Assessing receptive aphasia in patients after coma: validation of the Brief Evaluation of Receptive Aphasia (BERA)

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Abbreviation list:

BERA: Brief Evaluation of Receptive Aphasia

eMCS: emergence from the Minimally Conscious State

MCS: Minimally Conscious State

sABI: severe Acquired Brain Injury

SECONDs: Simplified Evaluation of CONsciousness Disorders

Dear Editor,

Consciousness is frequently underestimated in patients in a minimally conscious state (MCS, including MCS− with absence of language-related behaviors and MCS+ with presence of language-related behaviors) or in patients emerging from a MCS (eMCS) after a severe acquired brain injury (sABI) [1,2]. A key reason for such diagnostic errors is the presence of underlying cognitive or motor deficits that mask conscious behavior [3,4].

Among cognitive deficits, language impairments (particularly receptive aphasia) pose a significant barrier because most behavioral assessments of consciousness rely heavily on the patient's ability to understand and respond to verbal instructions. Deficits in language comprehension can lead clinicians to underestimate the patient's state of consciousness [5,6]. This issue applies to the assessment of both overt [5] and covert [7] consciousness, highlighting the critical need to disentangle language deficits from impaired consciousness in clinical evaluations [6,8]. In response, researchers have called for the development of dedicated tools to assess language functions in patients after coma, independently of general consciousness assessments [5,8,9].

To address this gap, we developed the Brief Evaluation of Receptive Aphasia (BERA), a bedside tool designed to provide a concise and domain-specific assessment of receptive language using a simple visual choice task to minimize motor and expressive demands. Whereas previous data demonstrated sensitivity to language impairments in conscious patients with aphasia and feasibility in 4 patients after coma [10], the present study aims to validate the BERA assessment in these patients with sABI.

A sample of 46 French-speaking adult patients (aged ≥18 years) with a documented history of coma following sABI was recruited from the University Hospital of Liège (intensive care units and neurology ward) and from specialized rehabilitation centers in Wallonia between January 2023 and July 2025. To be included, patients had to show preserved visual fixation or pursuit and a clinical diagnosis of MCS or eMCS according to repeated behavioral assessments performed by experts. Patients with unstable medical conditions, pharmacological sedation during assessment, or prior history of neurological or psychiatric disease were excluded. Written informed consent was obtained from legal representatives. The study was approved by local Ethics Committees (2022-241) and conducted in accordance with the Declaration of Helsinki.

The Simplified Evaluation of CONsciousness Disorders (SECONDs) scale [11,12] was performed by an experienced examiner who provided consciousness diagnosis in line with an additional index score (0–100) derived from the SECONDs assessment [12,13]. A language subindex score (0–53) was also computed from the items related to command-following and functional communication. Patients then underwent 4 BERA assessments based on the bedside clinical observation of eye fixation following verbal instruction. The procedure involved presentation of 2 images (target and distractor) approximately 40 cm from their face and 30 cm apart horizontally. The side of target presentation (left/right) was randomized across trials.

Patients were first asked to visually scan both images, then fixate centrally on the examiner's face. The examiner subsequently pronounced the target word or sentence (without a determiner for phonological items) and monitored gaze behavior. The 2 (parallel) BERA versions included 30 items for a total of 60 images (Figure 1A). Items varied in complexity depending on the degree of similarity between targets and distractors allowing to control distinct psycholinguistic variables, which is crucial for identifying aphasic-like patterns [14,15].

Fixation behavior was scored for each item as either correct (ie, fixation on target image for at least 2 seconds), incorrect (ie, fixation on distractor), hesitant (ie, gaze alternating between images) or random (ie, gaze not directed at either image), and the correct responses were added up to obtain the scores and sub-scores. Hesitant and random responses, though not scored, provide qualitative information for clinical interpretation. Auditory or tactile stimulation was used in cases of fatigue or somnolence, and a stop criterion was applied after 5 consecutive trials with no fixation.

