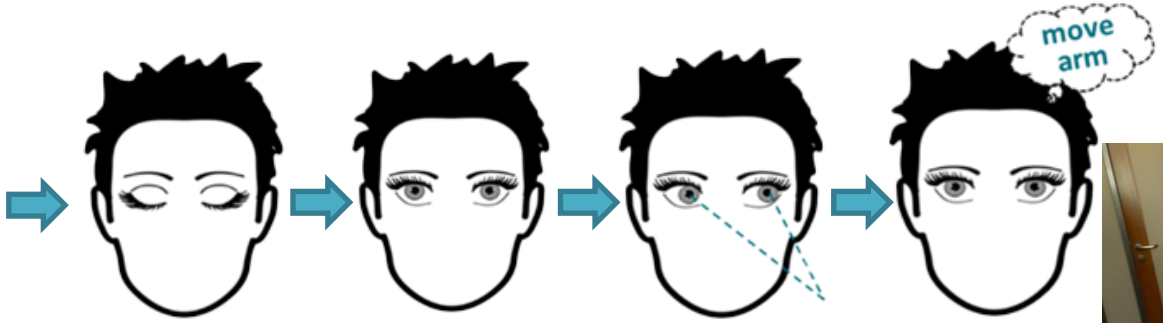
Reproducible signs of consciousness

Giacino et al., *Neurology*, 2002
Wannez et al., *Neuropsychol Rehabil*, 2017

Consciousness disorders in post-comatose recovery

Reproducible language signs of consciousness

Trauma
Anoxia
Hemorrhage
Metabolic
Infection
Inflammation



Coma

Unresponsive Wakefulness Syndrome (UWS)

Minimally Conscious State (MCS-)

Minimally Conscious State (MCS+)

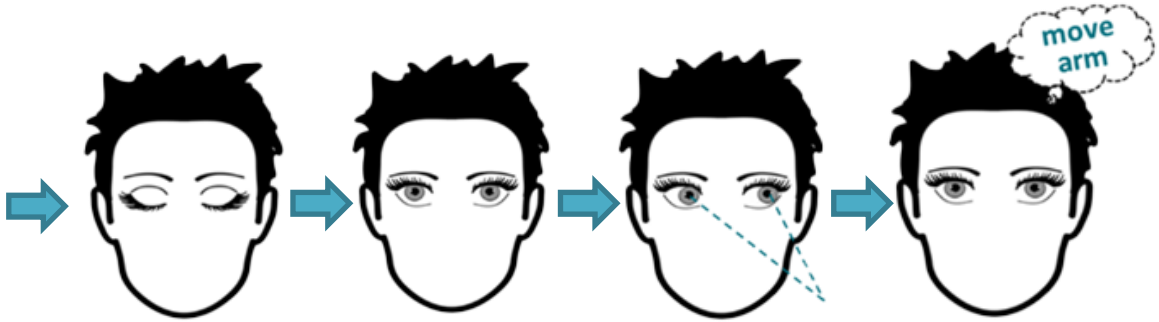
- **Command-following**

Bruno et al., *J Neurol*, 2011
Thibaut et al., *J Neurol*, 2020

Consciousness disorders in post-comatose recovery

Reproducible language signs of consciousness

Trauma
Anoxia
Hemorrhage
Metabolic
Infection
Inflammation

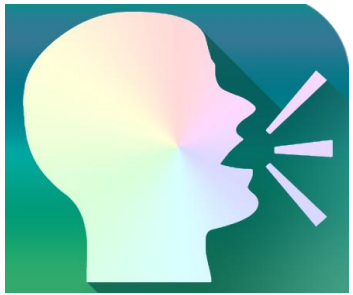


Coma

Unresponsive Wakefulness Syndrome (UWS)

Minimally Conscious State (MCS-)

Minimally Conscious State (MCS+)

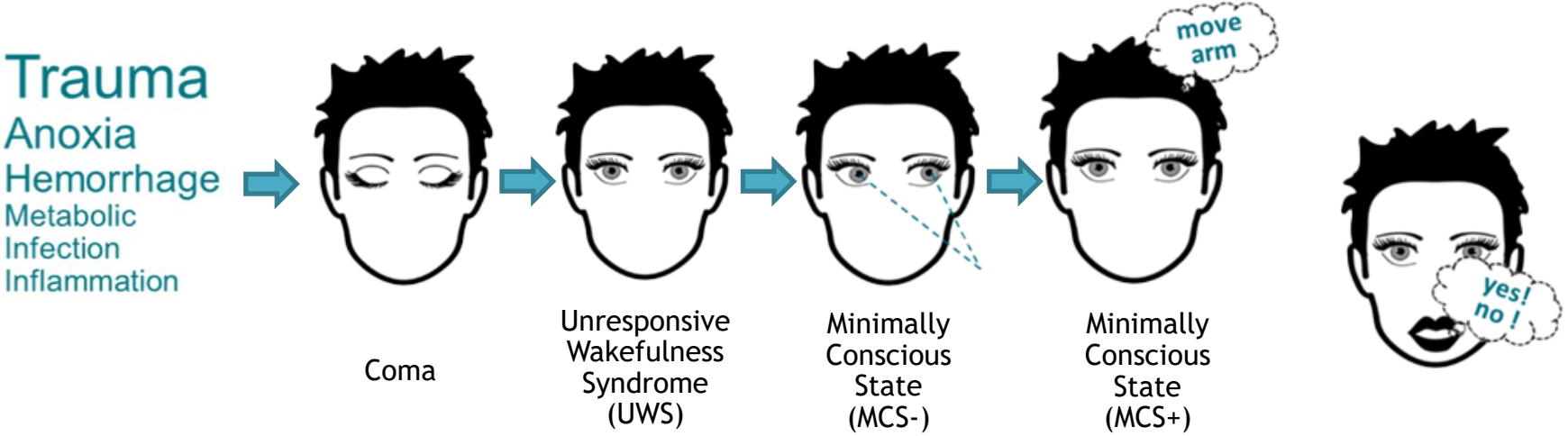


- **Command-following**
- **Intelligible verbalization**

Bruno et al., *J Neurol*, 2011
Thibaut et al., *J Neurol*, 2020

Consciousness disorders in post-comatose recovery

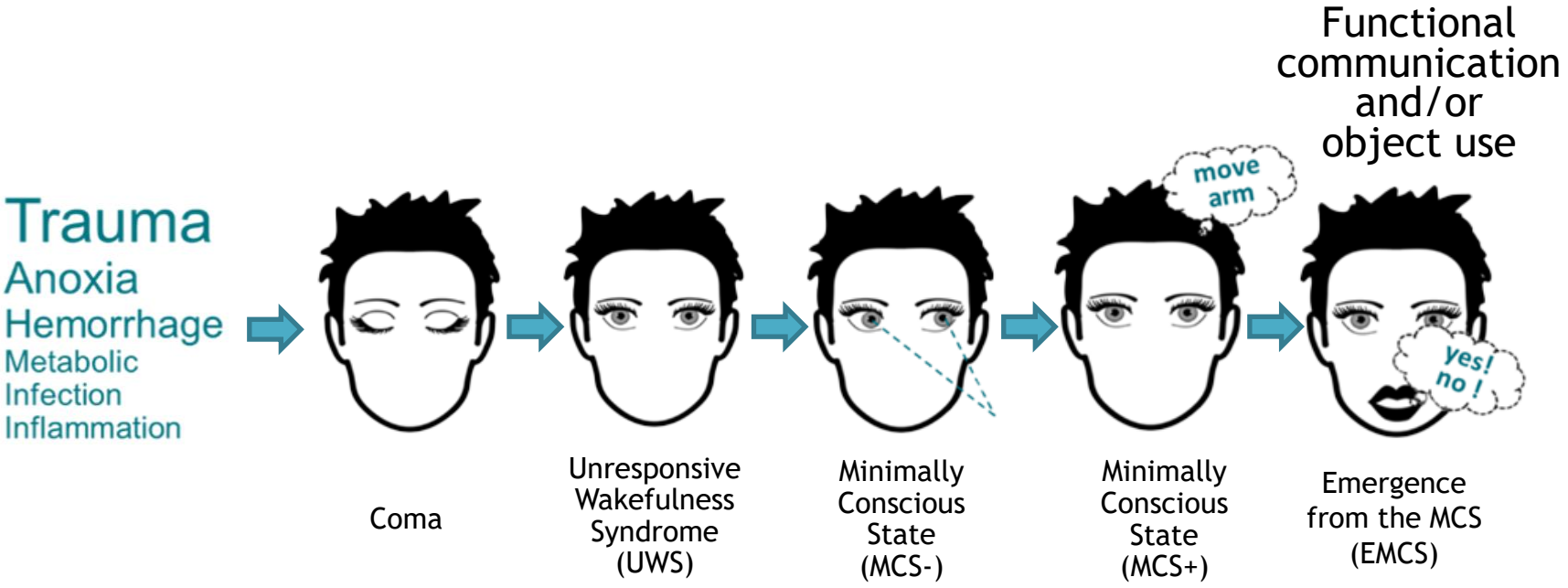
Reproducible language signs of consciousness



