Assessing language function in severely brain-injured patients – BERA

Charlène AUBINET

DoCBox Days – May 24th, 2024

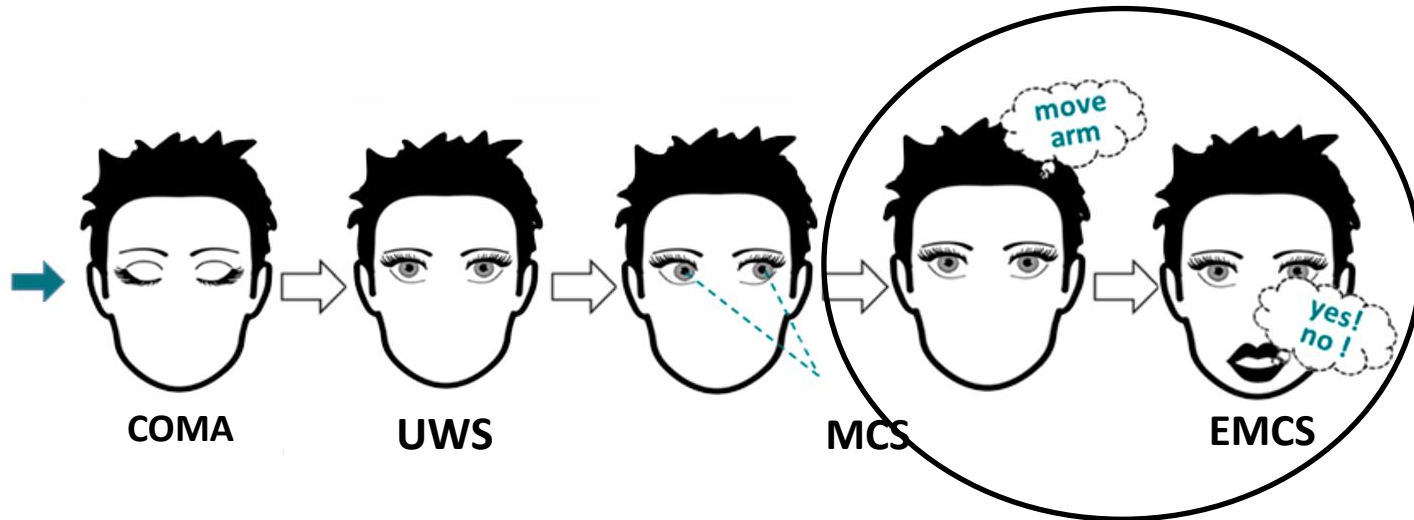DOC-BOX

Overview

1. Residual language abilities in DoC patients

Recovery of language abilities after coma

Command-following
Intelligible verbalization
Communication

Trauma
Anoxia
Hemorrhage
Metabolic
Infection
Inflammation
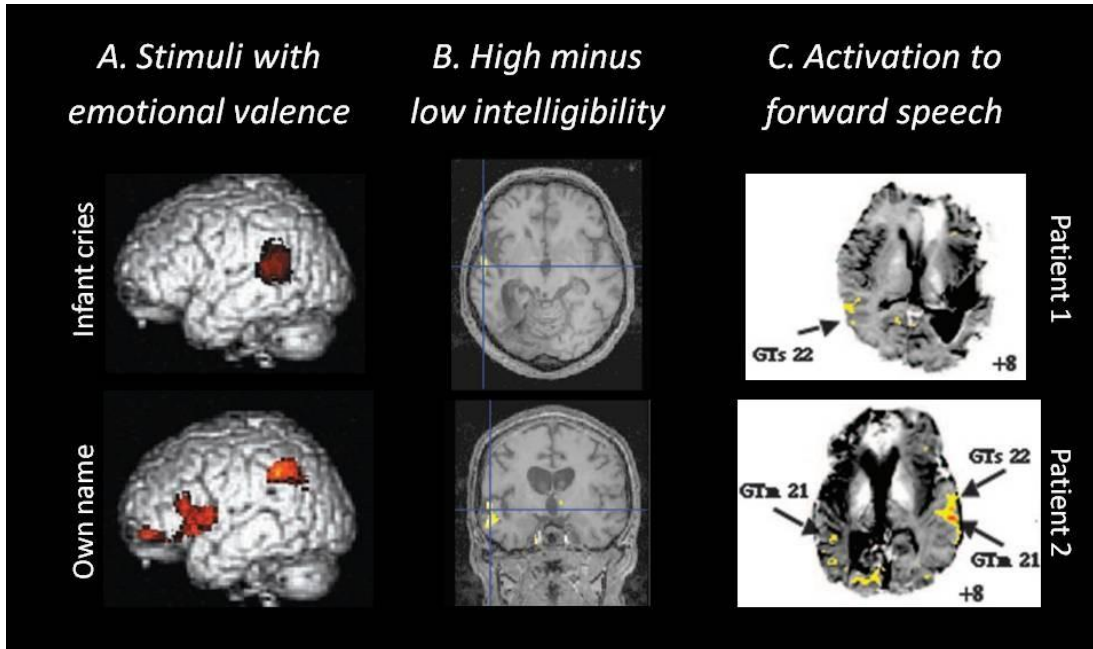
COMA

UWS

MCS

move arm

yes! no !

EMCS

Thibaut et al. Annals of Neurol., 2021
Sanz et al., *Rev. Neuropsychol.*, 2018
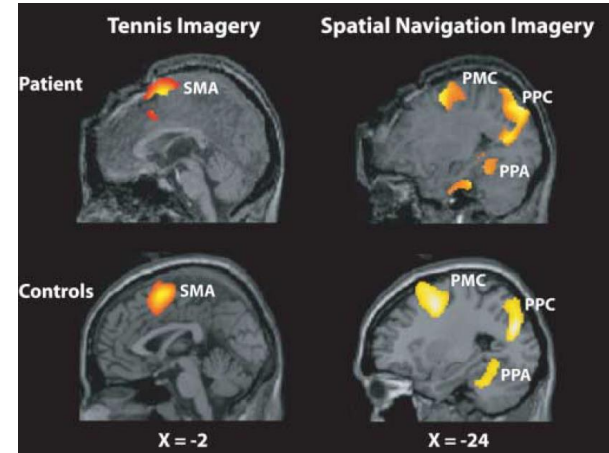Giacino et al., *Neurology*, 2002