Given its greater complexity, sentence-level evaluation (morphosyntax) was administered only if the patient fixated at least 50% of the word-level items. BERA examiners were blinded to patients' clinical diagnoses and to other assessment results, ensuring robust measurement of psychometric properties (Figure 1B). To minimize order and fatigue effects as well as examiner bias, the sequence of BERA versions and examiner assignments were pseudo-randomized, with 45–90 min between consecutive assessments. Additional demographic and clinical data were collected from medical records.

Descriptive statistics were used to summarize sample data. Kurskal-Wallis tests were performed to investigate differences between diagnostic groups for age and time since injury, while chi-squared tests were used for sex and etiology (traumatic vs non-traumatic) differences. Psychometric measures including the concurrent validity of the BERA compared to SECONDs scores were evaluated using Spearman's rank order correlations. Intraclass correlations (ICC) were also calculated for internal consistency (between the 2 BERA versions), and intra- and inter-rater reliability. A Mann-Whitney U test was used to determine whether BERA scores (ie, sum of the scores obtained for both versions on Day 1) differed significantly between patients without residual language (MCS−) and those with residual language (MCS+ and eMCS) according to the SECONDs assessment. In addition, the distributions of BERA scores and sub-scores (ie, on Day 1) were compared across the diagnostic groups (ie, MCS−, MCS+ and eMCS) using the Kruskal-Wallis test and Dunn's tests for post-hoc comparisons. Analyses were conducted using JASP (version 0.19.3.0) and R (version 4.5.0) and the significance threshold was set at $P < 0.05$.

The study sample consisted of 46 patients (23 women), including 12 MCS− (with no language-related behavior), 21 MCS+ (with command-following and/or intentional communication abilities), and 13 eMCS patients (with functional communication abilities) (Table 1). The diagnosis groups did not significantly differ regarding age ($H(2) = 1.26$, $P = 0.53$), time since injury ($H(2) = 1.17$, $P = 0.56$), sex ($\chi^2(2, 46) = 2.69$, $P = 0.26$) and etiology ($\chi^2(2, 46) = 0.89$, $P = 0.64$).

All patients completed the word-level subscales (ie, task including phonological and semantic items presented in randomized order), but only 18 of 46 patients (39%; 7 MCS+ and 11 eMCS patients) progressed to the morphosyntactic subscale. Patients who did not advance received a morphosyntactic sub-score of 0 due to insufficient performance on the earlier tasks. Two patients were unable to participate on the second day of assessment due to unforeseen unavailability. The mean duration of BERA assessments was 12 min (SD: 5 min; R: 2–25 min).

The concurrent validity analyses showed strong correlations between the SECONDs index score and the total BERA score of the same day ($\rho = 0.82$, $P < 0.001$, $Df = 44$; Figure 2A), the total of version 1 ($\rho = 0.77$, $P < 0.001$, $Df = 44$) and version 2 ($\rho = 0.82$, $P < 0.001$, $Df = 44$) [16]. Moderate to strong correlations were observed between the SECONDs language subindex score and the total BERA score ($\rho = 0.78$, $P < 0.001$, $Df = 44$; Figure 2B), the BERA score of version 1 ($\rho = 0.69$, $P < 0.001$, $Df = 44$) and version 2 ($\rho = 0.81$, $P < 0.001$, $Df = 44$). Moreover, the coefficients for intra-rater reliability were good (ICC(3,1) = 0.89, 95% CI 0.8–0.9; $\rho = 0.86$, $P < 0.001$, $Df = 44$) and the coefficients for inter-rater reliability were excellent (ICC(3,1) = 0.997, 95% CI 0.994–0.998; $\rho = 0.99$; $P < 0.001$, $Df = 44$) [17]. The internal consistency was excellent between the 2 versions (ICC(3,1) = 0.90, 95% CI 0.83–0.95; $\rho = 0.87$, $P < 0.001$, $Df = 44$).