- **Command-following**
- **Intelligible verbalization**
- **Intentional communication**

Bruno et al., *J Neurol*, 2011
Thibaut et al., *J Neurol*, 2020

Consciousness disorders in post-comatose recovery

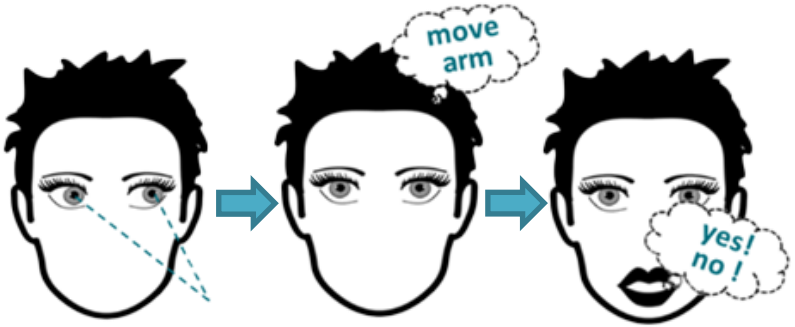


Giacino et al., *Neurology*, 2002
Wannez et al., *Neuropsychol Rehabil*, 2017

30-40% risk of DoC misdiagnosis

Deafness
Blindess
Motor impairment
Aphasia
…

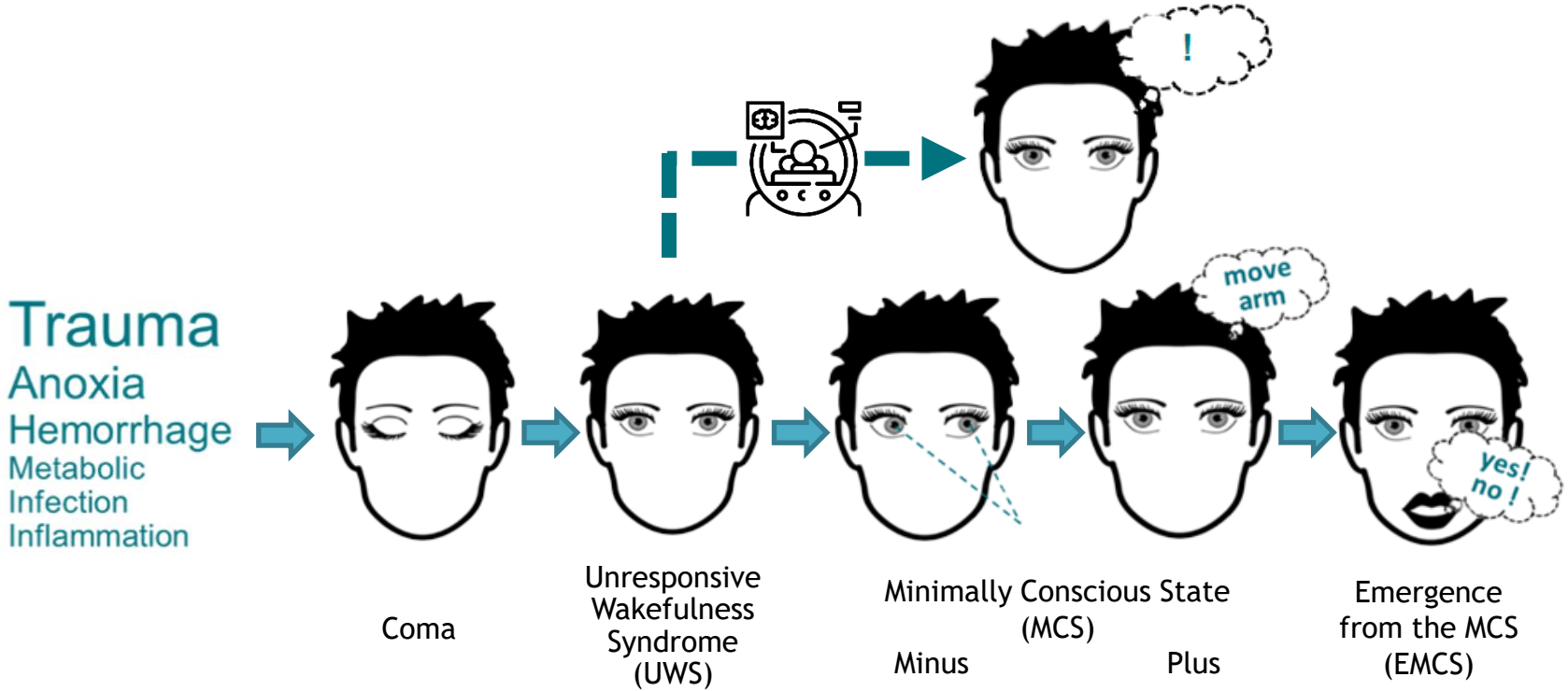
Underestimated consciousness!!!



Minimally Conscious State (MCS)
Minus Plus

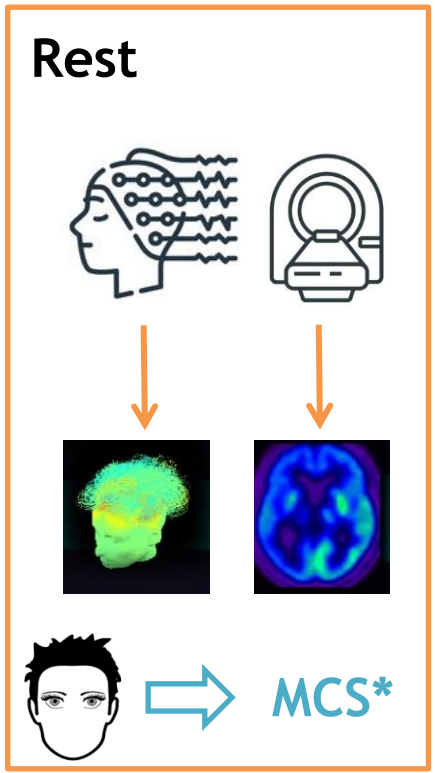
Emergence from the MCS (EMCS)