First insights of residual language skills in MCS patients
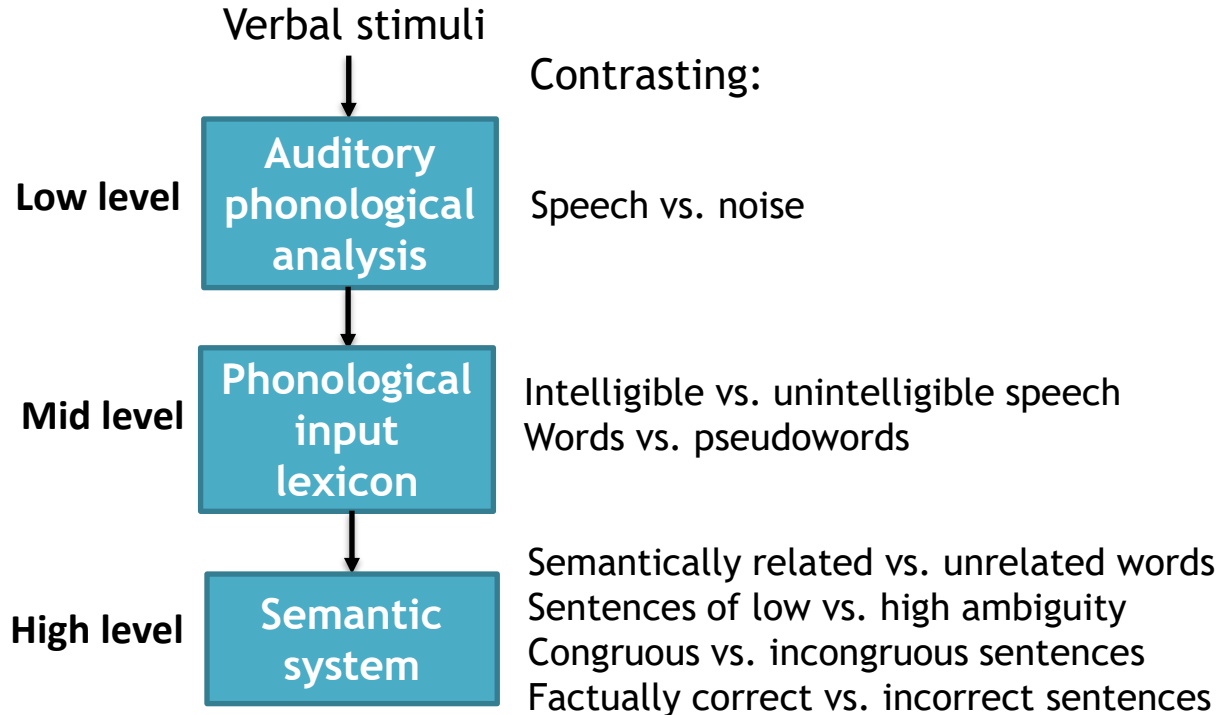
Passive tasks

Active tasks

Laureys et al., *Neurology*, 2004
Owen et al., *Neuropsychol. Rehabil.*, 2005
Schiff et al., *Neurology*, 2005

Passive tasks and detection of residual language

Distinction of various language components

Verbal stimuli

Contrasting:

Low level — Auditory phonological analysis — Speech vs. noise

Mid level — Phonological input lexicon — Intelligible vs. unintelligible speech / Words vs. pseudowords

High level — Semantic system — 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)

Active tasks and detection of residual language

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

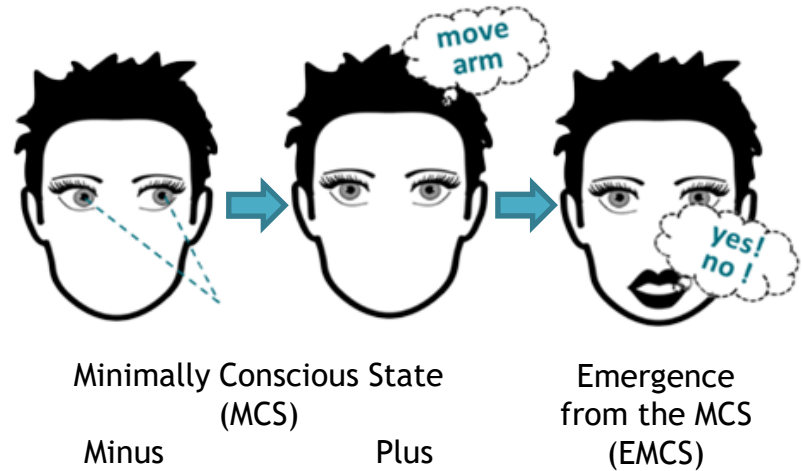→ ~20% UWS and ~33% MCS-

= CMD!

2. Why to assess language in these patients?

30-40% risk of DoC misdiagnosis

**Deafness
Blindess
Motor impairment
Aphasia
...**

**Underestimated
consciousness!!!**

Minimally Conscious State (MCS)

Minus

Plus

Emergence from the MCS (EMCS)

move arm

yes! no !

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

Language impairment after brain injury

Damage in language brain areas

Hickok & Poeppel (2004)
Saur et al. (2010)
Knecht et al. (2000)
Szafkarsju et al. (2002)
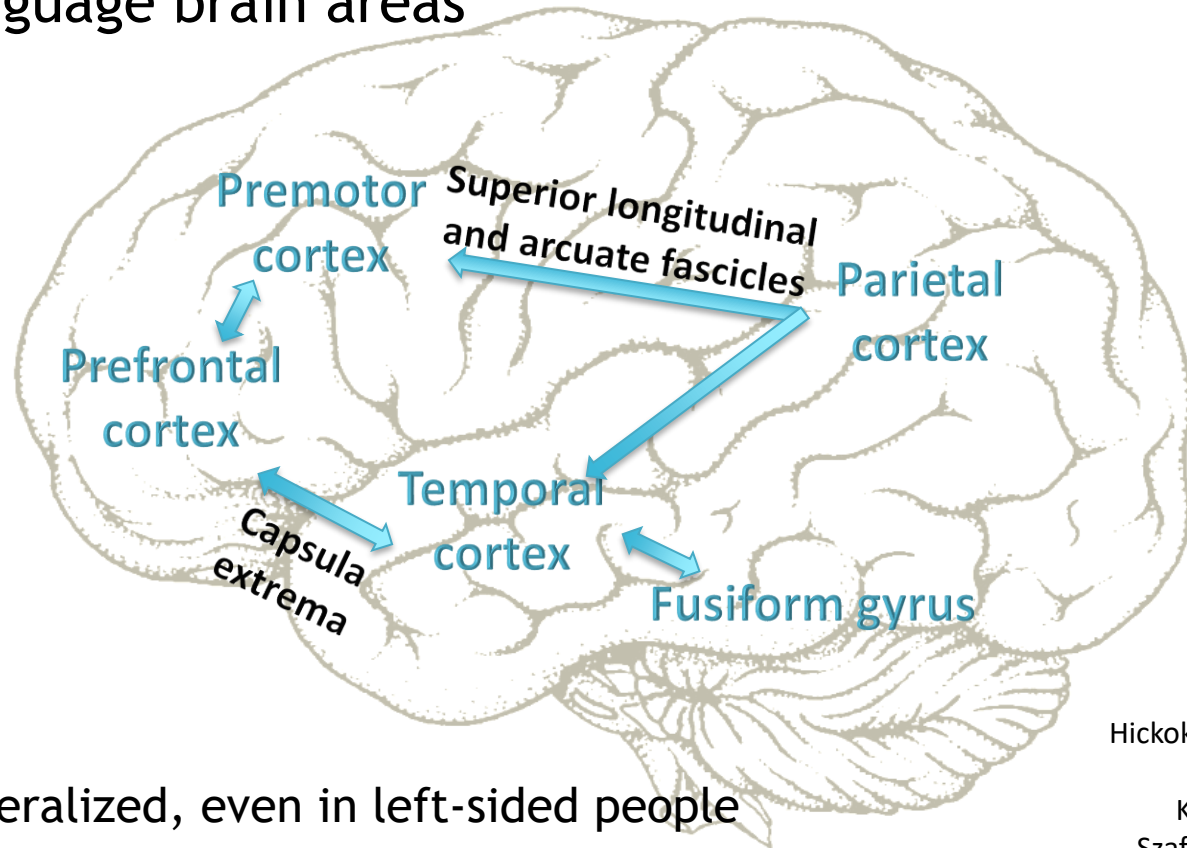
→ Mostly left-lateralized, even in left-sided people

