



Comprehension and production of nouns and verbs in temporal lobe epilepsy



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ABSTRACT

Previous research on linguistic performance at the single-word level in patients with temporal lobe epilepsy (TLE) has mostly been limited to the comprehension and production of nouns, and findings have been inconsistent. Results are likewise limited and controversial regarding the lateralization of the epileptogenic focus. The present study investigates comprehension and production of nouns and verbs in patients with left and right TLE (12 in each group). We designed a comprehension (word-picture matching) test and a production (naming) test, matched on a range of psycholinguistic parameters for the two word classes. The results showed impaired verb comprehension in patients with left TLE and impaired noun and verb production in both groups of patients compared to the control group. Patients with left and right TLE differed significantly on verb comprehension and noun production, whereas verb production was equally impaired in the two groups of patients. These findings suggest difficulties with single-word processing in patients with both left and right TLE, which are more prominent for verbs than for nouns in patients with left TLE. The verb production (action naming) test turned out to be the most effective tool for assessing linguistic difficulties at the single-word level in patients with TLE.

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1. Introduction

Evidence is accumulating on language comprehension and production at different linguistic levels in patients with temporal lobe epilepsy (TLE). Semi-structured interviews and stories elicited by one or a series of pictures [1–3] provide information about language production at the discourse level. Tasks on sentence-picture matching, performing oral commands, or describing situations have been used to investigate language processing at the sentence level [1,2,4]. Word-picture matching and naming tasks have been widely applied for the assessment of single-word comprehension and production (e.g., [1,2,4–7]). However, language assessment at the single-word level is usually limited to the comprehension and production of nouns. As a result, little is known about cross-class variation (specifically, nouns vs. verbs) in the language performance of patients with TLE, which may be related to semantic and grammatical differences between the word classes. Thus, evaluating the comprehension and production of both nouns and verbs in patients with left (dominant) and right (nondominant) TLE could contribute to a deeper understanding of the mechanisms of language impairment caused by the disease.

Although there is some evidence on single-word comprehension in patients with TLE, the results are not consistent. Giovagnoli and colleagues [5] observed impaired single-word comprehension in patients with left TLE compared to the healthy control group. The authors proposed that epilepsy may cause limited impairment in storing semantic knowledge and information retrieval in patients with left TLE. In contrast, Kho and coauthors [4] did not find any significant difference across patients with left TLE, patients with right TLE, and healthy controls for auditory and visual noun comprehension tasks using the Aachen Aphasia Test (AAT). Additionally, Bartha and colleagues [2] did not find any statistically significant difference between patients with left and right TLE on a word-picture matching task (AAT, Innsbrucker Benenntest), although ability was more often impaired in patients with left TLE as compared to patients with right TLE.

The results are more consistent on single-word production. In object naming tests, patients with left-lateralized epileptogenic focus showed lower performance as compared to patients with right-lateralized focus [5,7–11]. However, in several other studies both groups of patients showed significant naming and word finding difficulties [2,12] as compared to healthy controls [4,6,13]. Such heterogeneous results may be at least partly related to differences in the frequency of items included in the tests (for a comparison of the Boston Naming Test and Visual Naming Test, see [9,14]). In particular, failure to

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name low-frequency items during naming assessment might confound naming impairment with vocabulary demands [14].

The observed naming difficulties in patients with TLE are often attributed to a general impairment of lexical access, whereas semantic processing is considered to be intact (see, e.g., [6,11,13]). This suggestion is based on qualitative analyses of patients' responses and assessment of their performance in other language domains. Patients with TLE benefited from phonetic cues facilitating lexical access [6,11]. Moreover, during tip-of-tongue states they could provide information on the gender of a searched word [11], and performance was influenced by lexical frequency. Furthermore, in contrast to naming, semantic priming and picture matching tasks did not show any significant difference between patients with left and right TLE. This suggests a dissociation between lexical and semantic processing in patients with left TLE [15].

It is important to note that, so far, single-word level assessment in patients with TLE has only focused on nouns. However, other clinical and neuroimaging studies show that the language-dominant temporal lobe is involved in both noun and verb processing [16–21]. A number of studies on aphasia caused by damage to the language-dominant hemisphere show that verb production is impaired to the same or an even higher extent as compared to production of nouns [22–28]. Verb production was also found to be impaired in other clinical populations such as patients with Parkinson's [29–31] and Alzheimer's [19,32] diseases. Concerning single-word comprehension, some studies failed to show any difference between the comprehension of nouns and verbs in patients with aphasia [33] and Alzheimer's disease [34], whereas others indicated a significant impairment in the comprehension of verbs as compared to nouns in patients with aphasia [34–36]. Thus, assessment of both noun and verb comprehension and production in patients with TLE would be helpful for the investigation of language functioning in this clinical population.

