

## Targeted Review

## Object naming in epilepsy and epilepsy surgery



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## ABSTRACT

The ability to express oneself verbally is critical for success in academic, occupational, and social domains. Unfortunately, word-finding or “naming” difficulty is the most common cognitive complaint among individuals with temporal lobe epilepsy (TLE), and a substantial body of work over the past several decades has documented naming impairment in left (language-dominant) TLE, with further risk to naming ability following left temporal lobe resection for seizure control. With these findings well established, this paper reviews more recent work that has aimed to identify the neuroanatomical substrates of naming, understand how adverse structural and functional effects of TLE might impinge upon these brain regions, predict and potentially reduce the risk of postoperative naming decline, and begin to understand naming difficulty in TLE from a developmental perspective. Factors that have confounded interpretation and hindrances to progress are discussed, and suggestions are provided for improved empirical investigation and directions for future research.

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## Key questions

1. What is the psycholinguistic dysfunction that underlies naming difficulty in LTLE?
2. What are the neural substrates of object naming, and how are these affected by TLE?
3. What are the predictors of postoperative naming decline, and can the risk of decline be reduced?
4. What do we know about naming in children with epilepsy?

## 1. Introduction

Subjectively, we experience our thoughts as automatically transformed into speech, without conscious planning of each spoken word. On occasion, most healthy adults experience word-finding difficulty or the tip-of-the-tongue (TOT) phenomenon, i.e., the temporary inability to retrieve a word while knowing that it is in the mental lexicon. These transient states can be frustrating in the moment; yet, given their infrequency, they are not typically a source of significant distress. However, for many individuals with epilepsy, particularly those with seizures arising from the language-dominant temporal region, word-

finding difficulty can be a bitter frustration in everyday life. In fact, TOT has been reported to be the highest ranked cognitive complaint among people with epilepsy [1,2].

Given the prevalence of word-finding complaints among patients with epilepsy, assessment of word-finding or “naming” ability is a routine component of neuropsychological evaluation for these patients, and naming in epilepsy is a topic of research that has received considerable attention. With few exceptions, naming assessment, for both clinical and research purposes, has been in the form of object naming, mainly, visual object naming, in which the examinee is requested to name a series of line-drawn objects. Considering the complexity of word retrieval and the varied circumstances in which word finding difficulty occurs in natural language, it is reasonable to question why the assessment and investigation of this function have been reduced to object naming.

We can speculate that the task's ease of administration and time efficiency favored its utilization over other, more cumbersome and time intensive tasks (e.g., spontaneous speech analysis) that are used more often with patients with frank aphasia. Additionally, object naming does, in fact, capture multiple language mechanisms including semantic, lexical, and phonological processes. Importantly, the vast literature utilizing object naming in TLE has produced consistent and reliable results. Decades of research has established very clearly that naming impairment is a prominent finding in left language-dominant TLE (LTLE) [3,4] and that temporal lobe resection for seizure control presents a risk of naming decline among patients with left (dominant), but not right (nondominant), TLE (RTLE) [5–8].

With this solid body of research as a firm foundation, we can now turn our attention to more recent work that evolved from this original

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line of inquiry, with the goal of both deepening and expanding our understanding of naming in epilepsy and following epilepsy surgery. This review will address the key questions stated earlier.

## 2. What is the psycholinguistic dysfunction that underlies naming difficulty in LTLE?

Despite its apparent simplicity, object naming is a complex process involving an array of mechanisms leading to the identification of the word that best matches a specific meaning (semantics) and to the retrieval and realization of word sounds (phonology) [9–12]. Thus, naming failure can be caused by impairment in any of the subprocesses within this larger set of mechanisms (see Fig. 1). In contrast to the vast literature documenting naming deficits in LTLE, only a handful of studies have sought to identify the underlying source of naming impairment. Although limited, this literature is characterized by a controversy structured around whether naming errors are due to disturbances in the semantic processing and storage or in the lexical/phonological processing required for the retrieval of words and word sounds.

A similar debate transpired in the dementia literature in the 1980s and 1990s, ultimately concluding that naming impairment in patients with probable AD is due to a breakdown in the semantic system [13–16]. Some investigators have proposed a similar breakdown in LTLE. Studies that implicate impaired semantic functioning have reported poor quality of spoken definitions [17] and deficits on tasks that require identification of items named by the examiner among related or unrelated pictured objects (“Picture Pointing”) or decisions whether line drawings represent real or unreal objects (“Object Decision”) [18]. These deficits were shown to contrast with intact productive and receptive phonological speech processing. Most relevant, in postoperative patients, poorer discrimination of objects within a semantic category was associated with naming decline [19].