Language impairment after severe brain injury

Post-comatose language disorders	→	Impaired comprehension of verbal commands	→	Underestimation of consciousness level

24 conscious aphasic patients

→ CRS-R administration

→ 54% of patients with global aphasia: diagnosis = MCS!
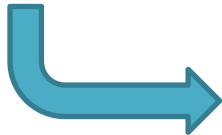
Crucial need to detect the presence of language deficits in post-comatose patients with DoC, despite their limited behavioral repertoire

Schnakers et al. (2015), *Neurorehabilitation and Neural Repair*
Majerus et al. (2009), *Progress in Brain Research*

Need to develop new behavioral language assessment tools

Aubinet, Schnakers & Majerus (2022), *Seminars in Neurology*
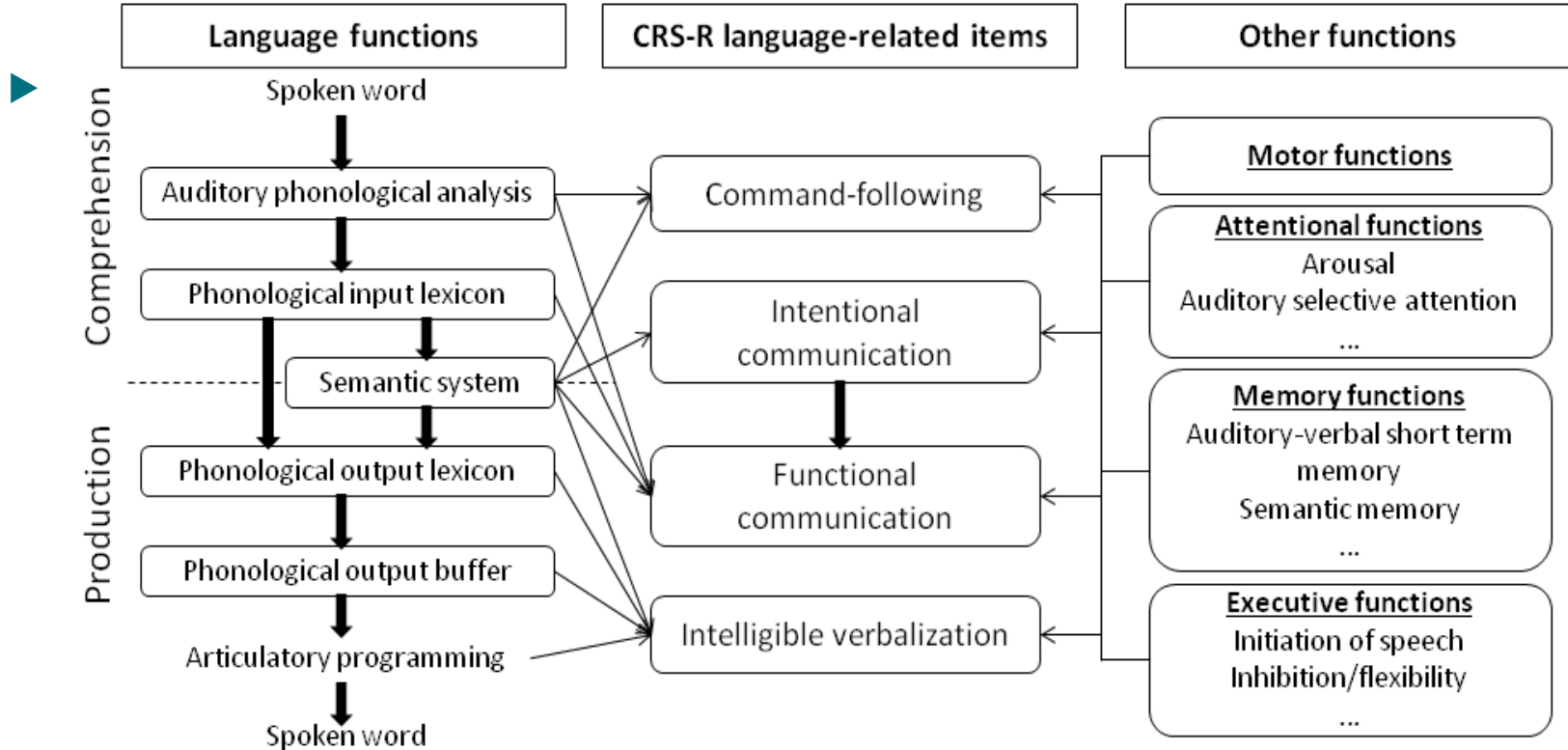
3. Elaboration of the BERA
(Brief Evaluation of Receptive Aphasia)

Elaboration of the BERA language-specific tool

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						

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.
Pantalon

Ours
vs.
Renne

Elle rit.
vs.
Elle pense.

Elle dort.
vs.
Elles dorment.