BERA total scores were significantly higher in patients showing residual language (MCS+ and eMCS) than in the group without language (MCS−) ($U = 41$, $P < 0.001$; Figure 2C). BERA total scores were significantly different among groups ($H(2) = 25.21$, $P < 0.001$; Figure 2D), with higher scores in eMCS compared to MCS+ ($P = 0.007$), eMCS compared to MCS− ($P < 0.001$), and MCS+ compared to MCS− ($P = 0.007$). The sub-scores for the 3 language domains also differed significantly between groups (on Day 1: Phonology: $H(2) = 23.60$, $P < 0.001$; Semantics: $H(2) = 24.92$, $P < 0.001$; Morphosyntax: $H(2) = 20.49$, $P < 0.001$, on Day 2: Phonology: $H(2) = 16.67$, $P < 0.001$; Semantics: $H(2) = 18.92$, $P < 0.001$; Morphosyntax: $H(2) = 17.53$, $P < 0.001$), including when considering post-hoc analysis. The only exception concerns the morphosyntactic scores, where MCS− and MCS+ patients did not differ significantly (on Day 1: $z = 1.46$, $P = 0.15$; on Day 2: $z = 1.01$, $P = 0.31$). This is likely due to an artificial floor effect created by the 0 scores received by all MCS− patients and by two-thirds of MCS+ patients, who were unable to complete this subscale.

While the feasibility of the BERA and its sensitivity to language impairment were previously shown [10], the present study demonstrates that the tool is valid and reliable in patients with sABI after coma. Strong correlations with SECONDs scores and excellent internal consistency support its validity, while robust inter- and intra-rater reliability further demonstrates its psychometric strength. BERA scores significantly differed across diagnostic categories, increasing from low to high levels of consciousness, which reflects the parallel trajectory of language and consciousness [18]. Patients without residual language, according to the SECONDs, also scored lower than those with preserved language, confirming clinical sensitivity.

The BERA is the first behavioral tool specifically designed to assess receptive language abilities in patients with MCS. Therefore, the most suitable candidates for evaluating its concurrent validity were existing coma recovery scales, and the fast SECONDs assessment was selected to minimize fatigue effects. The inclusion of phonological, semantic, and morphosyntactic subscales allows identification of selective receptive impairments, providing a more nuanced profile of language function than general consciousness scales [8]. Beyond its ability to qualitatively detect aphasia-like patterns through the impaired language domains and related psycholinguistic effects [14,15], the BERA may also yield information regarding visual cognitive disorders. For instance, patients' behavior when engaging with the pictures (eg, attitude, mimicry) may indicate visual agnosia or spatial neglect, the latter necessitating vertical item presentation to ensure that language components are evaluated in isolation.

By relying on visual fixation within a structured choice paradigm, the BERA reduces the risk of misclassifying patients whose receptive abilities are masked by motor or expressive limitations [3,19]. This is critical given that receptive aphasia may contribute to systematic underestimation of consciousness in clinical practice [5,7]. The BERA complements standard coma recovery assessments by distinguishing language deficits from broader cognitive impairments through specific aphasic profiles. This can improve diagnostic accuracy and guide rehabilitation. Importantly, MCS− patients who can clearly fixate several target pictures on the BERA should be referred for active neuroimaging or electroencephalographic assessments to confirm residual awareness.

Our sample was heterogeneous, and the French-speaking BERA tool will require adaptation for other languages. In addition, certain visual behaviors may reflect peripheral vision impairments, underscoring the need to explore adaptations for non-visual modalities. Future research should also assess the prognostic value of BERA performance for long-term outcomes, as residual language processing may predict subsequent recovery [20]. Cross-validation using neuroimaging would be valuable to determine whether left-sided lesions (ie, typically associated with aphasia) are linked to lower BERA performance and specific psycholinguistic effects. Such approaches would help clarify the contribution of specific language deficits vs more global cognitive impairment. Overall, the BERA appears to be a promising addition to the clinical toolkit for evaluating residual cognition in patients with sABI.

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Author contributions

CA created the BERA tool, designed the methods, analyzed data, and drafted the manuscript under the supervision of SM and OG. CA, AR, AG, PF, HJ, DL, and NL contributed to patient recruitment and data acquisition. All authors provided feedback on the manuscript.

Declaration of generative AI in the manuscript preparation process

During the preparation of this work, the authors used ChatGPT solely to improve the clarity and readability of the language. After using this tool, the authors carefully reviewed and edited the content as needed and take full responsibility for the content of the publication.