Schnakers et al., *BMC Neurol*, 2009
Schnakers et al., *NNR*, 2015



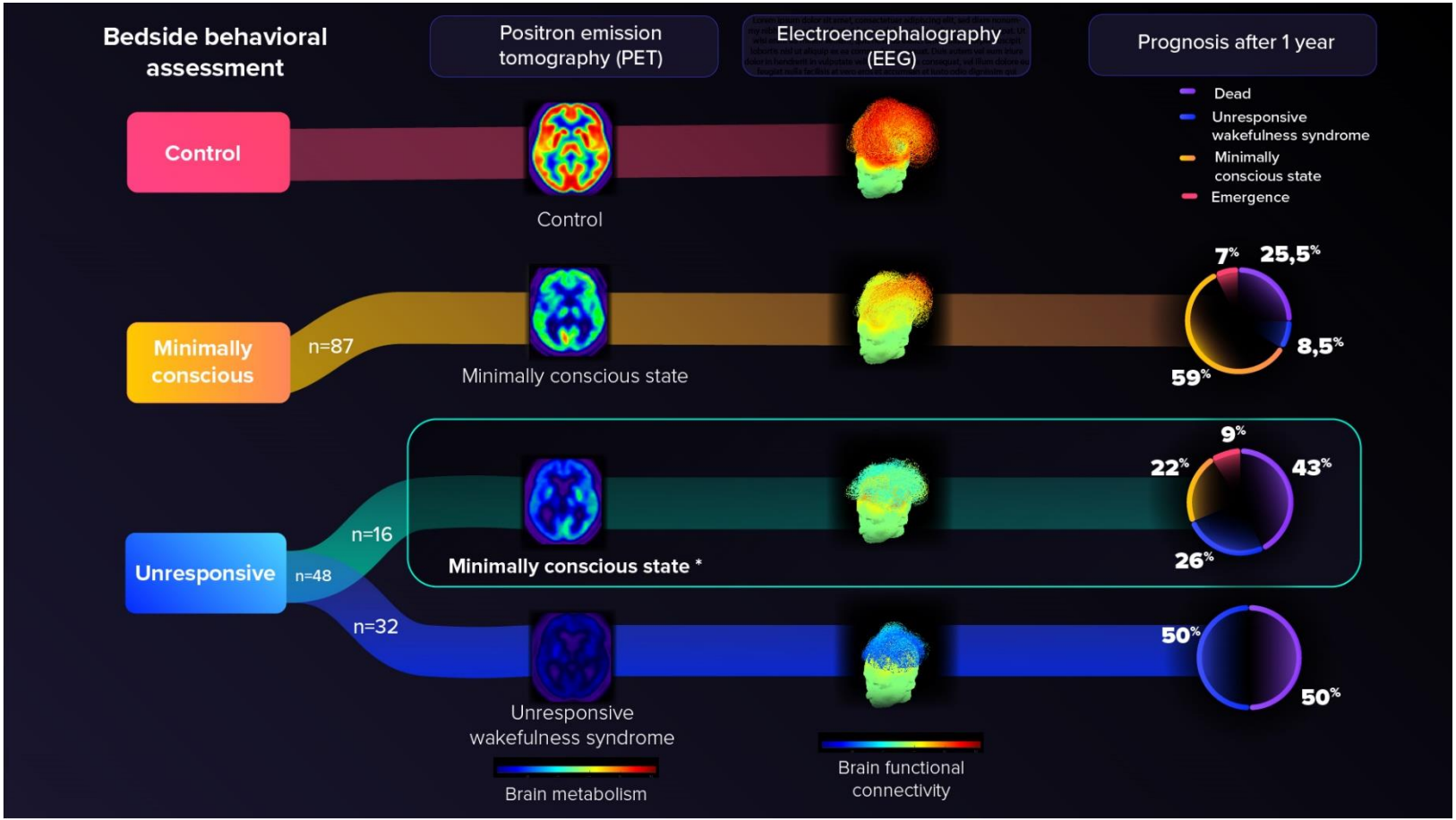
Thibaut et al. *Ann Neurol*, 2021

Detection of residual consciousness in post-comatose recovery



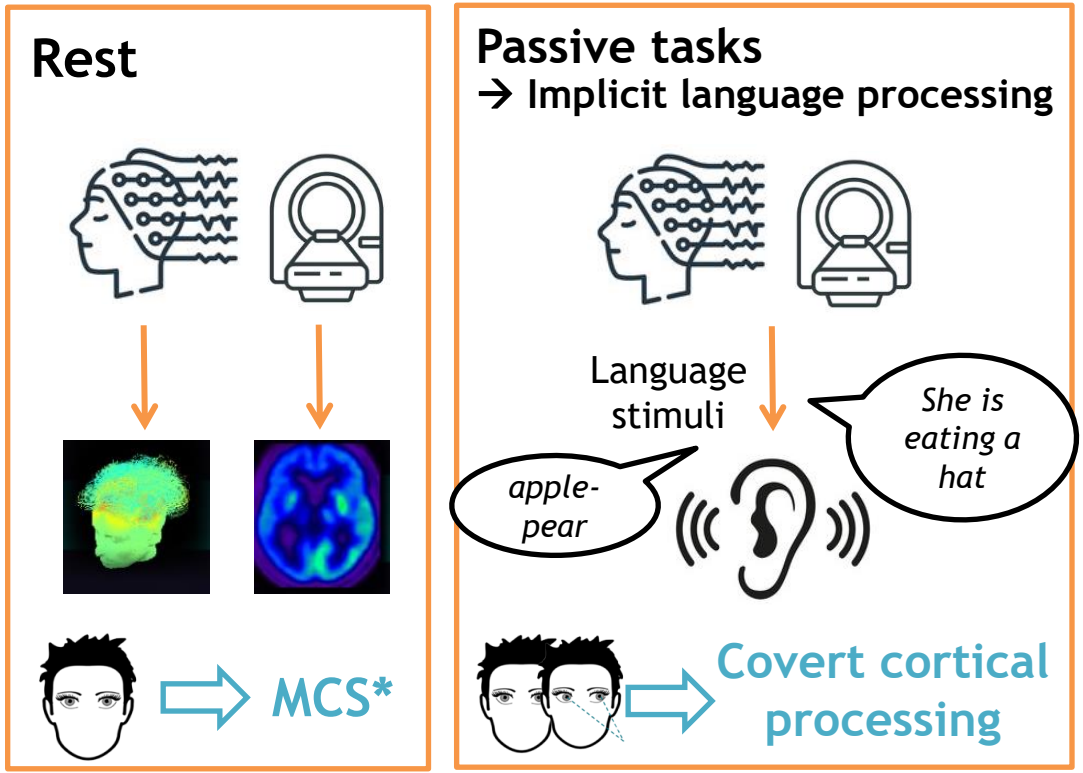
Thibaut et al. *Ann Neurol*, 2021
Aubinet et al., *Neurosci. Biobehav. Rev.*, 2022

DoC – Neuroimaging & electrophysiology – Behavioral tools – Theoretical implications



Thibaut et al. *Ann Neurol*, 2021

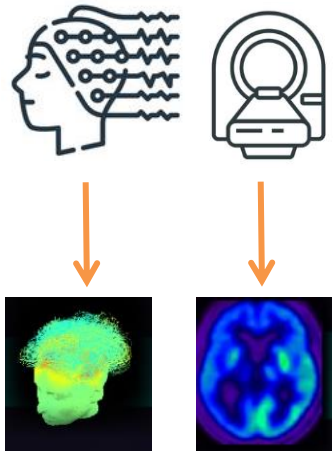
Detection of residual consciousness in post-comatose recovery



Thibaut et al. *Ann Neurol*, 2021
Aubinet et al., *Neurosci. Biobehav. Rev.*, 2022

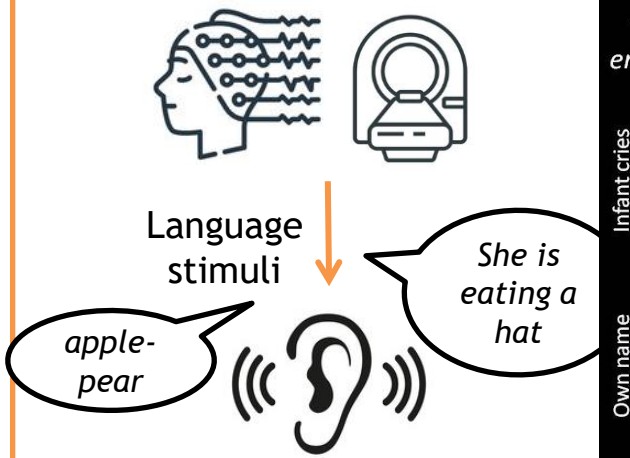
Detection of residual consciousness in post-comatose recovery

Rest

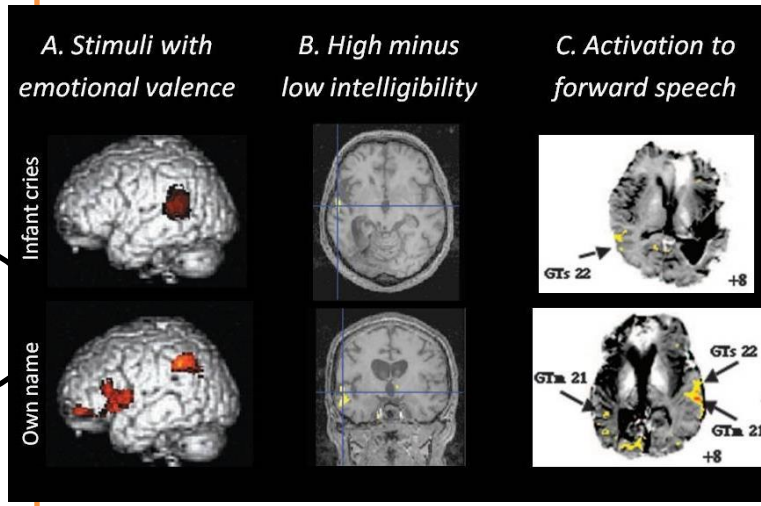


MCS*

Passive tasks
→ Implicit language processing



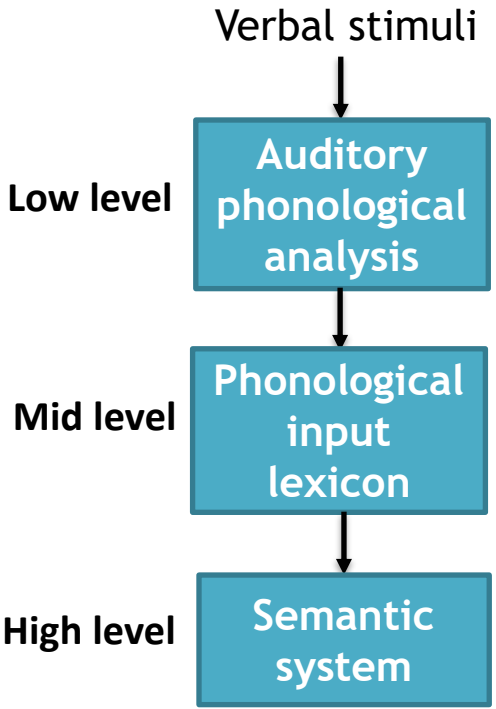
Covert cortical processing



Laureys et al., *Neurology*, 2004
Owen et al., *Neuropsychol. Rehabil.*, 2005
Schiff et al., *Neurology*, 2005
Thibaut et al. *Ann Neurol*, 2021
Aubinet et al., *Neurosci. Biobehav. Rev.*, 2022

Passive tasks and implicit language processing

Distinction of various language components



Contrasting:

Speech vs. noise

Intelligible vs. unintelligible speech
Words vs. pseudowords

Semantically related vs. unrelated words
Sentences of low vs. high ambiguity
Congruous vs. incongruous sentences
Factually correct vs. incorrect sentences

All language levels in all DoC → High level also in UWS!