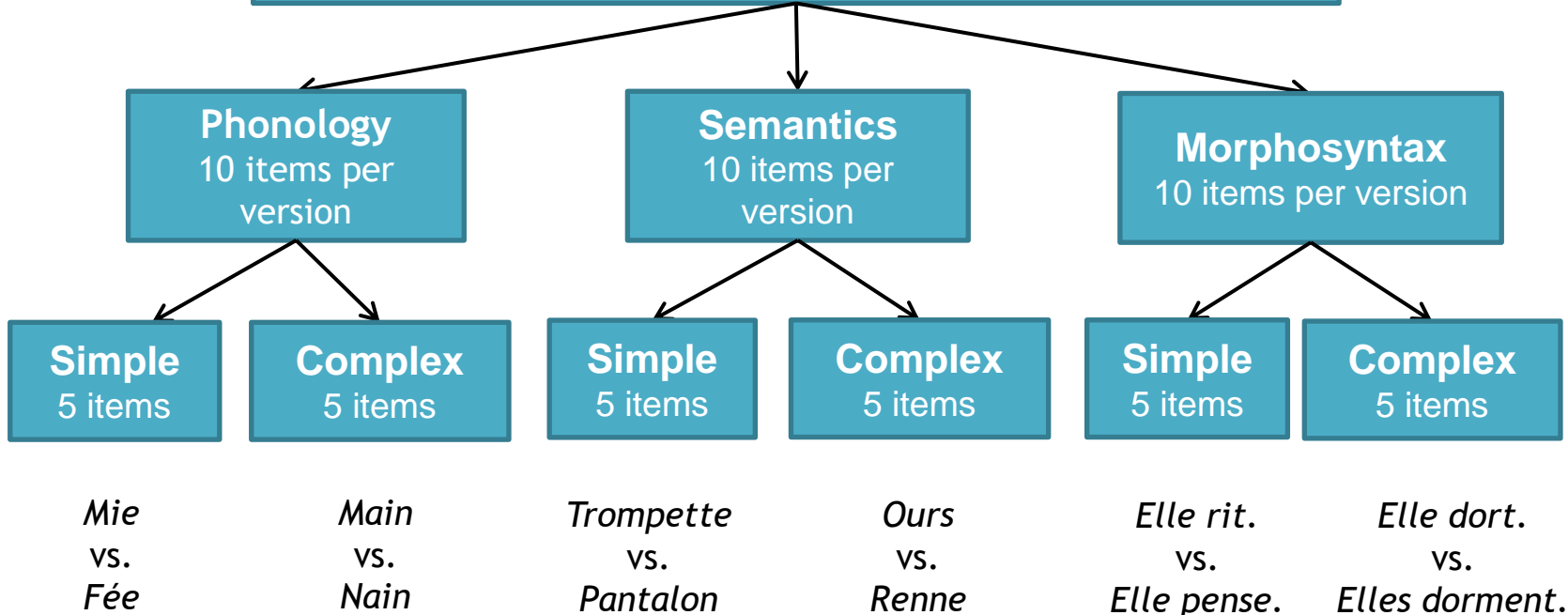Aubinet, Chatelle et al. (2021), *Brain Injury*

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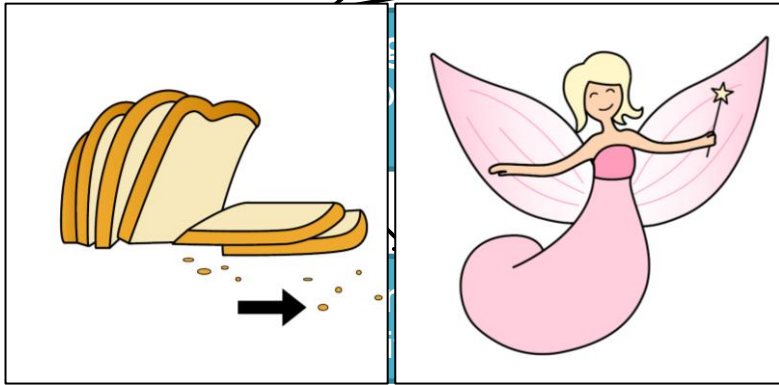
Language domain

Complexity level

Example

Sim
5 ite

Morphosyntax
10 items per version

Complex
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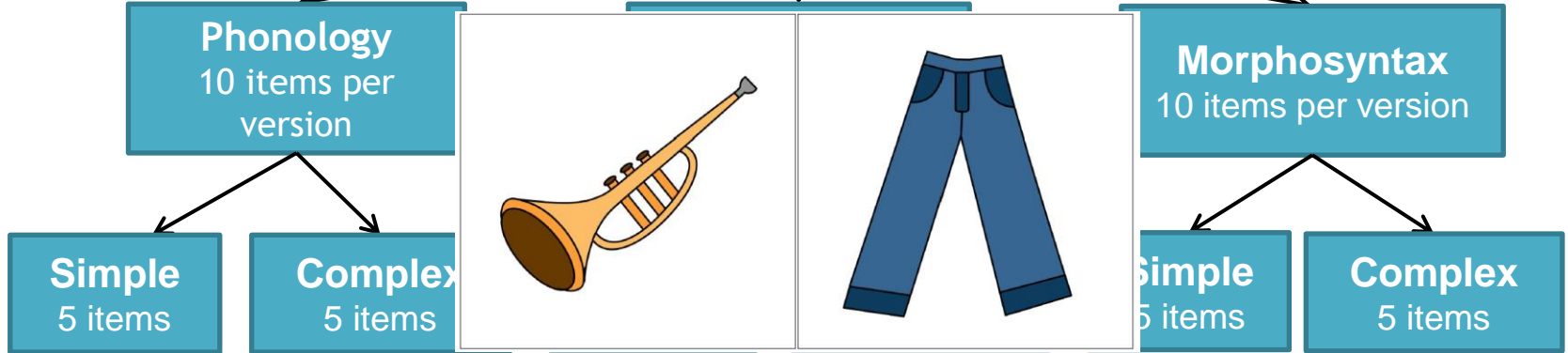*Elles dorment.*

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

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

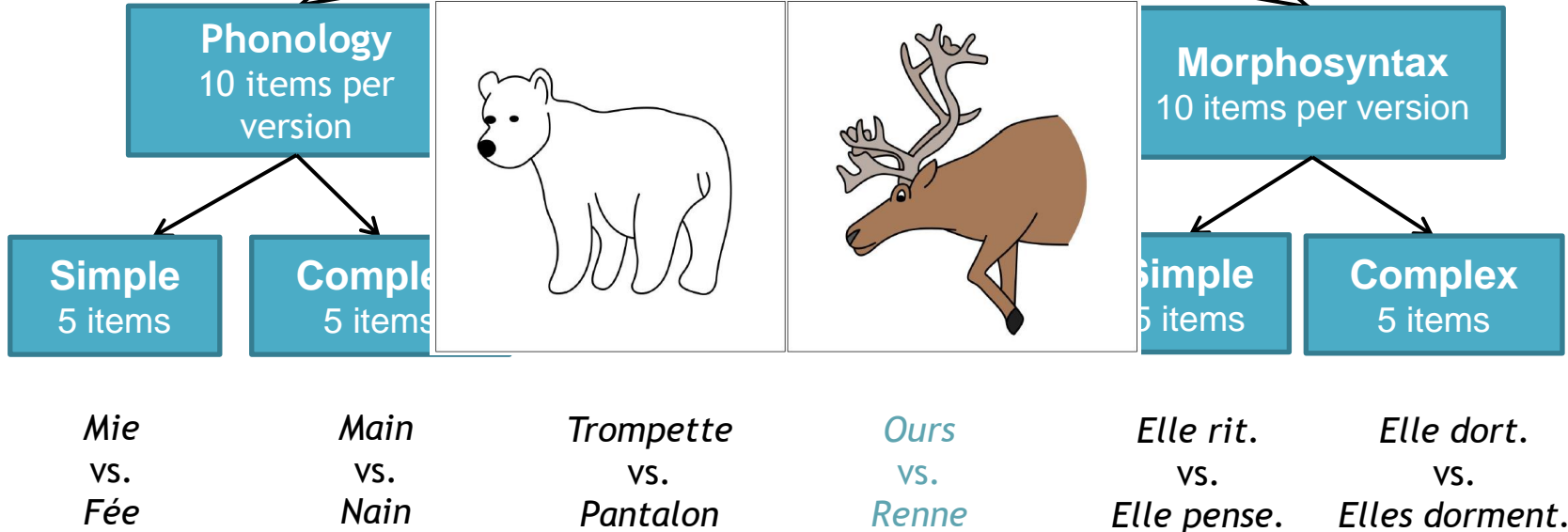# Elaboration of the BERA language-specific tool

