



## Lexical retrieval pre- and posttemporal lobe epilepsy surgery in a pediatric sample

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### ABSTRACT

**Purpose:** This study aimed to evaluate lexical retrieval, presurgery and postsurgery, among children and adolescents who had undergone temporal lobe resection for intractable epilepsy and to compare outcomes in patients whose surgery involved the left temporal lobe or the right temporal lobe.

**Materials and methods:** A retrospective chart review identified 36 patients from a major pediatric epilepsy treatment center who had undergone temporal lobe resection (21 underwent left temporal lobe resection; 15 underwent right temporal lobe resection) for intractable epilepsy and who had completed neuropsychological testing that included a measure of confrontation naming (Boston Naming Test, BNT) and verbal fluency (Delis–Kaplan Executive Function System (D-KEFS) Fluency) prior to and after surgery. Linear mixed effects regression models were used to evaluate presurgery and postsurgery changes and to compare the left temporal lobe resection group with the right temporal lobe resection group.

**Principal results:** Confrontation naming performance declined after left, but not right, temporal lobe resection ( $p < 0.05$ ). This effect was not documented for verbal fluency.

**Major conclusions:** Left temporal lobe resection for intractable epilepsy is associated with a decline in lexical retrieval. The risk of decline in specific language functions following surgery involving the left temporal lobe should be incorporated in the counseling of patients and families in decision-making with regard to surgery.

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### 1. Introduction

Children and adolescents with medically refractory epilepsy are increasingly considered for surgical treatment, largely aided by neurodiagnostic advances in imaging and video-EEG monitoring [1]. The temporal region is the most frequent site of surgery for localization-related epilepsies [2]. Because of the crucial role of the temporal areas for language and memory, especially the left temporal region, achieving seizure freedom by resecting the entire epileptogenic zone needs to be balanced against the longer term functional impact of the surgery. Although there is an established literature on the functional impact of surgery in adults, less is known about the pediatric population. Such knowledge is important in assessing the risk and benefits of surgery in these cases.

In the present study, we evaluated performance, pre- and post-epilepsy surgery, on two commonly used measures of lexical retrieval, visual confrontation naming and verbal fluency, in children and adolescents who had undergone either left temporal lobectomy or right temporal lobectomy to relieve intractable seizures. Visual

confrontation naming entails retrieving the name of a visually depicted item, and verbal fluency is the ability to generate words based on a phonologic (letter) or a semantic (category) cue. Studies with clinical populations as well as functional neuroimaging studies with healthy controls implicate different circuits for these two tasks. The posterior aspect of the left temporal lobe has been associated with visual naming in both fMRI paradigms in adult volunteers [3] and cortical stimulation mapping in adult patients undergoing epilepsy surgery [4]. In contrast, the left frontal lobes [5] and, more specifically, the left inferior frontal gyrus [6] have been associated with verbal fluency in fMRI studies. Adults undergoing resection of the left frontal lobe for intractable seizures [7], moreover, show declines in verbal fluency. Importantly, fMRI studies have identified comparable patterns of activation on verbal fluency paradigms in adults and in children 5 years of age and older [8].

Confrontation naming and verbal fluency have been assessed in clinical studies of adults, pre- and post-epilepsy surgery, as well as in several pediatric studies. Sherman et al. [9] reported a meta-analytic review of neuropsychological changes following temporal lobe epilepsy (TLE) surgery in adults, who typically had childhood-onset epilepsy. Approximately one-third of patients with left TLE surgery showed reliable declines in confrontation naming, with only a negligible number of patients showing reliable gains (4%) and no change in patients with right TLE surgery. In contrast, verbal fluency was more often associated

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with gains (27%) than with losses (10%) after left TLE surgery, and gains and losses were relatively similar (21% and 16%) after right TLE surgery.

Several studies have reported surgery-related changes in these functions in pediatric populations, with mixed results. Jambaque et al. [10] evaluated presurgical and postsurgical neuropsychological outcomes for 20 children (7 to 14 years of age) undergoing temporal lobe epilepsy surgery. Presurgically, patients with left TLE showed poorer confrontation naming compared with patients with right TLE, and naming performance improved after surgery for the groups combined. Although they did not analyze these outcomes separately for hemisphere, the mean scores suggested improvement in both groups. There was no difference in verbal fluency related to hemisphere, and there was no change after surgery.

In another study of 20 pediatric patients (10 to 16 years of age), Lentz et al. [11] also reported presurgical language difficulties in patients with left temporal lobe epilepsy, with language improvement postsurgically. They similarly documented no change, however, in verbal fluency. They did not administer a confrontation naming task, however.

Thus, the available reports suggest that confrontation naming declines in adults after surgery, but the findings are more equivocal in pediatric populations, and there is actually some suggestion of improvement. The available data also suggest no difference presurgery and postsurgery for verbal fluency.