Conflicts of interest

None.

Data availability

All data is available upon request, and a complete BERA manual can be accessed here: https://www.coma.uliege.be/wp-content/uploads/2025/04/bera-manual-fr.pdf.

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Figure Legends

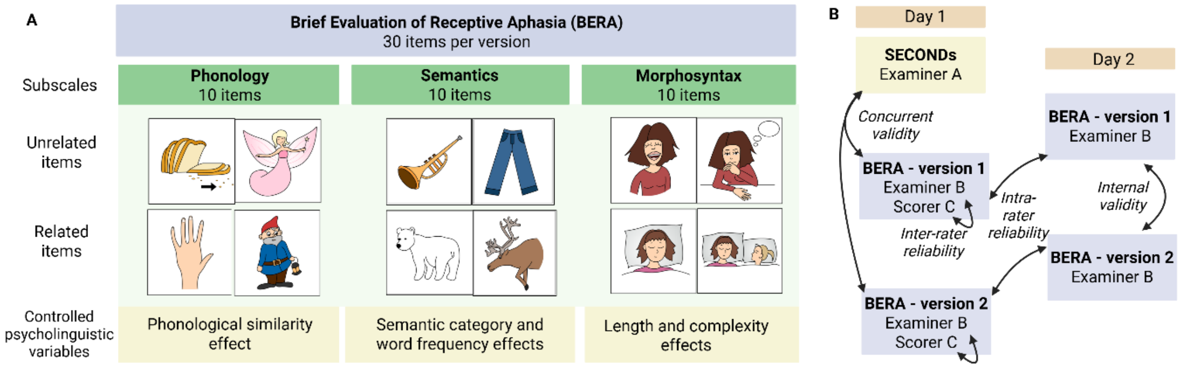

Figure 1. Validation of the BERA tool. A. Test items. Phonological items are monosyllabic words, paired either with phonologically neutral distractors (simple; eg, *mie-fée*) or with minimal pairs differing by a single consonant or vowel (complex; eg, *main-nain*). Semantic items are concrete nouns of varying frequency, paired with either semantically unrelated distractors (simple; eg, *la trompette-le pantalon*) or category-related distractors (complex; eg, *l'ours-le renne*). Morphosyntactic items consist of illustrated short and long sentence pairs differing in semantic and/or morphosyntactic features. Items either vary in content exclusively (simple: eg, *Elle rit – Elle pense*) or in sentence structure or specific grammatical aspects (complex: eg, *Elle dort – Elles dorment*) such as active vs passive voice, number, prepositions, or determiners. B. Data collection. Assessments were conducted over 2 consecutive days. On Day 1, following the SECONDs evaluation (performed by examiner A), the main examiner (examiner B) administered both BERA versions consecutively, while a second examiner (scorer C) independently scored the responses to assess inter-rater reliability. On Day 2, the main examiner repeated both versions to estimate intra-rater (test-retest) reliability.