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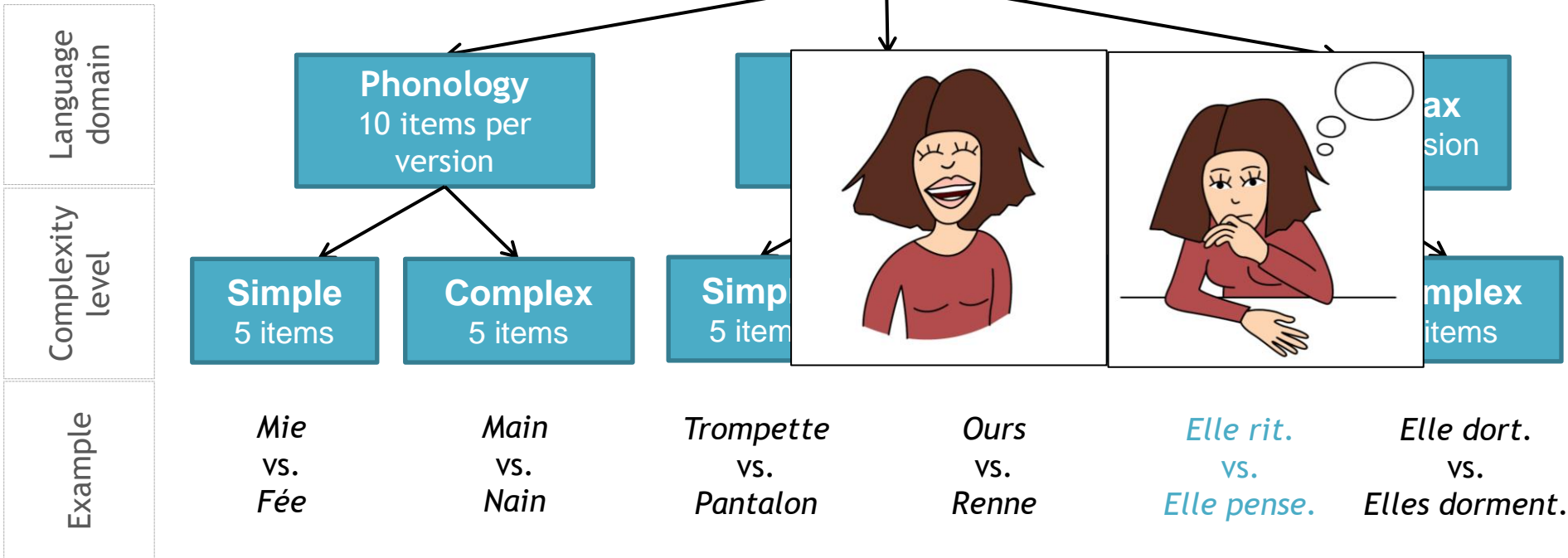2 versions of 30 items

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5 items

Complex
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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

Semanti...
10 items ...version

Complexity level

Simple
5 items

Complex
5 items

Simple
5 items

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Mie
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Ours
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Renne

Elle rit.
vs.
Elle pense.

Elle dort.
vs.
Elles dorment.

Version 1

PHONOLOGIE

1	**Mie**	Fée	
2	**Vent**	Chat	
3	**Mat**	Rond	
4	Quille	**Fût**	
5	Veau	**Bond**	
6	Paon	**Champ**	
7	Nain	**Main**	
8	**Chou**	Sous	
9	**Riz**	Rat	
10	Pont	**Pas**	
Gauche /5		Simples /5	
Droite /5		Complexes /5	
TOTAL		/10	

SEMANTIQUE

1	**Trompette**	Pantalon	F+
2	Chaise	**Bottes**	F+
3	**Ceinture**	Assiette	F+
4	**Renne**	Gaufre	F-
5	**Ananas**	Râteau	F-
6	Œil	**Oreille**	F+
7	**Chèvre**	Biche	F+
8	Cactus	**Tulipe**	F-
9	Ciseaux	**Scie**	F-
10	Cabane	**Igloo**	F-
	Gauche /5	F+ /5	Simples /5
	Droite /5	F- /5	Complexes /5
	TOTAL		/10

MORPHOSYNTAXE

1	Elle rit.	**Elle pense.**
2	Nicolas est triste.	**Nicolas est joyeux.**
3	**La fille mange une pomme.**	La fille pèle une poire.
4	Il apporte sa valise.	**Il caresse son chat.**
5	**Elles regardent la télévision.**	Elles regardent des photos.
6	**Le garçon est suivi par le chien.**	Le garçon suit le chien.
7	Le chat mord le chien.	**Le chien mord le chat.**
8	**Elle dort.**	Elles dorment.
9	**Le chien est derrière la maison.**	Le chien est devant la maison.
10	Tous les chats sont gris.	**Certains chats sont gris.**
Gauche /5		Simples /5
Droite /5		Complexes /5
TOTAL		/10

Version 2

PHONOLOGIE

1	**Main**	Paon	
2	**Chou**	Nain	
3	Pont	**Riz**	
4	Rat	**Champ**	
5	**Pas**	Sous	
6	Quille	**Mie**	
7	Fée	**Fût**	
8	**Bond**	Rond	
9	**Mat**	Chat	
10	Veau	**Vent**	
Gauche /5		Simples /5	
Droite /5		Complexes /5	
TOTAL		/10	

SEMANTIQUE

1	**Oreille**	Voiture	F+
2	Talon	**Chèvre**	F+
3	**Tulipe**	Loupe	F+
4	**Scie**	Crabe	F-
5	**Igloo**	Marron	F-
6	Guitare	**Trompette**	F+
7	**Bottes**	Chaussons	F+
8	Echarpe	**Ceinture**	F-
9	Ours	**Renne**	F-
10	Cerises	**Ananas**	F-
Gauche /5	F+ /5	Simples /5	
Droite /5	F- /5	Complexes /5	
TOTAL		/10	

MORPHOSYNTAXE

1	Emilie pleure.	**Emilie court.**	
2	Il est fâché.	**Il est content.**	
3	**Le garçon porte un manteau.**	Le garçon met ses chaussures.	
4	Elle attend le bus.	**Elle nourrit son chat.**	
5	**Elles écrivent une lettre.**	Elles écrivent au tableau.	
6	**L'homme est soigné par la femme.**	L'homme soigne la femme.	
7	Le chien tire l'enfant.	**L'enfant tire le chien.**	
8	**Elle lit.**	Elles lisent.	
9	**Le chat est sur la chaise.**	Le chat est sous la chaise.	
10	Le bébé a reçu peu de peluches.	**Le bébé a reçu beaucoup de peluches.**	
Gauche /5		Simples /5	
Droite /5		Complexes /5	
TOTAL		/10	

