**Stereoelectroencephalographic language mapping of the basal temporal cortex predicts postoperative naming outcome**

Chifaou Abdallah, MSc, MD,1,4 Hélène Brissart, PhD, Sophie Colnat-Coulbois, MD, PhD,2 Ludovic Pierson, MSc, Olivier Aron, MD,1 Natacha Forthoffer, MS, Jean-Pierre Vignal, MD,1 Louise Tyvaert, MD, PhD, Jacques Jonas, MD, PhD,1,3 and Louis Maillard, MD, PhD1,3

Departments of 1Neurology and 2Neurosurgery, University Hospital of Nancy, Lorraine University, Nancy, France; 3Neurosciences of Systems and Cognition Project, BioSIS Department (Department Biologie, Signaux et Systèmes en Cancérologie et Neurosciences), Research Center for Automatic Control of Nancy (CRAN), Lorraine University, CNRS, UMR 7039, Vandoeuvre, France; and 4Neurology and Neurosurgery Department, Montreal Neurological Institute, McGill University, Montreal, Quebec, Canada

**OBJECTIVE** In drug-resistant temporal lobe epilepsy (TLE) patients, the authors evaluated early and late outcomes for decline in visual object naming after dominant temporal lobe resection (TLR) according to the resection status of the basal temporal language area (BTLA) identified by cortical stimulation during stereoelectroencephalography (SEEG).

**METHODS** Twenty patients who underwent SEEG for drug-resistant TLE met the inclusion criteria. During language mapping, a site was considered positive when stimulation of two contiguous contacts elicited at least one naming impairment during two remote sessions. After TLR ipsilateral to their BTLA, patients were classified as BTLA+ when at least one positive language site was resected and as BTLA− when all positive language sites were preserved. Outcomes in naming and verbal fluency tests were assessed using pre- and postoperative (means of 7 and 25 months after surgery) scores at the group level and reliable change indices (RCIs) for clinically meaningful changes at the individual level.

**RESULTS** BTLA+ patients (n = 7) had significantly worse naming scores than BTLA− patients (n = 13) within 1 year after surgery but not at the long-term evaluation. No difference in verbal fluency tests was observed. When RCIs were used, 5 of 18 patients (28%) had naming decline within 1 year postoperatively (corresponding to 57% of BTLA+ and 9% of BTLA− patients). A significant correlation was found between BTLA resection and naming decline.

**CONCLUSIONS** BTLA resection is associated with a specific and early naming decline. Even if this decline is transient, naming scores in BTLA+ patients tend to remain lower compared to their baseline. SEEG mapping helps to predict postoperative language outcome after dominant TLR.

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**KEYWORDS** temporal lobe epilepsy; intracranial recordings; stereoelectroencephalography; language; epilepsy surgery; neuropsychological outcome

**TEMPRAL LOBE RESECTION (TLR) REMAINS THE MOST EFFECTIVE TREATMENT OPTION WITH THE HIGHEST FAVORABLE POSTSURGICAL SEIZURE OUTCOME IN FOCAL REFRACTORY TEMPORAL LOBE EPILEPSY (TLE). HOWEVER, NAMING DECLINE OCCURS IN UP TO 60% OF DOMINANT TLR IN ADULTS. THE MOST COMMON LANGUAGE DEFICIT AFTER TLR IS ANOMIA, WHICH NEGATIVELY IMPACTS THE QUALITY OF LIFE OF THESE PATIENTS. LATER EPILEPSY ONSET, ABSENCE OF HIPPOCAMPAL SCLEROSIS (HS), LEFT TEMPORAL LOBE SURGERY, AND POSTOPERATIVE SEIZURE OUTCOME ARE THE MAIN PREDICTIVE FACTORS OF THIS POSTOPERATIVE NAMING DECLINE.