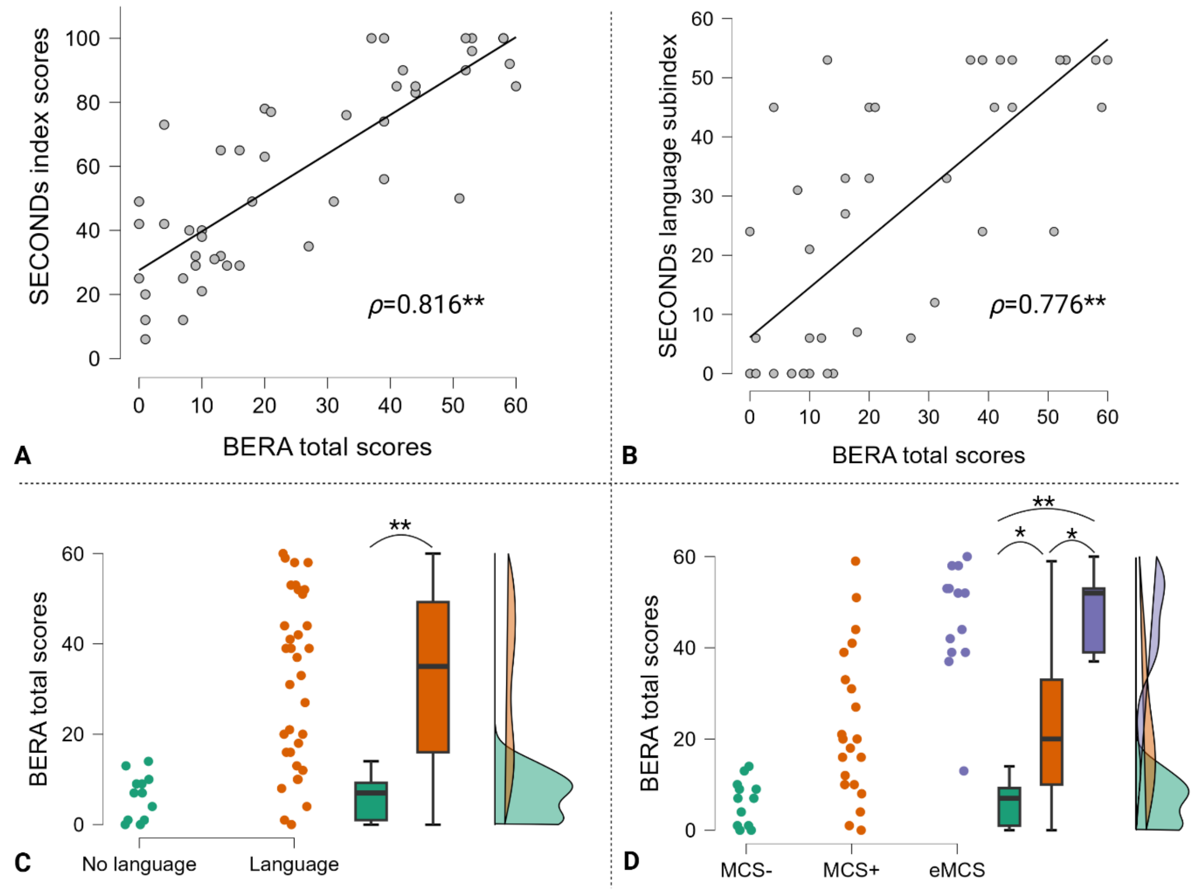

Figure 2. BERA total scores on Day 1 in relation to SECONDs scores and diagnoses. A. Significant correlation between SECONDs index scores and BERA total scores. B. Significant correlation between SECONDs language subindex scores and BERA total scores. This figure illustrates the distribution of patients with MCS+, patients with MCS− scored 0, and patients with eMCS scored 53 on the SECONDs language subindex. C. Significant difference between patients without language (ie, MCS−) and patients with residual language abilities (ie, MCS+ and eMCS) according to the SECONDs assessment. D. Significant differences across consciousness diagnostic categories. *P <0.05; ** P <0.001.

Table

Table 1. Summary of sample data (*n* = 46)						
			Mean	**SD**	**Median**	**Range**
Demographics		Age (years)	51.2	16.2	56.5	18-76
		Time since injury (weeks)	173	955	19	2-6495
		Sex : 23 women				
		Etiology : 18 traumatic				
SECONDs		Index	12.4	10.3	53	6-100
		Language subindex	27.2	22.1	29	0-53
BERA	Duration (min)		11.8	4.8	12	2-25
	Day 1 (*n* = 46)	Version 1 (main examiner)	12.4	10.3	9.5	0-30
		Version 2 (main examiner)	12.7	10.1	9.5	0-30
		Version 1 (blind scorer)	12.3	10.2	10	0-29
		Version 2 (blind scorer)	12.7	10.1	9.5	0-30
		Phonology	8.8	6.1	8	0-20
		Semantics	10	6.7	10	0-20
		Morphosyntax	6.1	7.9	0	0-20
	Day 2 (*n* = 44)	Version 1	14.0	9.7	14	0-30
		Version 2	13.4	9.9	12.5	0-30
		Phonology	10.3	6.1	10	0-20
		Semantics	10.9	6.8	12.5	0-20
		Morphosyntax	5.8	8	0	0-20