Administration of the BERA tool

- ▶ The patient is asked to look at the target that is pronounced aloud
  - E.g. : « Look at the trumpet »
  - Phonology: do not pronounce « the » (*le/la*) in French

- ▶ Word comprehension (= phonology and semantics) then sentence comprehension **if** the patient succeeds at least for half of targets

- ▶ Drowsiness: apply auditory or tactile stimulations, and postpone the assessment if needed

- ▶ Stop criterion : no visual fixation (either correct or incorrect) for 5 consecutive items

Scoring of the BERA tool

► For each item, indicate whether the fixation was:
- Correct (C)
- Incorrect (E) = towards the distractor
- Hesitant (H) = from one image to the other one
- Random (A) = elsewhere, anywhere

► Word comprehension /20
- Phonology /10 (simple /5 vs. complex /5)
- Semantics /10 (simple /5 vs. complex /5 + frequent /5 vs. non-frequent /5)
→ Targets on the left /10 vs. on the right /10

► Sentence comprehension (if the patient previously correctly looked at half of targets) → Total /30
- Morphosyntax /10 (simple /5 vs. complex /5)
→ Targets on the left /15 vs. on the right /15

4. Validation of the BERA
(Brief Evaluation of Receptive Aphasia)

Pre-validation of the BERA tool
→ Aphasic conscious patients

DAY 1

LAST*
(Assessor 1)

40-100 min

Concurrent validity

BERA
(Assessor 2)

Intra-rater reliability (test-retest)

DAY 2

BERA
(Assessor 2)

Inter-rater reliability

BERA
(Assessor 3)

Randomized order
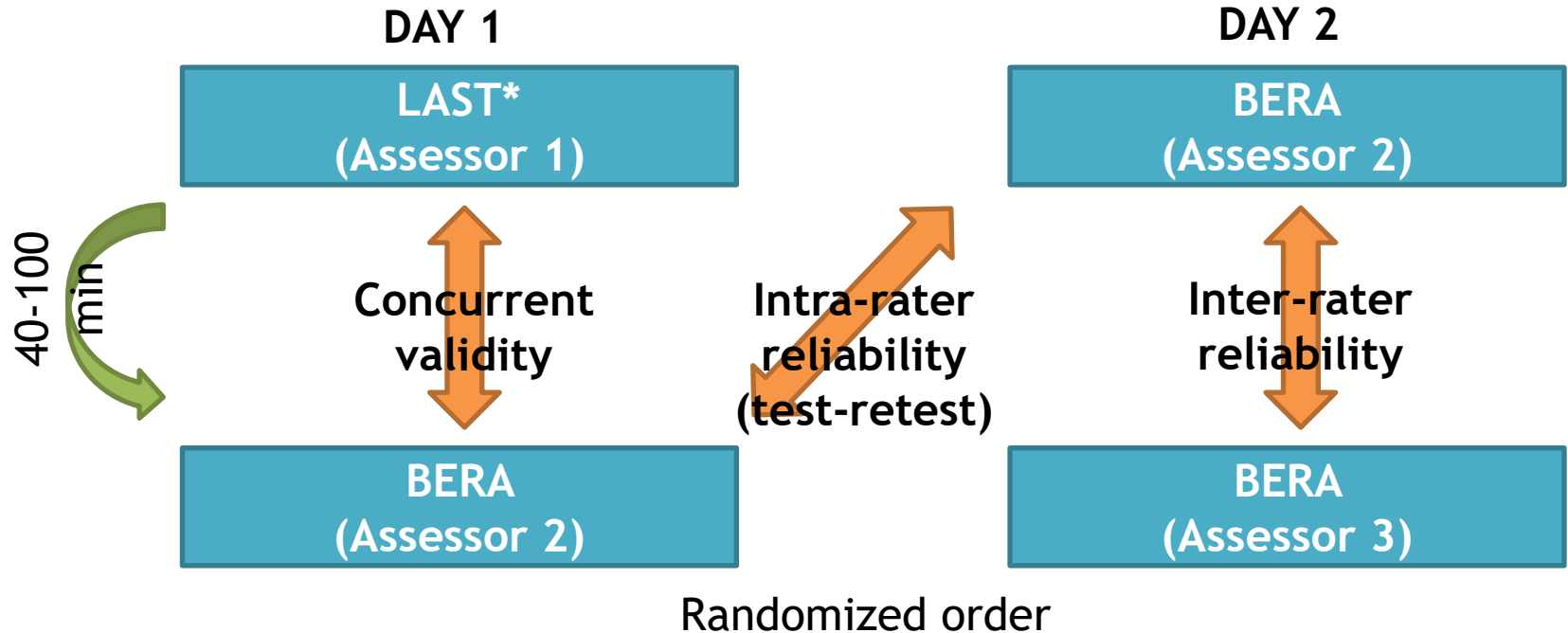
* Language Screening Test

Pre-validation of the BERA tool
→ Aphasic conscious patients (n=52)

Content validity

	V1	V2	V3
V2	r = 0,858* p = 0,003	/	/
V3	r = 0,945* p < 0,001	r = 0,833* p = 0,020	/
V4	r = 0,677* p = 0,045	r = 0,935* p < 0,001	r = 0,670* p = 0,049

Concurrent validity
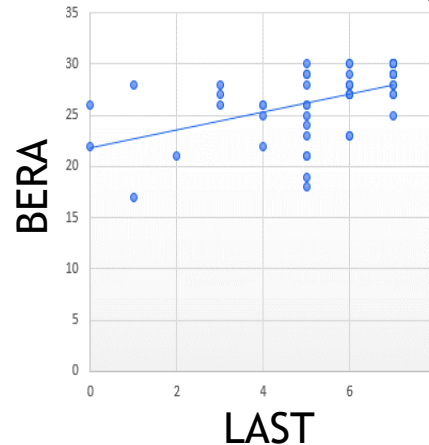
Intra-rater reliability
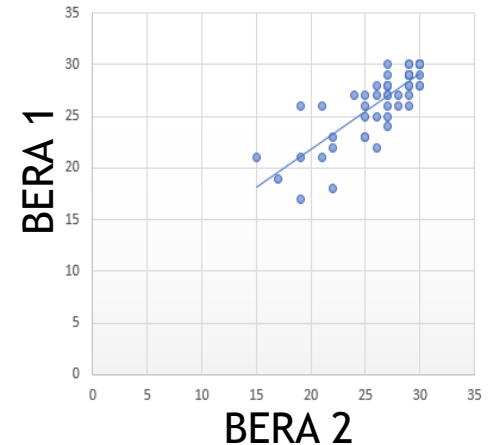
Inter-rater reliability: α=0,919*

Pre-validation of the BERA tool
→ Post-comatose patients (n=4)