Numerous studies have identified a region in the domi-
nant basal temporal cortex for which cortical stimulations produce transient language deficits. This region has been coined the basal temporal language area (BTLA). The BTLA is centered on the fusiform gyrus (FG) \[^{14-16}\] and extends to the inferior temporal and parahippocampal gyri \[^{16}\] and to the occipito-temporal sulcus (OTS). \[^{17}\] The effect of BTLA resection on postoperative decline in visual object naming has been poorly studied and is still debated. While some studies have shown that patients with BTLA resection perform worse in visual object naming evaluations than those without, \[^{18}\] other studies \[^{9,15}\] have supported the idea that sparing the BTLA would not impact postoperative naming. All of these studies were conducted with a single early (within 1 year) postoperative neuropsychological evaluation; none of them assessed late naming outcome, and thus all may have overlooked possible long-term recovery. Moreover, per cortical language mapping, all of these studies used grids and/or strips that did not allow specific stimulation of deep structures and sulci. \[^{17,19}\] In the present study, we aimed to evaluate both early and late outcomes in visual object naming according to the resection status of the BTLA identified by cortical stimulations performed during stereoelectroencephalography (SEEG). We hypothesized that patients with at least partial resection of the BTLA would have significant naming declines at the early postoperative evaluation compared to patients with preserved BTLAs, but that patients with a decline might recover during a long-term follow-up. The originality of this study relies on the early and late postoperative cognitive assessments and on the use of SEEG, which allows exploration of deep structures and sulci.

**Methods**

**Patient Selection**

In this monocentric study, 20 consecutive adult patients with TLR were retrospectively included at the tertiary Epilepsy Center of Nancy University Hospital between 2010 and 2016 from our SEEG prospective database of 149 refractory epilepsy patients (flowchart in Fig. 1). The included patients met the following criteria: 1) had undergone TLR ipsilateral to the BTLA previously identified by cortical stimulations during SEEG, 2) had undergone comprehensive preoperative and early and late postoperative neuropsychological evaluations, 3) had undergone an IQ assessment with the Wechsler adult intelligence scale IV with a score equal or superior to 65, and 4) spoke French as their native language.

All patients underwent the usual noninvasive investigations, including a neurological examination, a comprehensive medical history, a high-resolution structural MRI, long-term video-EEG recordings, and interictal FDG-PET. SEEG was performed for patients suspected of having bitemporal epilepsy on scalp EEG, patients with no structural abnormality on the MRI, and patients with neuropsychological results discordant with the localization of the presumed epileptogenic zone (EZ).

This study was approved by the ethics board of the Uni-

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**FIG. 1.** Flowchart of patients undergoing SEEG in the tertiary care center of Nancy from 2010 to 2016.
University Hospital of Nancy, and all patients consented to participate in this noninterventional retrospective study.

**Pre- and Postoperative Neuropsychological Examinations**

All patients underwent a comprehensive neuropsychological test battery that was systematically performed pre- and postoperatively and included tests of intelligence, language function (visual naming, verbal fluency), and psychomotor speed, attention, and verbal and nonverbal memory, as well as the Edinburgh Handedness Inventory. The preoperative evaluation was the baseline assessment (T1). The postoperative evaluations were performed 6 to 12 months after surgery (early assessment [T2]) and then between 12 and 58 months after surgery (late assessment [T3]).

The language visual naming function was assessed with the Dénomination Orale d’images 80 (DO80), a French visual object naming test, in which patients were requested to name one by one a series of 80 black-and-white drawings of various objects. The test duration was around 3 minutes. The total score took into account the number of correct responses, excluding errors (e.g., those associated with anomia or semantic paraphasia).

Verbal fluency tests (phonological and semantic) were performed by asking the patient to generate the maximum number of words beginning with a specific letter (e.g., “p”) and within a semantic category (e.g., animal) in 2 minutes.