A concern in interpreting some of this work is related to the use of verbal responses to evaluate the semantic system. Defining words requires word retrieval, potentially confounding the quality of the definitions. Additionally, tasks involving phonological analysis might not utilize the particular aspects of phonological functioning that are required for object naming.

Results from another small group of studies suggest that naming difficulty more likely arises from problems in postsemantic, phonological processing. Two of these studies, which analyzed object-naming errors, found that neither semantic errors (i.e., incorrect word substitution, e.g., “seagull” for “penguin”) nor accuracy scores (which merely correlated with IQ) predicted laterality of seizure onset. Rather, the presence of phonological paraphasic errors (i.e., incorrect phoneme substitution, such as, “zeef” for “reef”), although relatively infrequent (i.e., mean = 1.60,  $SD = 1.68$  in the left/dominant group [20]), significantly predicted left TLE versus right TLE for individual patients [21]. Moreover, only the frequency of phonological errors was associated with object-naming performance [20]. Finally, in a detailed analysis of both conscious

(effortful) semantic processing and unconscious (automatic) semantic processing that analyzed response time rather than verbal responses, we found intact semantic priming on a lexical (i.e., word–nonword) decision task and intact performance, i.e., comparable with healthy controls and patients with RTLE, on a semantic judgment task that required detailed object knowledge [22]. Importantly, in this context of comparable performances across semantic measures, only patients with LTLE exhibited impaired object-naming performance, suggesting that the naming impairment in TLE cannot be attributed to impaired semantic processing.

Although subjective reports should be considered with caution, the frequently reported complaint of TOT could be taken to suggest that word finding difficulty in LTLE occurs after semantic access. During TOT states, individuals can typically describe the item they are unable to name, underscoring successful semantic retrieval, [23] and can often provide the first phoneme, number of syllables, and syllabic stress of the item name, indicating partial access to phonological information [24–27]. However, TOT states per se have not been studied empirically in TLE.

Overall, most of the evidence thus far points to postsemantic difficulty in word retrieval; however, the well-established verbal learning deficit in patients with LTLE [28–30] would be consistent with a reduction in semantic knowledge, which could potentially alter the threshold at which concepts and words become activated. Nevertheless, the relative reduction in conceptual knowledge in LTLE might not be sufficiently severe to underlie a deficit in retrieving words that are solidly within an individual’s working vocabulary. To date, most investigations of naming have relied on the Boston Naming Test (BNT) [31] or similar measures, which contain many high-level, low frequency items (e.g., palette and sphynx) that confound the assessment of naming with vocabulary knowledge. Further work, utilizing appropriately familiar items and focusing on the aspects of semantic processing and phonological processing that are directly relevant to object naming, will hopefully clarify the nature and the proportional contribution of semantic difficulty and phonological difficulty to naming impairment in LTLE.

## 3. What are the neural substrates of object naming, and how are these affected by TLE?

### 3.1. Semantics

The mental organization, processing mechanisms, and neural correlates of semantic memory have been the subjects of numerous empirical investigations. This literature is well summarized in several comprehensive reviews to which the reader is referred [10,32,33] and, therefore, is only briefly summarized here. Although the concentration on object naming in investigations of semantic processing could be considered restrictive, one advantage is that its routine use has allowed for comparison across methodologies and subject populations. Results from lesion analyses of large cohorts of neurological patients, together with functional neuroimaging findings in both patient and healthy populations,

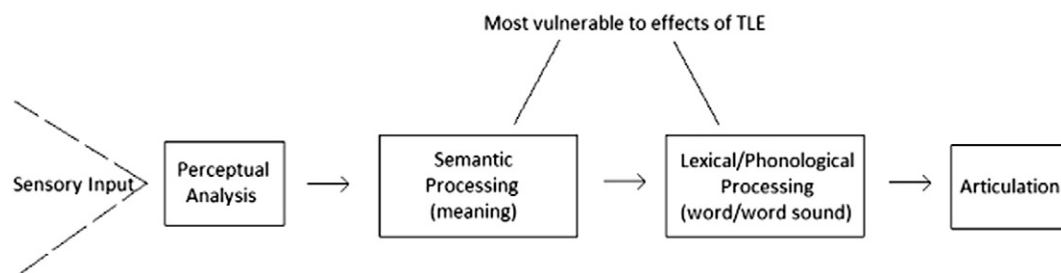


Fig. 1. Underlying psycholinguistic subprocesses of object naming.

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