To our knowledge, the only work that has addressed both object and action naming (i.e., the production of nouns and verbs) in patients with TLE is the study by Messas and coauthors [37]. According to their results, patients with left and right TLE performed significantly worse on object naming as compared to healthy participants, whereas no difference among the groups was found for action naming. Similar results were observed for the word-picture matching tests, which included items not named during the naming tasks. However, the noun and verb tests differed significantly in size (naming tests included 64 trials for objects vs. 13 trials for actions; the number of trials used for the word-picture matching tests depended on the naming performance and differed for each individual patient), and the authors did not report psycholinguistic parameters of the used items, thus making it difficult to assess the comparability of the tests. Since such parameters as word frequency and age of acquisition influenced naming performance in various clinical populations [9,14,38–40], the observed differences in patients' performance between nouns and verbs may be attributed to discrepancies in the characteristics of the tests.

The goal of the present study was to investigate the comprehension and production of nouns and verbs in patients with left and right TLE using items with comparable characteristics for the two word classes. We assumed that the assessment of verb comprehension and production could be an additional and presumably more sensitive instrument that would allow us to more deeply understand the mechanisms underlying language functioning in patients with TLE. Based on previous results on single-word comprehension in patients with TLE, we hypothesized that the ability would be impaired in patients with left TLE as compared to healthy individuals and patients with right TLE, whereas patients with right TLE will not differ from the control group. Concerning single-word production, we expected that object naming would be impaired in patients with left TLE and, presumably, those with right TLE, as compared to healthy individuals. The difference between the two groups of

patients may also reach significance. The results concerning noun and verb comprehension and production in other clinical populations also suggest that the differences between patients with TLE and control participants would be more prominent for the verb comprehension and production tests as compared to the noun comprehension and production tests, correspondingly.

2. Method

2.1. Participants

Twelve patients with left TLE (nine females; mean age = 29.7 years, SD = 6.9, range = 20–47 years; mean years of education = 14.4, SD = 1.9) and twelve patients with right TLE (five females; mean age = 31.7 years, SD = 15.3, range = 22–56 years; mean years of education (including school education, higher education (college and/or university), and PhD programs) = 15.3, SD = 3.6) participated in the study. The control group included twelve healthy individuals (eight females; mean age = 32.3 years, SD = 8.2, range = 20–48 years; mean years of education = 16.1, SD = 2.6) with no history of neurological or psychiatric disorders. All participants were right-handed, were native speakers of Russian, and had no uncorrected vision or hearing problems. The three groups of participants were matched on the male/female ratio, age, and years of education. Demographic data are presented in Table 1.

The epileptogenic focus in each patient was localized using ictal and interictal video electroencephalograms, seizure semiology, and brain MRI data. In the group of patients with left TLE, five patients had hippocampal sclerosis, whereas six patients were diagnosed with a tumor (two – dysembryoplastic neuroepithelial tumor, four – ganglioglioma) and one patient had a cavernoma. The group of patients with right TLE included seven patients with hippocampal sclerosis, two patients with a tumor (one – dysembryoplastic neuroepithelial tumor, one – astrocytoma), two patients with a cavernoma, and one patient with an encephalocele. Five patients in the group with left TLE and eight patients with right TLE only had nonconvulsive seizures, whereas seven patients in the group with left TLE and four patients with right TLE also suffered from convulsive seizures (in six patients with left TLE and three patients with right TLE, convulsive seizures occurred less than once a month). The two groups of patients did not differ regarding age at seizure onset, duration of epilepsy in years, current frequency of seizures, and number of antiepileptic drugs (for clinical data see Table 1).

All participants signed an informed consent. The study was approved by the Committee on Interuniversity Surveys and Ethical Assess of Empirical Research of the National Research University Higher School of Economics.

Table 1
Demographic and clinical data of participants.

	Group with left TLE	Group with right TLE	Control group	<i>p</i>
	Mean (SD)	Mean (SD)	Mean (SD)	
Gender	3 m/9 f	7 m/5 f	4 m/8 f	0.22 ^a
Age (years)	29.7 (6.9)	31.7 (15.3)	32.3 (8.2)	0.68 ^b
Education (years)	14.4 (1.9)	15.3 (3.6)	16.1 (2.6)	0.35 ^c
Age at seizure onset (years)	11.1 (13.4)	15.7 (12.3)		0.15 ^d
Duration of epilepsy (years)	18.6 (9.2)	16.0 (10.4)		0.52 ^d
Current frequency of seizures (per month)	43.2 (86.3)	17.2 (42.1)		0.35 ^d
Number of antiepileptic drugs	1.6 (0.7)	2.1 (0.5)		0.08 ^d

^a χ^2 Test.

^b Kruskal–Wallis *H* test.

^c One-way ANOVA test.

^d Mann–Whitney *U* test.

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