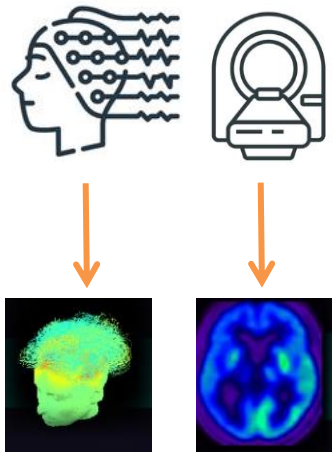
Brain response: UWS < MCS < EMCS

E.g.: Formisano et al., 2019; Kotchoubey et al., 2013; Balconi & Arangio, 2015; Kempny et al., 2018; Lechinger et al., 2016, Risetti et al., 2013, Rohaut et al.., 2015; Tomaiuolo et al., 2016; …

Patterson and Shewell (1987)

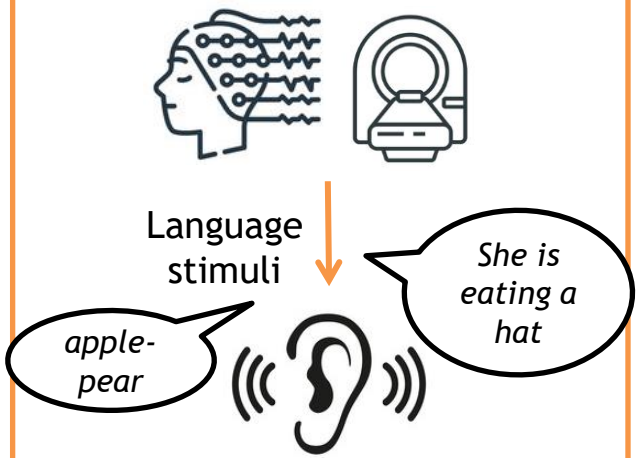
Detection of residual consciousness in post-comatose recovery

Rest



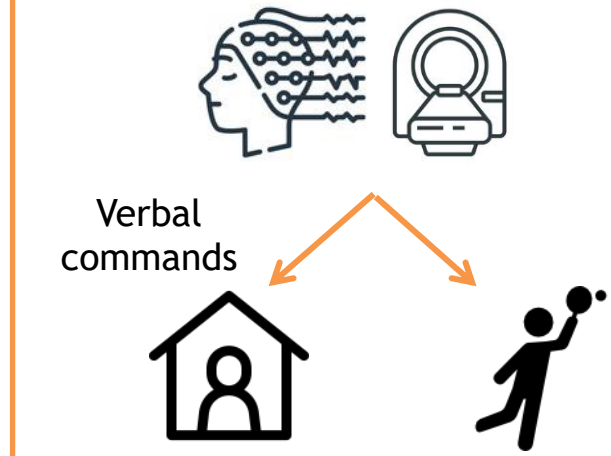
MCS*

Passive tasks
→ Implicit language processing



Covert cortical processing

Active tasks
→ Explicit language processing

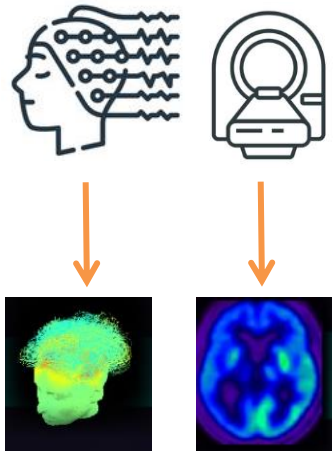


Cognitive-motor dissociation

Thibaut et al. *Ann Neurol*, 2021
Aubinet et al., *Neurosci. Biobehav. Rev.*, 2022

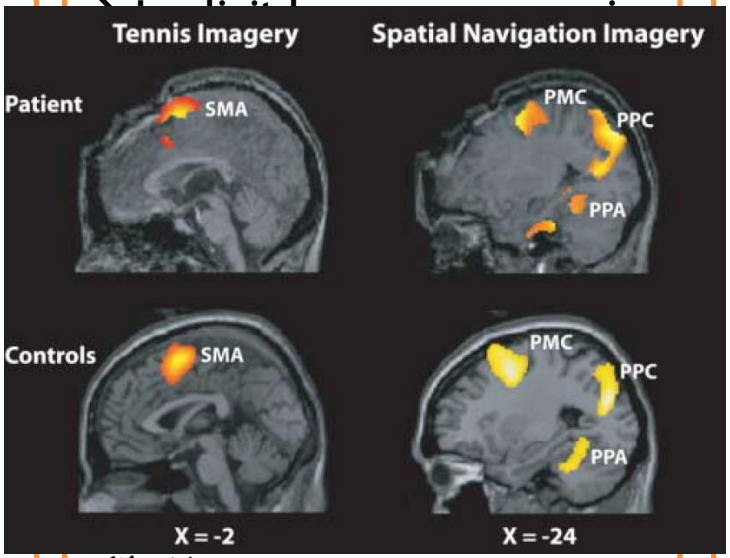
Detection of residual consciousness in post-comatose recovery

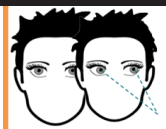
Rest



MCS*

Passive tasks



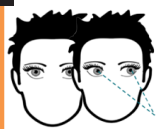


Covert cortical processing

Active tasks

→ Explicit language processing

Verbal commands



Cognitive-motor dissociation

Owen et al., *Neuropsychol. Rehabil.*, 2005
Thibaut et al. *Ann Neurol*, 2021
Aubinet et al., *Neurosci. Biobehav. Rev.*, 2022

Active tasks and explicit language processing

Covert command-following

Mental tasks

Motor imagery

- Tennis, navigation, swimming, hand moving,…

E.g.: Coleman et al., 2009; Braiman et al., 2018, Edlow et al., 2017; Bodien et al., 2017