**Language Mapping Procedure**

**Stereotactic Placement of Intracerebral Electrodes**

In order to localize the EZ and to map language, intracerebral electrodes (Dixi Medical) were stereotactically implanted mainly in the temporal regions. Each intracerebral electrode consisted of a cylinder of 0.8 mm in diameter and contained 8–15 independent recording contacts of 2 mm in length separated by 1.5 mm from edge to edge. Details about the electrode implantation procedure have been previously described. Regarding the sampling of the basal temporal cortex, we used two basal temporal electrodes orthogonal to the sagittal plane, from the inferior temporal gyrus (ITG) laterally to the entorhinal cortex medially for the anterior trajectory and to the parahippocampal gyrus (PHG) for the more posterior trajectory. These trajectories also allowed sampling of the anterior and posterior lateral OTS, FG, and collateral sulcus (CS). (Figs. 2–5). To determine and localize the anatomical location of each electrode contact, we performed coregistration on each patient between the individual preoperative structural 3D MRI and the postimplantation CT scan, using a program we developed called Imagerie Cérébrale Multimodale (ICEM) that uses MatLab tools allowing the automatic detection and semiautomatic labeling of depth electrode contacts.

**Identification of the BTLA and Contact Localization of Positive Sites in the Individual Structural Anatomy**

To map the BTLA for each patient, bipolar stimulations were applied between two contiguous contacts (50 Hz, 5–10 seconds, 0.5–2 mA, according to clinical criteria). Functional mapping of language was assessed using a visual confrontation naming task. Briefly, patients were shown sets of black-and-white drawings representing living or manufactured objects presented one by one in a random order. Patients had to name each image. For each set, the patient had to name approximately 10 images before, during, and after the electric cortical stimulation. One to 4 consecutive images were shown during the stimulation. For identification of the BTLA, we defined a positive naming site as 2 contiguous contacts whose electrical stimulation elicited at least one naming impairment during two remote sessions. A naming impairment was defined as anomia and/or paraphasia and/or latency. A site was considered as positive if a clear naming impairment was elicited during stimulation relative to the patient’s baseline performance. Cortical stimulations followed by regional postdischarge or seizures were excluded. All stimulations were performed at least 2 hours after the last seizure to exclude any potential bias related to postictal aphasia.

Based on the coregistered individual preimplantation, anatomical MRI, and postimplantation CT scan, we localized each positive stimulated site and calculated the corresponding coordinates on the Talairach space using our ICEM software (Fig. 2). One of the following anatomical temporal structures was assigned to each positive site: the PHG, FG, OTS, ITG, CS, and amygdala.

**Surgical Procedure**

The resection site and limits, mainly the posterior and lateral extent in the basal temporal cortex (anterior FG, ITG, and PHG), were individually determined based on the EZ SEEG delineation. Seventeen patients had a resection of antero-medial temporal lobe structures, including the temporal pole, amygdala, hippocampus, and PHG, and of the anterior ventro-temporal cortex, including the anterior part of the fusiform and inferior temporal gyri. The remaining 3 patients had only neocortical resection that spared the medial temporal structures. The surgical approach was the same for all patients with antero-medial TLR and for all patients with neocortical resection. They were all operated on by the same neurosurgeon (S.C.-C.).

For the purpose of this study, we classified patients into two groups according to the involvement of the BTLA in the resection. We considered patients as having a resected BTLA (BTLA+) if they had at least one language-positive site located in the surgical cavity or its edges in the individual postoperative anatomical MRI. In contrast, if all of the positive sites were located outside the surgical cavity, the patients were classified as having a nonresected BTLA (BTLA−).

The evaluation of the resected status of the BTLA site was performed after the coregistration of the individual postoperative anatomical MRI (performed at least 6 months after surgery) and the postimplantation CT scan for each patient. The quality of the coregistration was visually confirmed in each step.

The posterior limits of resection were assessed on the postoperative MRI for each patient. We specifically measured the distance between the tip of the pole and the posterior margins of the superior temporal gyrus (STG),...
middle temporal gyrus (MTG), ITG, FG, PHG, and amygdalo-hippocampal complex (AH).