Patient 1 – MCS+

BERA: *21/30*
Phonology: 8/10
Semantics: 8/10
Morphosyntax: *5/10*

CRS-R: 11/23

Patient 2 – EMCS

BERA: 22/30
Phonology: 7/10
Semantics: 8/10
Morphosyntax: 7/10
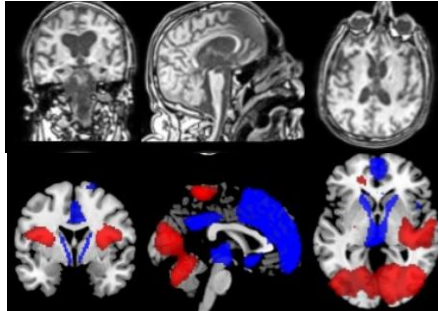
CRS-R: 23/23

Patient 3 – MCS+

BERA: *16/30*
Phonology: 8/10
Semantics: 6/10
Morphosyntax: *2/10*

CRS-R: 15/23

Diabetes
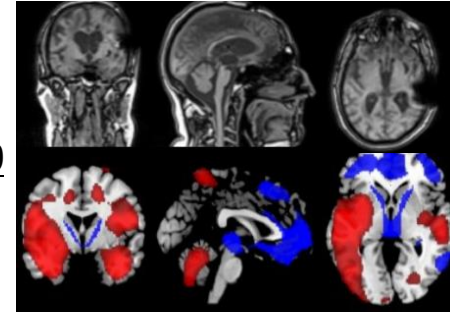
Patient 4 – MCS-

BERA: *16/30*
Phonology: 7/10
Semantics: 6/10
Morphosyntax: *3/10*

CRS-R: 9/23
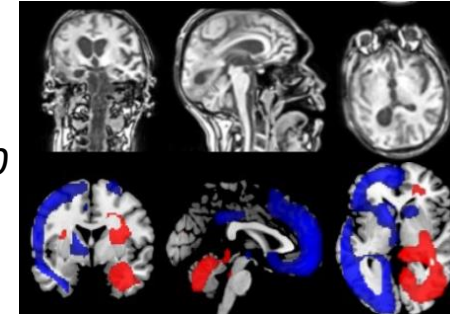
Aubinet, Chatelle et al. (2021), *Brain Injury*

Validity and feasibility of the BERA tool

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

   - Concurrent validity with the Language Screening Test (LAST)

      → Sensitive tool regarding language impairment

   - Content validity (2 versions)

   - Intra-/inter-rater reliability (α=0,919)

   Aubinet, Chatelle et al. (2021), *Brain Injury*
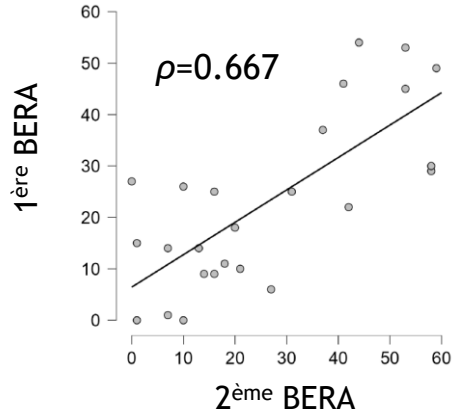
Validation of the BERA tool in post-comatose patients
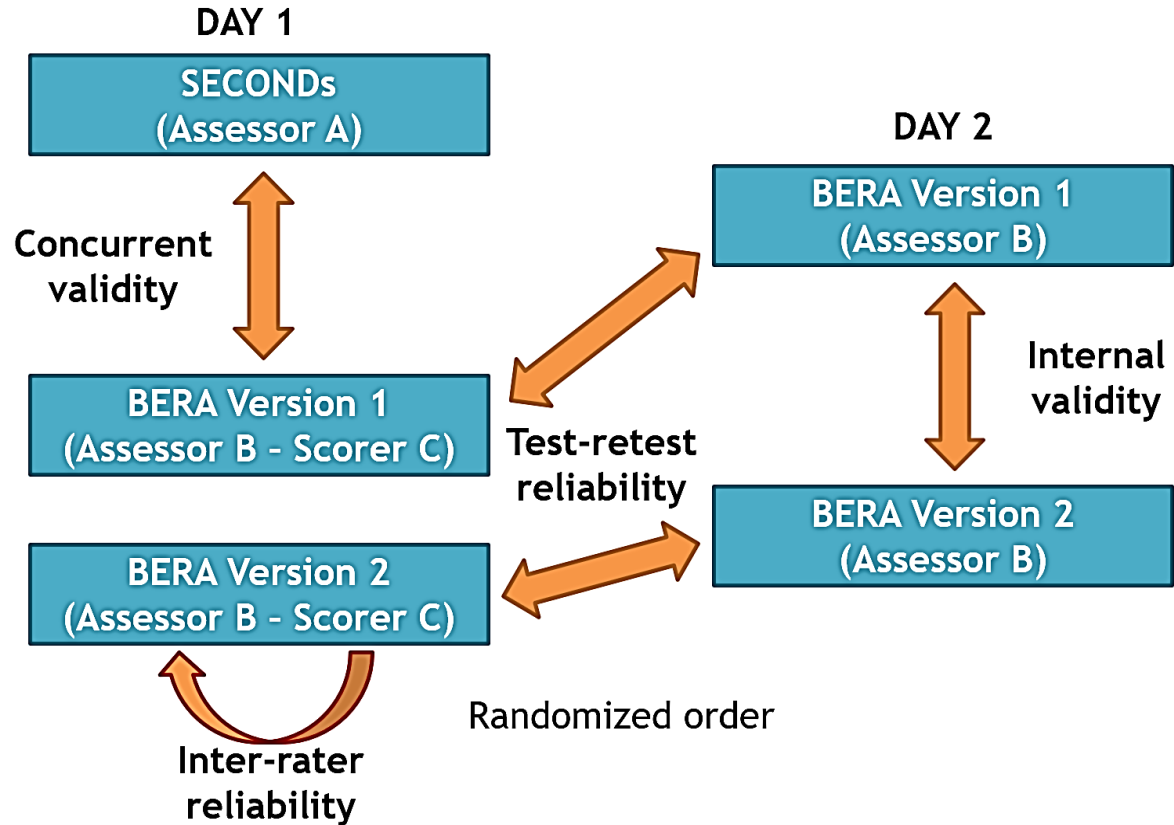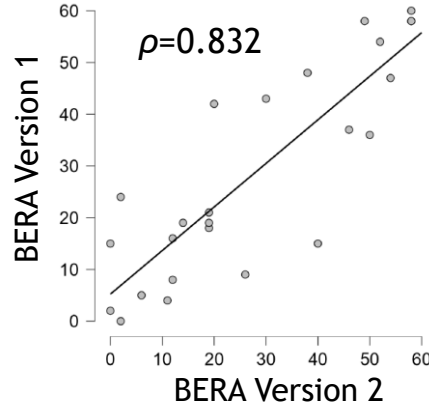
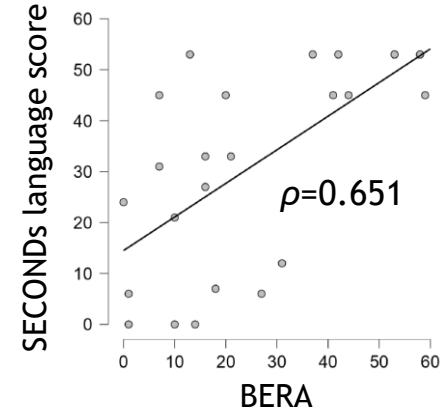# Validation of the BERA tool in post-comatose patients