Counting

- Subject's own name, targeted sound or word

E.g.: Hauger et al., 2015; Naci & Owen, 2013; Haug et al., 2018

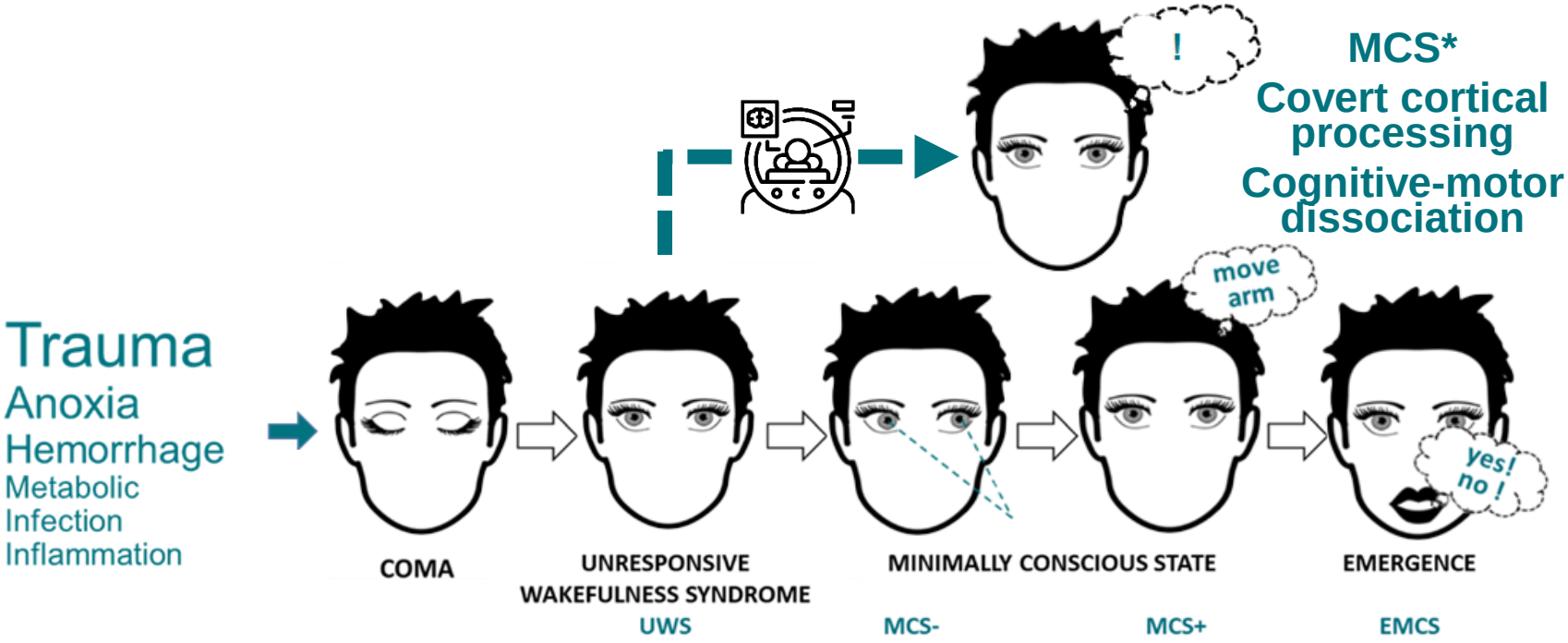
Silent picture naming

Rodriguez-Moreno et al., 2010

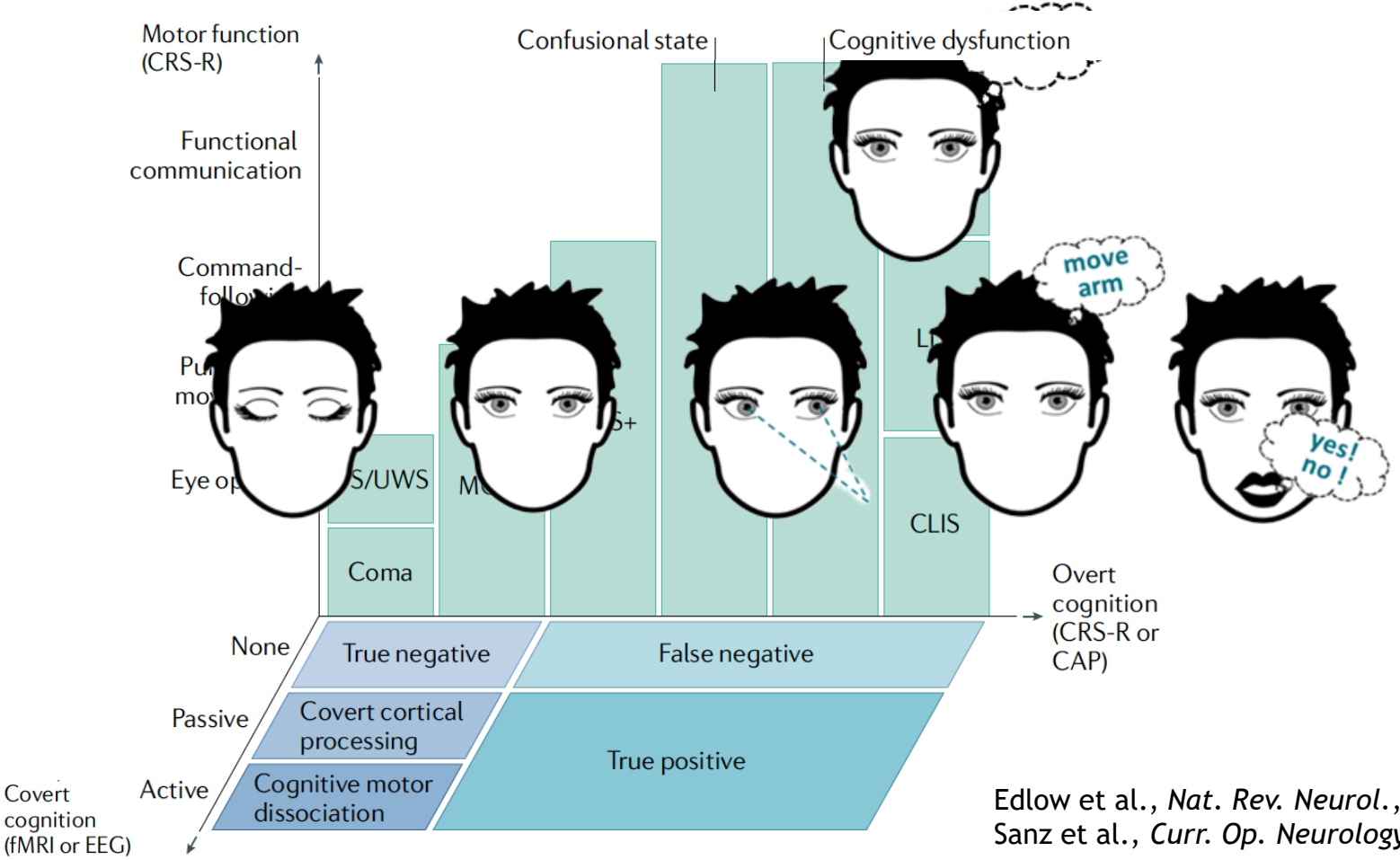
Potential residual brain response in all DoC categories

→ ~20% UWS and ~33% MCS-

= CMD!


!
MCS*
Covert cortical processing
Cognitive-motor dissociation
move arm
yes!
no !
Trauma
Anoxia
Hemorrhage
Metabolic
Infection
Inflammation
COMA
UNRESPONSIVE WAKEFULNESS SYNDROME
UWS
MINIMALLY CONSCIOUS STATE
MCS-
MCS+
EMERGENCE
EMCS

Multi-dimensional model



Edlow et al., *Nat. Rev. Neurol.*, 2020
Sanz et al., *Curr. Op. Neurology*, 2021

Behavioral scales including command-following items

Coma Recovery Scale-Revised
(CRS-R)

Simplified Evaluation of CONsciousness Disorders
(SECONDs)

…

Aubinet et al., *Brain Inj.*, 2021

Behavioral scales including command-following items

DoC diagnosis

BUT no language assessment…

→ Language components?
→ Psycholinguistic variables?