The long-term postoperative seizure outcome was assessed for all patients (mean 3.87 years at last follow-up). Seizure outcome was evaluated according to the Engel classification.28

**Statistical Analyses**

As the 3 visual naming score variables (T1, T2, and T3) were negatively skewed and not normally distributed, we applied a square root transformation (SQRT) to their corresponding reflected variables. The new variables were normally distributed and were used for statistical analyses. All of the other variables were normally distributed. After checking that all the assumptions were satisfied, ANCOVA was carried out two times (early and late postoperatively), with the status of the BTLA resection (BTLA+ vs BTLA−) as the independent variable and the postoperative SQRT as the dependent variable. For
the covariates, we first evaluated the statistical correlation (Pearson) between the main variables reported in the literature that might have impacted the postoperative results (age at seizure onset, age at surgery, posterior resection margins, and preoperative scores) and the postoperative SQRT scores. In this study, only the preoperative naming SQRT score was significantly correlated with the postoperative SQRT variables ($r = 0.8$, $p < 0.001$ at T2 and $r = 0.6$, $p = 0.009$ at T3) and was then considered as a covariate. We also performed an independent t-test between the seizure outcomes classified as seizure free (Engel class I) and non–seizure free (Engel classes II to IV) and the postoperative SQRT scores at T2 and T3. No statistically significant differences were found. For this reason, the seizure outcome was not considered for further analysis.

The same analysis was done for verbal fluency tests. Only the preoperative scores were significantly correlated with the postoperative scores (phonological test $r = 0.8$, $p < 0.001$ at T2 and $r = 0.7$, $p = 0.001$ at T3; semantic test $r = 0.7$, $p = 0.002$ at T2 and $r = 0.5$, $p = 0.02$ at T3) and were then also considered as covariates.

At the individual level, to minimize common sources of error measurement in test-retest design, such as practice effects, we calculated the reliable change index (RCI) to evaluate the clinically meaningful change for our naming and verbal fluency tests. To do so, we computed RCI, following the adapted method of Jacobson and Truax, from control group data ($n = 37$) of nonoperated epileptic patients. Indeed, after calculating test-retest reliability coefficients for each test score ($0.86$ for DO80, $0.9$ for phonological fluency, and $0.88$ for semantic fluency), we then calculated the SE of measurement and the SE of difference. The RCI was obtained through calculating the RCI (reliable change), which is defined by $RC = x_2 - x_1/\text{S}_{\text{diff}}$, where $x_1$ represents the preoperative score, $x_2$ the postoperative score, and $\text{S}_{\text{diff}}$ the SE of the difference between scores. Within a 95% change score confidence interval, the RCI values were $2.84$ for DO80, $5.47$ for phonological, and $7.85$ for semantic fluency tests. We considered patients as having a decline in naming outcome if each raw score decrease ($T2 - T1, T3 - T1$) was $\geq 1$ RCI in absolute value, and a severe decline if this score decrease was $\geq 2$ RCI in absolute value. On the other hand, the patient was considered as having a gain in naming if the score increased by $\geq 1$ RCI. The RCI cutoff values were

![FIG. 3. Example of imaging from a patient with partial resection of the BTLA (patient 5, BTLA+ group). Each solid blue line intersection represents one of the positive language sites identified by cortical stimulation during SEEG. This SEEG contact was resected during surgery. Figure is available in color online only.](image-url)
± 6 for phonological and ± 8 for semantic tests. Outcomes were classified into decline and no decline (gain and no change scores) and a Fisher exact test was used to calculate the association between the status of naming decline at T2 and T3 and the status of BTLA resection.

All analyses were done in IBM SPSS version 24 (IBM Corp.).

Results

Patients
The main descriptive characteristics for each patient group are summarized in Table 1.

No statistical differences were found between the BTLA+ and BTLA− groups in terms of age at seizure onset, age at surgery, delays between surgery and postoperative neuropsychological assessments, structural anatomical abnormalities, preoperative cognitive performance (IQ, verbal fluency, and naming tests), and seizure freedom at the last follow-up (at least 2 years).