In the present study, we hypothesized, based on the literature, (1) that, prior to surgery, children and adolescents with left TLE will perform more poorly compared with those with right TLE on both confrontation naming and verbal fluency; (2) that left temporal resection (LTR) will be associated with postsurgical decline in confrontation naming but not right temporal resection (RTR); and (3) that there will be no surgery-related change in verbal fluency.

## 2. Materials and methods

### 2.1. Patients

Forty-three patients who underwent temporal lobectomy for intractable epilepsy at Boston Children's Hospital between 2004 and 2012 were identified through archival review from a total of 80 who had undergone temporal lobe epilepsy surgery (of a total of 230 focal epilepsy surgeries completed during this period). Participants were included in the final sample if they were eight years or older at the time of the presurgical evaluation. The age cutoff was determined by the established norms for the neuropsychological outcome measures. Other inclusion criteria were IQ greater than 70 (presurgical) and availability of both presurgical and postsurgical neuropsychological evaluations. Two patients in the left temporal resection (LTR) group (one because of age and the other because of IQ < 70) and five patients in the right temporal resection (RTR) group (four because of age, one because of IQ < 70) were excluded.

The final sample, thus, included 36 patients, 21 (52% were female) in the LTR group and 15 (40% were female) in the RTR group.

Language dominance was determined by a Wada test, as well as by fMRI when available. Other medical history was abstracted from the medical record (age at seizure onset, seizure frequency presurgery and postsurgery, tissue pathology, and polypharmacy). Presurgical intellectual functioning was assessed using one of the following measures: Wechsler Intelligence Scale for Children—Fourth Edition, Wechsler Adult Intelligence Scale—Third Edition, or Wechsler Adult Intelligence Scale—Fourth Edition [12–14]. Socioeconomic status (SES) was characterized using the Hollingshead Four-Factor Scale [15].

Table 1 shows the demographic characteristics of the two groups, and Table 2 shows the medical variables. There were no statistically significant differences between the LTR group and the RTR group in terms of their sex distribution, age, IQ, or SES. Similarly, there were no differences in their seizure or medication histories. One patient in each

**Table 1**  
Demographic characteristics.

	Left temporal resection	Right temporal resection
N	21	15
Female sex, N (%)	11 (52)	6 (40)
Ethnicity	86% white	87% white
Handedness	17 right, 4 left	10 right, 5 left
SES: Hollingshead modified		
Low, N (%)	6 (33%)	3 (25%)
Middle, N (%)	9 (50%)	4 (33%)
High, N (%)	3 (17%)	5 (42%)
Baseline VIQ, M (SD)	89.73 (11.18)	92.67 (13.96)
Baseline PIQ, M (SD)	99.53 (14.53)	96.22 (7.45)

group was taking topiramate. The age at seizure onset ranged between 0 and 16 years, and age at surgery ranged between 8 and 21 years. Two patients (without lesions) had seizure recurrence following surgery but had been seizure-free for six months at the time of neuropsychological follow-up.

### 2.2. Design

A mixed models design was used, with side of surgery as the between-subjects factor and presurgery and postsurgery as the within-subject factors.

### 2.3. Procedure

Data were obtained from a retrospective chart review. Neuropsychological assessments were conducted in an outpatient hospital setting. All measures were administered by a licensed clinical neuropsychologist or by a postdoctoral fellow in neuropsychology under the supervision of a licensed clinician. Presurgical assessments were conducted approximately six months prior to surgery (median = 5, range = 1–29 months). Postsurgical assessments took place within the first year after the surgery (median = 8, range = 4–36 months).

### 2.4. Measures

The neuropsychological assessment protocol typically included the following measures of word retrieval, which were abstracted from the clinical reports for the present study.

The Boston Naming Test (BNT) [16] is a standard measure of confrontation naming in which the patient is shown a series of line drawings of objects of increasing difficulty and asked to name them. Z-scores for the total number of items answered correctly were calculated using published age norms [16,17]. Presurgical and postsurgical data were available for 21 patients in the LTR group and for 10 patients in the RTR group.

The Delis–Kaplan Executive Function System (D-KEFS) [18], Letter Fluency and Category Fluency, is a measure of verbal fluency in which the patient is asked first to name all the words they can think of beginning with a certain letter (phonologic cue) and then to name all the

**Table 2**  
Seizure-related variables.

	Left (N = 21)	Right (N = 15)
Age at seizure onset in years, median (range)	3.5 (0–16)	7 (9–21)
Seizure onset prior to age 2, N (%)	8 (38)	4 (27)
Age at surgery in years, median (range)	16 (8–21)	15 (9–21)
Seizure duration in years, median (range)	7 (2–18)	8 (2–20)
Nonlesional MRI, N (%)	7 (33)	3 (20)
Language dominance (left/right/bilateral)	20/1/0	12/0/3
Wada/fMRI/both	5/3/13	2/5/6

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