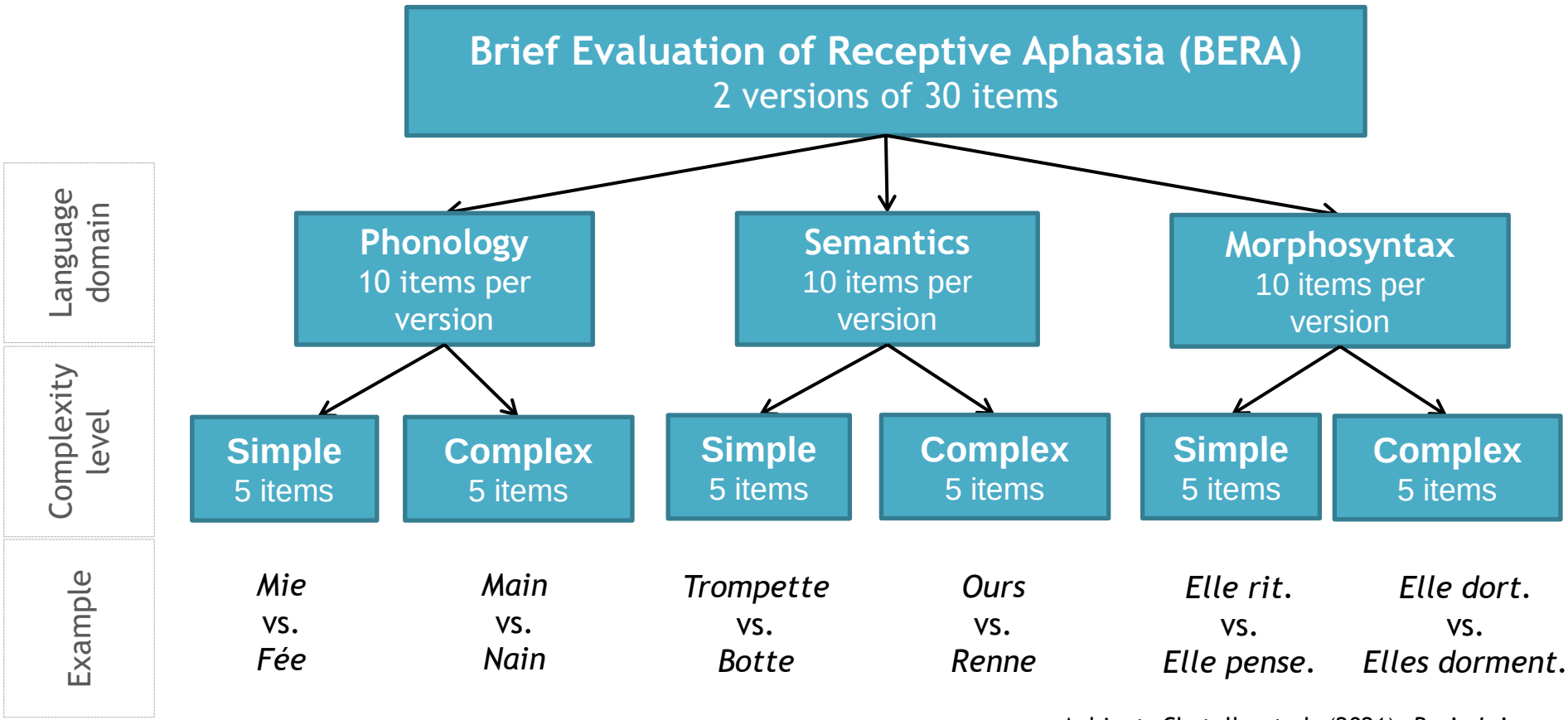
Aubinet et al., *Brain Inj.*, 2021

Towards a language-specific assessment…

***Brief Evaluation of Receptive Aphasia* (BERA)**

→ *Poster session (Pauls et al.)*

Aubinet et al., *Brain Inj.*, 2021; Aubinet et al., *in prep*



Aubinet, Chatelle et al. (2021), *Brain Injury*

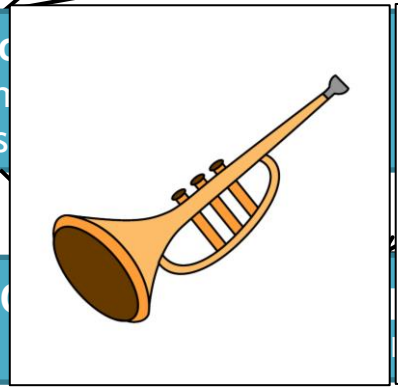
Brief Evaluation of Receptive Aphasia (BERA)
2 versions of 30 items

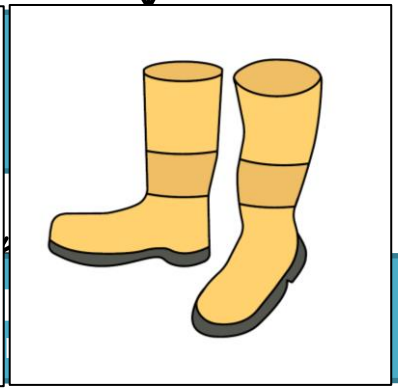
Language domain

Complexity level

Example

Phonc
10 iten
vers





Morphosyntax
10 items per version

Simple
5 items

Simple
5 items

Complex
5 items

Mie vs. *Fée*

Main vs. *Nain*

Trompette vs. *Botte*

Ours vs. *Renne*

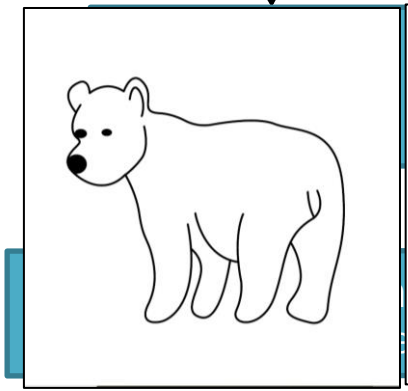
Elle rit. vs. *Elle pense.*

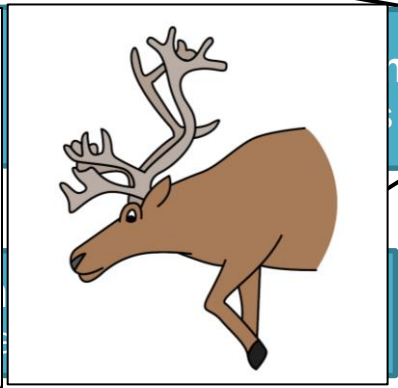
Elle dort. vs. *Elles dorment.*

Aubinet, Chatelle et al. (2021), *Brain Injury*

Brief Evaluation of Receptive Aphasia (BERA)
2 versions of 30 items

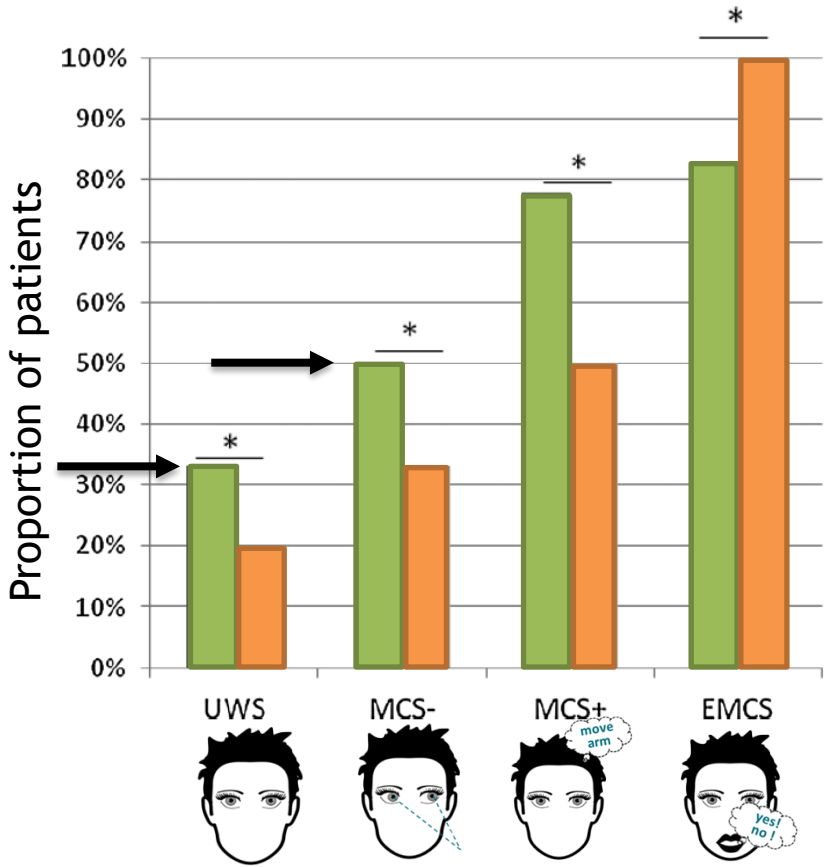
Language domain	**Phonology** 10 items per version			**…nosyntax** …s per version	
Complexity level	**Simple** 5 items	**Complex** 5 items			**Complex** 5 items
Example	*Mie* vs. *Fée*	*Main* vs. *Nain*	*Trompette* vs. *Botte*	*Ours* vs. *Renne*	*Elle rit.* vs. *Elle pense.*	*Elle dort.* vs. *Elles dorment.*





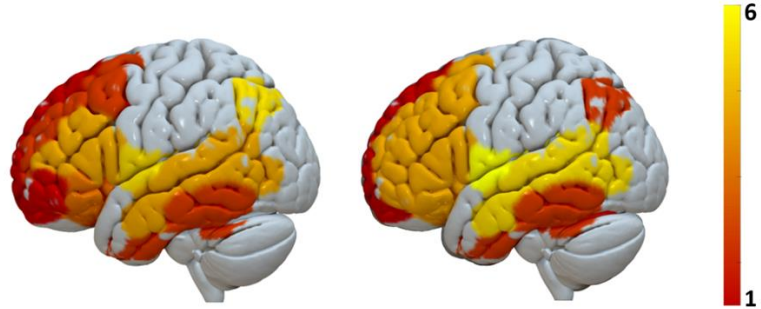
Aubinet, Chatelle et al. (2021), *Brain Injury*