Stimulation for Language Mapping
Overall, a total of 123 BTLA+ naming sites were found. BTLA was strictly lateralized in the left temporal lobe in 19 patients and in the right temporal lobe in 1 patient with right TLR (and bilateral implantation). The mean numbers of positive sites per patient were similar in the BTLA+ and BTLA− groups (8.43 ± 7.11 vs 5 ± 2.51, respectively, p = 0.12). Among the 123 positive naming sites, 78 (63%) elicited anomia, 19 (15%) anomia and paraphasia, 14 (11%) paraphasia, and 12 (10%) latency. The distance from the tip of the pole to the resected eloquent contacts was significantly lower than that for the nonresected eloquent contacts (average 24.5 vs 40.8 mm, respectively; 2-tailed t-test, p = 0.00001; Fig. 2).

For the anatomical localization, 50 (41%) of the positive naming sites were located in the FG, followed by 33 (27%) in the PHG (including 6% in the entorhinal cortex), 18 (15%) in the ITG, 11 (9%) in the CS, 7 (5%) in the OTS, and 4 (3%) in the amygdala.

Effect of BTLA Resection on Language Outcome: BTLA+ Versus BTLA− Groups

Naming Test
Seven patients were BTLA+ and 13 BTLA−. As men-
tioned earlier in the Methods section, age at seizure onset, age at surgery, posterior resection margins, and postoperative seizure outcome were not correlated with the postoperative naming SQRT scores in bivariate analysis and were therefore not considered in the ANCOVA model. Only the preoperative naming SQRT score was significantly correlated with the postoperative SQRT naming variables and was considered as a covariate.

A statistical difference was found between the BTLA+ and BTLA− groups only at T2 (ANCOVA: F = 4.6, p = 0.04, partial eta square 0.2), and not at T3 (ANCOVA: F = 3.3, p = 0.08). The higher value of partial eta square at T2 (> 0.14) indicates a large effect of the BTLA resection on the postoperative SQRT scores.

We refer the reader to Figs. 3 and 4 for examples of illustrative patients with resected BTLA (patient 5, BTLA+ group) and preserved BTLA (patient 12, BTLA− group).

Verbal Fluency Tests

No statistical differences were found between the BTLA+ and BTLA− groups regarding both verbal fluency tests, whether at T2 or at T3 (ANCOVA for phonological test: F = 0.01, p = 0.9 at T2 and F = 0.1, p = 0.7 at T3; ANCOVA for semantic test: F = 1.7, p = 0.2 at T2 and F = 0.9, p = 0.3 at T3).

Individual Effect of BTLA Resection on Language Outcome Using Naming Test RCI Score

Eighteen of 20 patients had available early assessments (missing data for patients 14 and 15 in the BTLA− group), and 18 of 20 had available late assessments (missing data for patient 1 in the BTLA− group and patient 6 in the BTLA+ group).

Five of 18 patients (28%) had a significant decline in naming score at T2 (raw score decrease ≥ 1 RCI). This decline was severe (≥ 2 RCI) in 4 of 5 patients. Four patients had HS, 4 were older than 14 years at seizure onset, and all of the patients were Engel class I at least 2 years after surgery. Four of the patients (80%) were BTLA+, corresponding to 57% of all BTLA+ patients. Only 1 of the patients was BTLA−, corresponding to 9% of all BTLA− patients. As illustrated in Fig. 5, this false negative of BTLA map-
ping is most probably related to a sampling bias with no anterior temporo-basal depth electrode. A statistical correlation was found between the naming decline and the BTLA resection status (Fisher exact test, \( p = 0.04 \)). Only 1 patient whose naming had declined at T2 maintained this decline at T3 (BTLA+ case).

Among the remaining 13 patients who did not decline at T2, 2 declined at T3 (1 BTLA+ patient and 1 BTLA− patient; both had a structurally normal hippocampus that was not resected). Interestingly, there was no significant correlation between naming decline at T3 and resection of the BTLA (Fisher exact test, \( p = 0.2 \)).

Four of 18 patients (22%) had a gain in naming score at T2. In addition, 2 other patients presented a late gain at T3. Only 1 patient presented an important gain (> 2 RCI), and it occurred at T3. All of the patients with gains at T2 or T3 were BTLA−; 2 patients had an HS, 4 had an age at seizure onset < 14 years, and 5 were Engel class I.