Ongoing study (n=25)

Test-retest reliability

ρ=0.667

Internal validity

ρ=0.832

Concurrent validity

ρ=0.651

Inter-rater reliability: ICC = 0.961

Aubinet et al., *in prep*

Validity and feasibility of the BERA tool

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

   - Concurrent validity with the Language Screening Test (LAST)

     → Sensitive tool regarding language impairment

   - Content validity (2 versions)

   - Intra-/inter-rater reliability (α=0,919)

   - Appropriate et feasible in post-comatose patients

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

2. **Ongoing validation study in post-comatose patients (n=25)**

   - Good preliminary psychometric data

   - Communicative vs. non-communicative patients

   Aubinet et al., *in prep*

5. Development of the ET-BERA

(Brief Evaluation of Receptive Aphasia with eye-tracking)

ET-BERA: BERA + eye-tracker

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

ET-BERA: Delphi study (1st round)

Distribution of the experts according to their profession

Neuropsycho-logists 11%

Occupational therapists 11%

Orthoptists 6%

SLTs 72%

Familiarity with the use of an eye-tracker

39%

61%

■ Familier avec l'eye-tracker
■ Non familier avec l'eye-tracker

Did use the ET-BERA?

50%

50%

■ A manipulé   ■ N'a pas manipulé
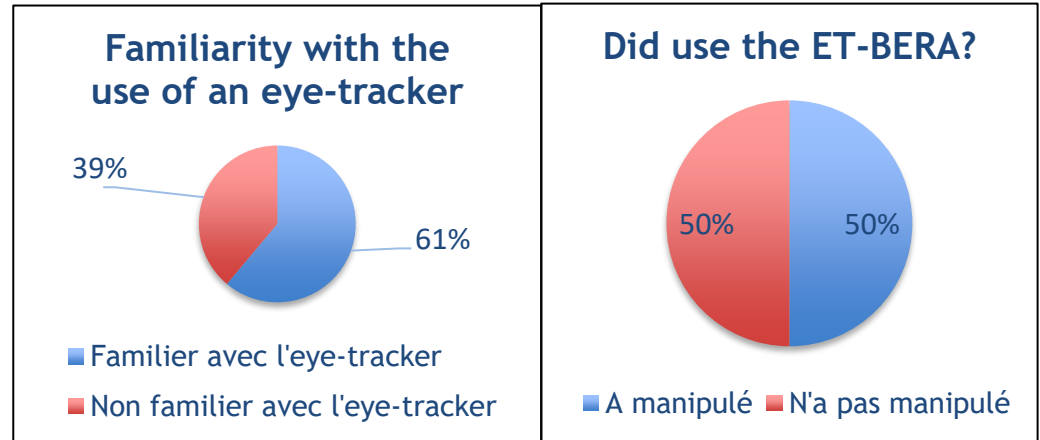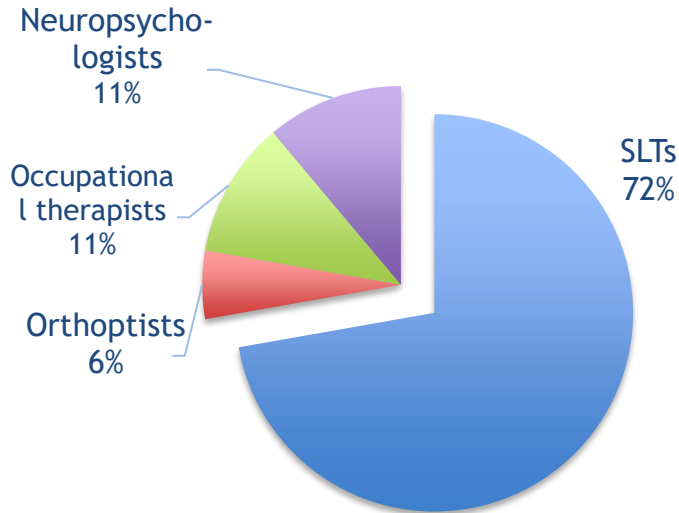
→**100%** of experts highlight the need for specific tools dedicated to the assessment of oral comprehension in this population

→**100%** of experts consider that eye-tracking is interesting in this context

Mazué et al. (2022), *Master thesis*
Rabilloud et al. (in prep), *Master thesis*

ET-BERA: Delphi study (1st round)

According to feasibility criteria

H2 : Content criteria

- Clarity
- Relevance
- Usefulness

H3 : Form criteria

- Temporal accessibility
- Ease of use
- Adaptability
- Limitation of distractors
- Visual fixation objectification
- Human factor
- Repeatability

Familiarity with the ET

- ❖ Higher reconsideration from those who are familiar with the ET

- ❖ **Content of the tool**

- ❖ Mostly regarding what is about the ET

Experience of the ET-BERA

- ❖ Higher reconsideration from those who had the opportunity to use the ET-BERA

- ❖ **Both content and format are questioned**

- ❖ Mostly regarding some practical elements appearing during the administration + the usefulness of an ET table

Mazué et al. (2022), *Master thesis*
Rabilloud et al. (in prep), *Master thesis*

BERA assessment

▶ Residual language abilities in numerous DoC patients...
probably more than we can imagine → Covert awareness!

▶ Importance to detect and characterize them:
- To improve/optimize speech-language therapies
- To avoid the underestimation of consciousness levels!

▶ BERA assessments with and without ET are promising
- Feasible and appropriate for post-comatose patients
- Validity of the BERA in conscious aphasic patients
- Ongoing validation in post-comatose patients

Open-access material here: https://www.coma.uliege.be/severe-brain-injury/#dc-diagnosis

Additional Signs of Consciousness scale (ASC scale)

Objective: *Develop a new behavioural scale to systematically assess the recently highlighted potential signs of consciousness*
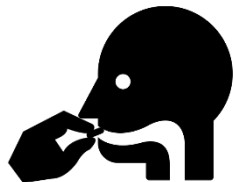
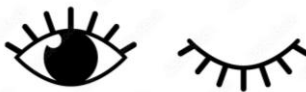Melotte et al, *J Neurology*, 2018
Melotte et al, *APRM*, 2020

Chatelle et al, *APMR*, 2018
Sangaré et al, *under review*

Hermann et al, *Brain*, 2020

van Ommen et al, *J Neurology*, 2018

Magliacano et al, *Neurosci Lett*, 2020

Rémi et al, *Neurology*, 2011

Arzi et al, *Nature*, 2020

Carrière et al, *Brain Communication*

→ *Online survey to collect expert opinions on the administration and scoring guidelines of the ASC*

https://survey.alchemer.eu/s3/90670805/Additional-Signs-of-Consciousness-ASC-Online-survey

Questions?

caubinet@uliege.be

Open-access material here:
https://www.coma.uliege.be/severe-
brain-injury/#dc-diagnosis