Comparing both implicit and explicit language recovery



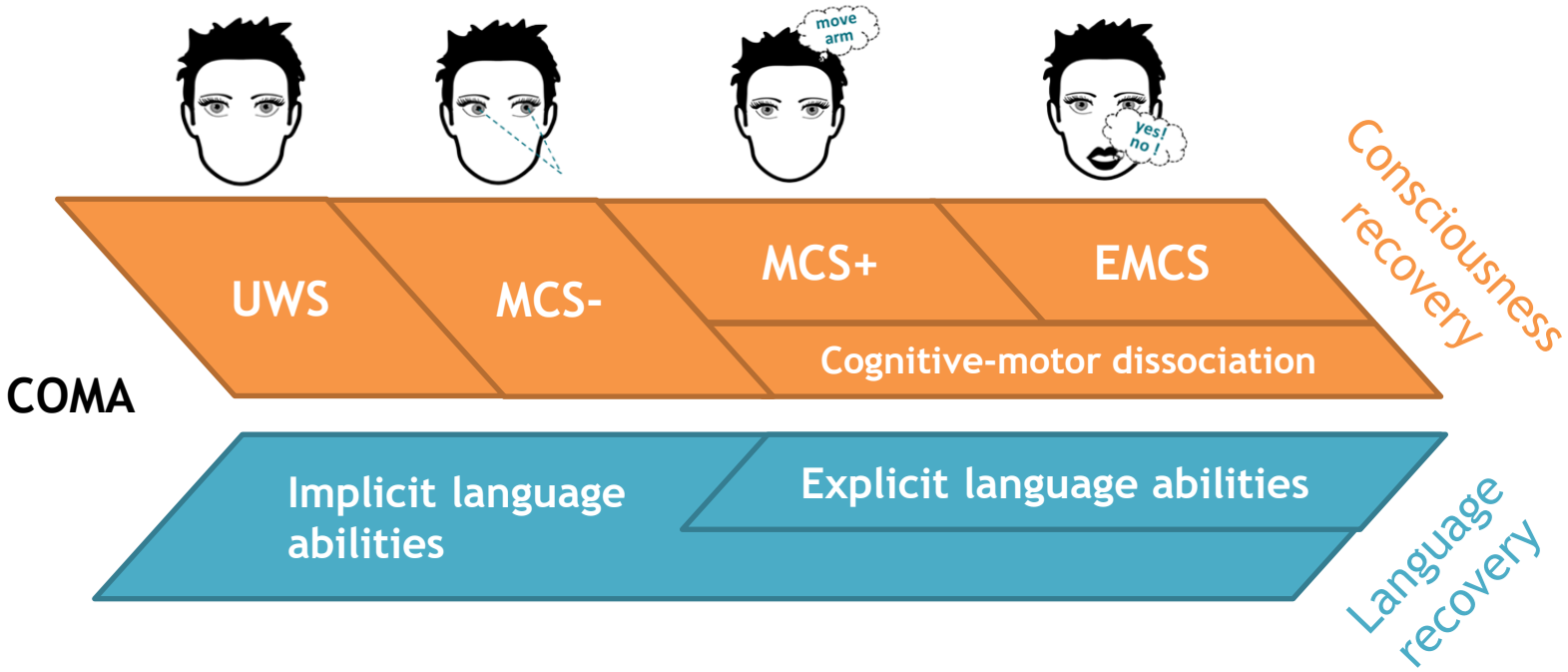
Implicit language abilities

Explicit language abilities



Aubinet et al., *Neurosci. Biobeh. Rev.*, 2022

Language recovery // consciousness recovery



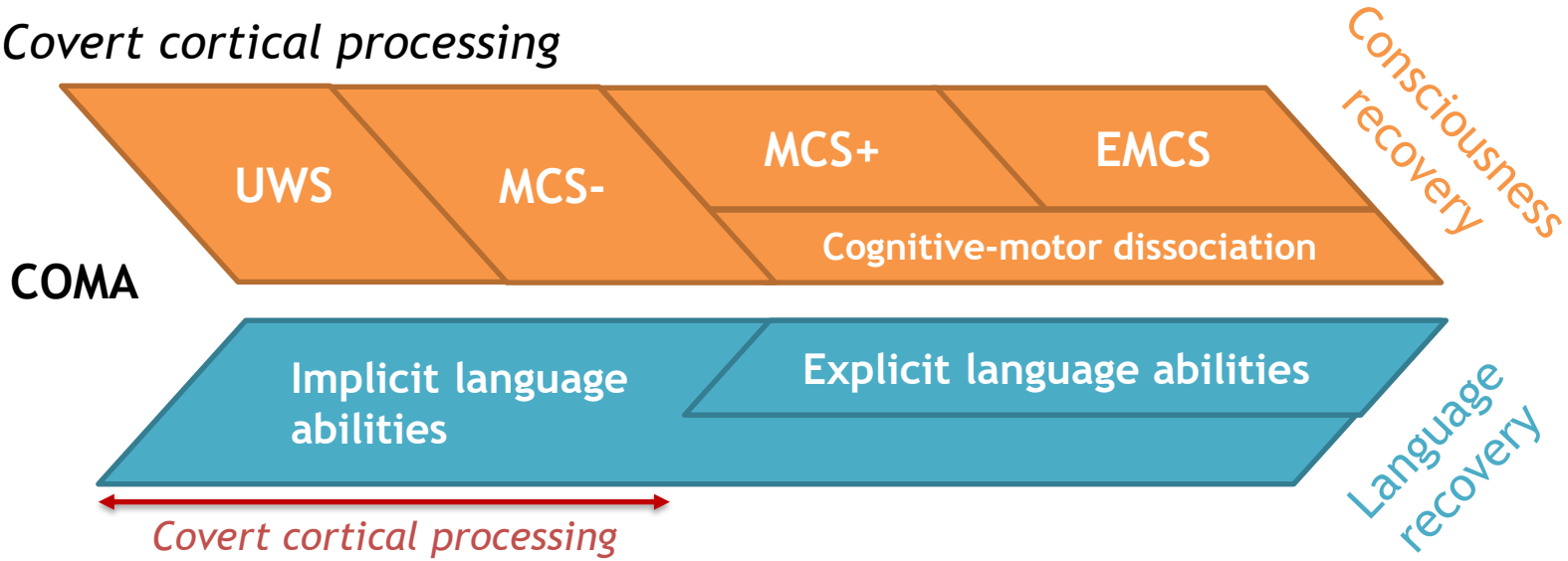
Aubinet et al., *Neurosci. Biobeh. Rev.*, 2022

Complex language processing in the absence of 'consciousness'?

DoC taxonomy?

Cognitive-motor dissociation

Covert cortical processing



UWS patients with residual brain activity reflecting semantic processing

Aubinet et al., *Neurosci. Biobeh. Rev.*, 2022
Edlow et al., *Brain*, 2017

Complex language processing in the absence of 'consciousness'?

Explicit language assessment

→ Detect **cognitive-motor dissociation** and reduce DoC misdiagnosis

Implicit language assessment

- **Covert cortical processing:** not considered in the current DoC taxonomy!
- Patients with the lowest level of consciousness can show residual brain activity reflecting complex semantic processing

→ *Is the presence of complex language processing in the absence of "consciousness" possible?*

  - First-order theories (activity in sensory areas → Consciousness) vs. higher-order theories (higher-order activity focusing on sensory activity → Consciousness) of consciousness

Melloni et al., *Science*, 2021
Edlow et al., *Brain*, 2017

Conclusion

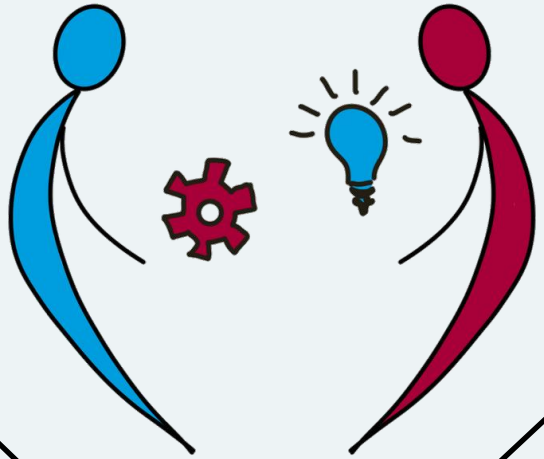
- Language assessment is crucial to avoid misdiagnosis in post-comatose patients
  - MRI – EEG
  - Need for behavioral tools → BERA assessment
- Language recovery // consciousness recovery
- Theoretical implications
  - DoC taxonomy
  - Consciousness theories
  - Language ←→ Consciousness?

caubinet@uliege.be

fnrs
FREEDOM TO RESEARCH

Psychologie & Neuroscience Cognitives
PsyNCog
Psychology & Neuroscience of Cognition