**Verbal Fluency Tests**

For phonological fluency, 1 patient (5%) had a decline at T2, and another patient had a decline at T3. Three patients (17%) had a gain at T2. Two of these patients maintained this gain at T3. In addition, another patient presented a late gain at T3. Among these patients with phonological gain, 2 were BTLA+.

For the semantic fluency test, only 1 patient (5%) had a decline at T2, and this decline was maintained at T3. Three patients (17%) had a gain at T2. All of these patients maintained this gain at T3. In addition, 3 other patients presented a late gain at T3. Among these 6 patients with gains, 1 was BTLA+, 5 had a resection of a pathological hippocampus including 3 with an HS, and all of them were Engel class I.

**Discussion**

The present study aimed at evaluating the postoperative naming outcome according to the status of the BTLA resection. In our study patients, resection of the BTLA (BTLA+ group) involved a high risk of early postoperative naming decline (57%). Early and late postoperative neuro-

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**TABLE 1. Patient characteristics**

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>BTLA Resected (n = 7)</th>
<th>BTLA Preserved (n = 13)</th>
<th>p Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age, yrs</td>
<td>36.43 ± 6.42 (28–47)</td>
<td>37.77 ± 11.36 (21–56)</td>
<td>0.77*</td>
</tr>
<tr>
<td>Sex, F</td>
<td>3</td>
<td>6</td>
<td>0.88†</td>
</tr>
<tr>
<td>Rt handed</td>
<td>6</td>
<td>9</td>
<td>0.53†</td>
</tr>
<tr>
<td>Side of epilepsy: Lt</td>
<td>6</td>
<td>13</td>
<td>0.16†</td>
</tr>
<tr>
<td>Side of BTLA: Lt</td>
<td>6</td>
<td>13</td>
<td>0.16†</td>
</tr>
<tr>
<td>MRI negative</td>
<td>2</td>
<td>5</td>
<td>0.6†</td>
</tr>
<tr>
<td>Hippocampus resection ipsilateral to BTLA</td>
<td>6</td>
<td>11</td>
<td>0.9†</td>
</tr>
<tr>
<td>Engel 1 class postop</td>
<td>6</td>
<td>12</td>
<td>0.6†</td>
</tr>
<tr>
<td>Age at seizure onset, yrs</td>
<td>18.85 ± 6.98</td>
<td>11.37 ± 11.09</td>
<td>0.12*</td>
</tr>
<tr>
<td>Epilepsy duration, yrs</td>
<td>13.43 ± 6.21</td>
<td>23.69 ± 14.52</td>
<td>0.09*</td>
</tr>
<tr>
<td>Individual no. of positive sites</td>
<td>8.43 ± 7.11</td>
<td>5 ± 2.51</td>
<td>0.12*</td>
</tr>
<tr>
<td>Time from 1st neuropsychological battery to op, mos</td>
<td>13.43 ± 6.80</td>
<td>14.08 ± 8.50</td>
<td>0.86*</td>
</tr>
<tr>
<td>Time from op to 1st postop neuropsychological assessment, mos</td>
<td>6.71 ± 1.49</td>
<td>7.09 ± 2.02</td>
<td>0.67*</td>
</tr>
<tr>
<td>Time from op to 2nd postop neuropsychological assessment, mos</td>
<td>26.17 ± 14.51</td>
<td>24.33 ± 12.35</td>
<td>0.78*</td>
</tr>
<tr>
<td>Preop IQ score</td>
<td>83.71 ± 19.81</td>
<td>92.77 ± 16.45</td>
<td>0.28*</td>
</tr>
<tr>
<td>Preop phonological fluency test score</td>
<td>14.29 ± 5.28</td>
<td>17.46 ± 5.10</td>
<td>0.20*</td>
</tr>
<tr>
<td>Preop semantic fluency test score</td>
<td>18.57 ± 9.60</td>
<td>20.62 ± 6.59</td>
<td>0.58*</td>
</tr>
<tr>
<td>Preop D080 test</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Raw score</td>
<td>70.86 ± 7.19</td>
<td>74 ± 6.57</td>
<td></td>
</tr>
<tr>
<td>SORT score</td>
<td>2.99 ± 1.17</td>
<td>2.42 ± 1.11</td>
<td>0.29*</td>
</tr>
<tr>
<td>Limit of resection, mm</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>STG</td>
<td>17.25 ± 5.05</td>
<td>18.55 ± 4.36</td>
<td>0.55*</td>
</tr>
<tr>
<td>MTG</td>
<td>24.18 ± 11.97</td>
<td>25.25 ± 7.98</td>
<td>0.81*</td>
</tr>
<tr>
<td>ITG</td>
<td>21.69 ± 8.65</td>
<td>22.25 ± 4.52</td>
<td>0.85*</td>
</tr>
<tr>
<td>FG</td>
<td>29.36 ± 9.22</td>
<td>32.58 ± 7.49</td>
<td>0.41*</td>
</tr>
<tr>
<td>PHG</td>
<td>32.80 ± 10.92</td>
<td>36.95 ± 10.21</td>
<td>0.41*</td>
</tr>
<tr>
<td>AH</td>
<td>39.12 ± 11.06</td>
<td>44.04 ± 11.46</td>
<td>0.37*</td>
</tr>
</tbody>
</table>