BAPS 2023



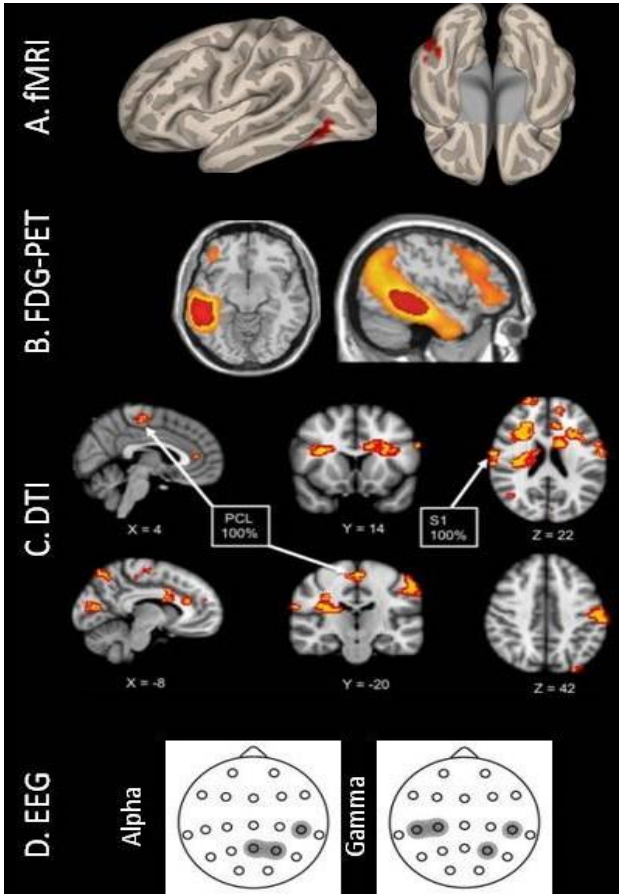
BAPS
BELGIAN ASSOCIATION FOR PSYCHOLOGICAL SCIENCES

UMONS
Université de Mons

Command-following

Neural correlates

MCS- < MCS+



Aubinet et al., *HBM*, 2018

Aubinet et al., *NNR*, 2020

Zheng et al., *HBM*, 2017

Claassen et al., *Ann Neurol*, 2016

Validity and feasibility of the BERA tool: preliminary results

1. Validation study on aphasic conscious patients (n=52)

- Concurrent validity with Language Screening Test (LAST)

  → Sensitive to language disorders
- Content validity (2 versions)
- Intra-/inter-rater reliability (α=0,919)

Aubinet, Chatelle et al. (2021), *Brain Injury*

2. BERA with eye-tracker: Delphi study (n=18)

- 100% highlight the need for such tools
- 100% consider that the use of an eye-tracker is appropriate in this context

Mazué, Aubinet et al. (2022), Master Thesis

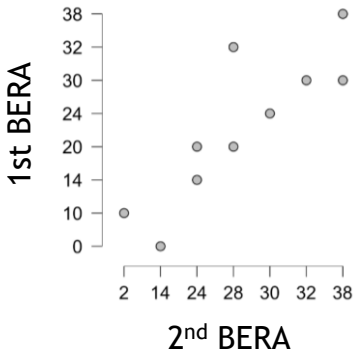
3. Ongoing validation study on DoC patients (n=10)

Aubinet et al., *in prep*

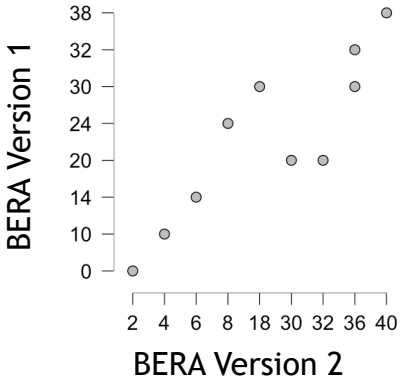
Validity and feasibility of the BERA tool: preliminary results

3. Ongoing validation study on DoC patients (n=10)

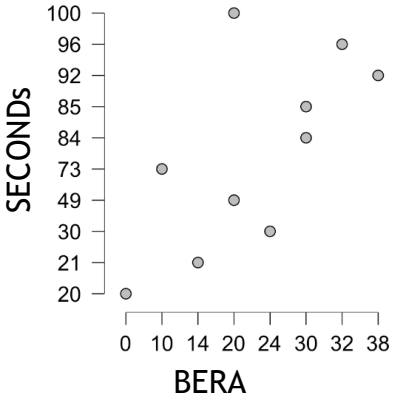
Intra-rater reliability



Content validity



Concurrent validity



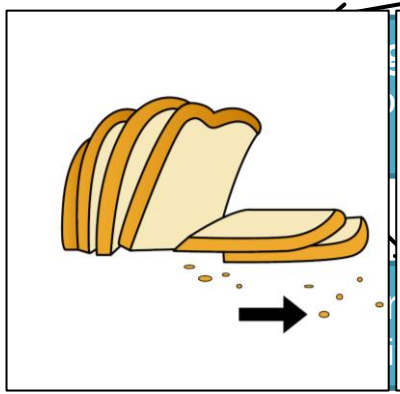
Inter-rater reliability: α = 0.989

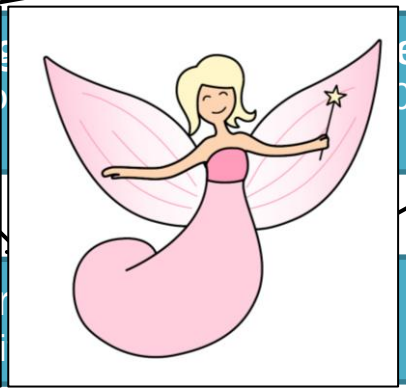
Aubinet et al., *in prep*

Elaboration of the BERA language-specific tool

Brief Evaluation of Receptive Aphasia (BERA)
2 versions of 30 items

Language domain		**emantics** 0 items per version		**Morphosyntax** 10 items per version	
Complexity level			**Complex** 5 items	**Simple** 5 items	**Complex** 5 items
Example	*Mie* vs. *Fée*	*Main* vs. *Nain*	*Trompette* vs. *Botte*	*Ours* vs. *Renne*	*Elle rit.* vs. *Elle pense.*	*Elle dort.* vs. *Elles dorment.*



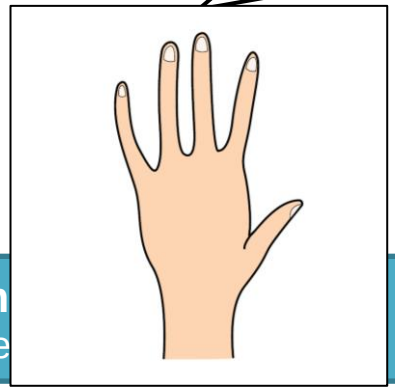


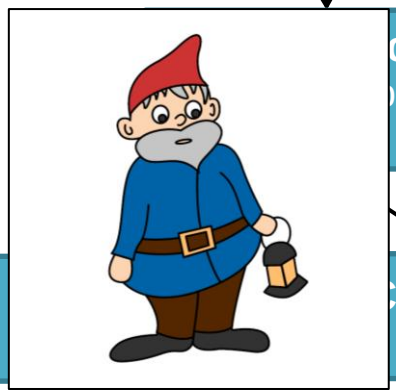
Aubinet, Chatelle et al. (2021), *Brain Injury*

Elaboration of the BERA language-specific tool

Brief Evaluation of Receptive Aphasia (BERA)
2 versions of 30 items

Language domain	Complexity level	Example
		Mie vs. *Fée*
		Main vs. *Nain*
		Trompette vs. *Botte*
	cs …er **Complex** 5 items	*Ours* vs. *Renne*
Morphosyntax 10 items per version	**Simple** 5 items	*Elle rit.* vs. *Elle pense.*
	Complex 5 items	*Elle dort.* vs. *Elles dorment.*





Aubinet, Chatelle et al. (2021), *Brain Injury*

Elaboration of the BERA language-specific tool

Brief Evaluation of Receptive Aphasia (BERA)
2 versions of 30 items

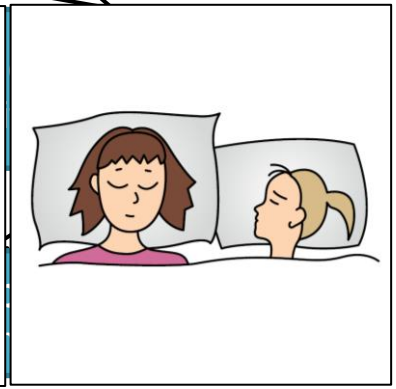
Language domain	**Phonology** 10 items per version					**ax** sion
Complexity level	**Simple** 5 items	**Complex** 5 items	**Simp** 5 item			**mplex** items
Example	*Mie* vs. *Fée*	*Main* vs. *Nain*	*Trompette* vs. *Botte*	*Ours* vs. *Renne*	*Elle rit.* vs. *Elle pense.*	*Elle dort.* vs. *Elles dorment.*

Aubinet, Chatelle et al. (2021), *Brain Injury*

Elaboration of the BERA language-specific tool

Brief Evaluation of Receptive Aphasia (BERA)
2 versions of 30 items

Language domain	**Phonology** 10 items per version		**Semant** 10 items version			
Complexity level	**Simple** 5 items	**Complex** 5 items	**Simple** 5 items			
Example	*Mie* vs. *Fée*	*Main* vs. *Nain*	*Trompette* vs. *Botte*	*Ours* vs. *Renne*	*Elle rit.* vs. *Elle pense.*	*Elle dort.* vs. *Elles dorment.*



Aubinet, Chatelle et al. (2021), *Brain Injury*