Values are presented as number of patients or mean ± SD (range) unless otherwise indicated.

* t-test.
† Pearson chi-square test.
psychological evaluations showed that, when present, the early postoperative naming decline tended to recover during the longer term. In contrast, sparing BTLA (BTLA− group) prevented patients from postoperative naming decline (9%), provided that sufficient spatial sampling had been performed with anterior and posterior basal temporal depth electrodes. The main originality of our study was the use of early and late postoperative neuropsychological evaluation and the use of SEEG for language mapping, unlike previous multicase stimulation studies that used subdural grids and strips.\textsuperscript{14–16,18,31} Electrocorticography has long been considered as the only gold standard in terms of language mapping.\textsuperscript{32} Our study is, to our knowledge, the first to demonstrate the utility of SEEG language mapping to predict cognitive outcome after dominant TLR.

So far, few studies have addressed the cognitive effect of BTLA site resection, and the results of previous studies are still debated. The observed specific and direct effects of BTLA resection on early postoperative naming are consistent with the reported effects in a few electrocorticography studies published on this topic\textsuperscript{18,33} with a 6- to 12-month evaluation after surgery. It has further been shown that the early naming decline was not maintained later and thus followed a biphasic evolution consistent with a previous report of naming outcome after standard dominant TLR without previous language mapping.\textsuperscript{34} We suggest that this biphasic evolution would apply specifically to patients with BTLA resection. The resected eloquent contacts were more anterior than the nonresected eloquent contacts (on average 24.5 vs 40.8 mm in resected vs nonresected eloquent sites, respectively; see Fig. 2) and were all located within 35 mm from the tip of the temporal pole corresponding to the limits of the so-called standard left anterior temporal lobectomy.\textsuperscript{35} In line with this result, the posterior margins of resection were not different between the BTLA+ and BTLA− patients and did not correlate with the postoperative naming score. Altogether, our results strongly suggest that the early naming decline observed after BTLA resection did not depend on the posterior limits of temporal neocortical resection\textsuperscript{36,37} but was related to the great interindividual variability of the BTLA anterior limit.\textsuperscript{17} Therefore, when it is possible to perform SEEG language mapping, a tailored cortectomy sparing the BTLA is more efficient to prevent postoperative naming decline than a standard temporal resection in the dominant hemisphere.

The results of the individual analyses were consistent with the group-level results. Indeed, clinically meaningful postoperative naming decline occurred in 57% of BTLA+ and 9% of BTLA− patients. The 9% rate of naming decline in BTLA− patients was much lower than the usual 25%–60% range previously reported in adult patients after dominant TLR.\textsuperscript{3–5,38} In contrast, the 57% rate in BTLA+ patients was in the upper range. These rates emphasize the importance of BTLA mapping for the individual prediction of postoperative naming outcome.

Only 1 BTLA− patient had early naming decline. We think that this false negative of SEEG language mapping was related to undersampling of the BTLA anterior extent, with only a posterior and no anterior basal temporal electrodes because of vascular constraints. Few studies\textsuperscript{3,38,39} have evaluated the gains in naming scores after dominant TLR. Interestingly, 33% of our patients experienced gains in naming scores, although all resections were performed in the dominant temporal lobe. All of these patients were BTLA− and 83% were Engel class I. These gains may be attributable to a release of language function and reserve capacities that were disrupted by epilepsy before surgery.\textsuperscript{39}

For the extratemporal language functions, only 1 patient presented a postoperative decline for both phonological and semantic fluency tests. Importantly, 4 patients improved their scores postoperatively. In contrast to the naming function, BTLA+ and BTLA− patients were equally represented among the patients whose phonological and semantic fluency improved. This result further supports the specificity of BTLA mapping for naming outcome.

In contrast to previous studies,\textsuperscript{7,9,13,40} we did not find a correlation between older age at seizure onset and the postoperative naming decline. This result might be explained by the higher rate of HS (50%) and the smaller size of our cohort.

The fact that not all BTLA+ patients had an individual naming decline at T2 suggests that early naming decline depends not only qualitatively on the resection of the BTLA but also quantitatively on the percentage of resected positive language sites. Because of the small number of patients in the BTLA+ group, we were not able to properly test this hypothesis.

Finally, at both the individual and group levels, early naming decline observed after resection of the BTLA did not statistically persist at the long-term follow-up, suggesting long-term recovery. At the group level, the difference between the BTLA+ and BTLA− groups tended to be significant, suggesting that this recovery might be incomplete. At the individual level, this recovery is clinically meaningful and relevant for individual prediction in practice. Our study thus contributes to the resolution of the ongoing controversy regarding the effect of language site resection in dominant TLR.\textsuperscript{11,2,14–16,18}

The limitations of our study are its retrospective and noninterventional design and the possible spatial sampling bias with SEEG.

It was not possible to compare the prediction value of SEEG language mapping to the individual risk values obtained from the recently published nomogram,\textsuperscript{4} because, instead of the z-score, the nomogram used BNT (Boston Naming Test) raw scores, which do not allow the use of other naming tests.

**Conclusions**

To conclude, our study shows the utility of SEEG language mapping in the ventro-temporal cortex before dominant TLR. The results provide evidence that resection of the SEEG-mapped BTLA causes early significant but nonenduring specific decline in postoperative naming ability and contribute to resolution of the ongoing controversy regarding the effect of BTLA resection in dominant TLR. We strongly believe that patients should be informed preoperatively regarding the high risk of early significant naming decline in cases of BTLA resection. Moreover, in such situations, an intensive language rehabilitation pro-
gram could be planned preoperatively to improve postoperative long-term recovery.

Key Points
- The BTLA was delineated by high-frequency cortical stimulation during SEEG.
- Resection of the BTLA in epilepsy surgery is associated with a specific and early postoperative naming decline.
- In the longer term, this decline recovers, but the naming score tends to remain lower compared to the preoperative score.
- SEEG language mapping is useful to predict postoperative language outcome after dominant TLR.

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Disclosures
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Author Contributions
Conception and design: Maillard, Abdallah. Acquisition of data: all authors. Analysis and interpretation of data: Maillard, Abdallah, Brissart, Colnat-Coulbois, Aron, Forthoffer, Vignal, Jonas. Drafting the article: Maillard, Abdallah, Jonas. Critically revising the article: Maillard, Abdallah, Brissart, Colnat-Coulbois, Jonas. Reviewed submitted version of manuscript: all authors. Approved the final version of the manuscript on behalf of all authors: Maillard. Statistical analysis: Maillard, Abdallah. Study supervision: Maillard.

Correspondence
Louis Maillard: Lorraine University, Nancy, France. l.maillard@chru-nancy.fr.