

WHAT'S IN A WORD? (. . . AND WHY IT MATTERS)

Brain Stimulation Reveals Critical Auditory Naming Cortex

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One challenge in dominant temporal lobe epilepsy surgery is to remove sufficient epileptogenic tissue without compromising postoperative language functioning. Pre-resection electrical stimulation mapping enables identification of language areas that can be spared from resection, and also provides a unique opportunity to investigate brain–language relationships. Visual object naming is the gold standard for identifying “essential” language cortex; however, sparing visual naming (VN) sites has not reliably prevented postoperative language decline. In addition to visual object naming, we included a more “ecologically valid” auditory description naming task in our pre-

resection cortical mapping protocol. Of the seven patients who had auditory naming (AN) sites removed, six declined postoperatively, whereas of the 12 patients who did not have AN sites removed, only 3 declined postoperatively ($p = 0.02$), suggesting an association between AN site removal and postoperative naming decline. Interestingly, although VN sites were preserved in all patients, AN site removal resulted in decline in both auditory and VN tasks. These findings not only have potentially critical clinical significance, but also argue for modality specificity, with considerable integration within the semantic system.

COMMENTARY

An important aspect of human language is the simple but essential ability to retrieve a word when needed in conversation. Breakdown in the ability to efficiently retrieve a target word usually involves a noun, fact, or name—in other words, some aspect of what is known as semantic knowledge. Clinically, the ability to retrieve words is tested by confrontation naming, which entails showing an object or a line drawing of an object (e.g., a fork) to a patient and requesting the correct verbal label. A variety of errors can result, including blocking (i.e., an inability to name), circumlocution (i.e., describing rather than naming the object, such as “you use it to eat”), or substitutions of various types, including semantic (spoon) and literal (pork) paraphasias or neologisms. The familiar “tip-of-the-tongue” phenomenon occurs when there is an inability to name an object or person but the correct name “feels” as if it is about to become available. Tests of confrontation naming or nominal speech are incorporated into virtually all the standard language batteries (e.g., Boston Diagnostic Aphasia Examination, Multilingual Aphasia Examination) as well as commonly used mental status screening measures (e.g., Mini-Mental Status Examination). The most well known of all naming tests is the Boston Naming Test—a 60-item test of visual confrontation

naming, with items of progressively increasing difficulty, ranging from bed to abacus (1).

Confrontation naming has an interesting history in epilepsy research and care. Word finding problems are a very common patient complaint, and naming ability is tested during routine neuropsychological evaluations, carefully assessed in surgical candidates when searching for impairments of lateralizing significance, and evaluated during the intracarotid amobarbital procedure to help determine language lateralization. At surgical epilepsy centers, naming also is a core component of language assessment during intraoperative or extraoperative mapping (2–5).

Epilepsy surgical centers vary in regard to how patients with temporal lobe epilepsy without cortical lesions are managed during left (dominant) anterior temporal lobe resection. In fact, very different approaches date back to the beginning of the modern era of anterior temporal lobectomy. Penfield and colleagues at the Montreal Neurological Institute intraoperatively mapped language and other abilities in the awake patient, while Falconer and associates at the Maudsley Hospital in London performed dominant anterior temporal lobectomy en bloc, without mapping. Subsequently, neurological surgeons have been schooled in these and other approaches, and each camp has its own views of process and outcome.

Discussions regarding the relative merits of mapping versus not mapping in nonlesional temporal lobe epilepsy came into sharp focus during the Second Palm Desert International Conference on the Surgical Treatment of the Epilepsies (6).

Questions relating to the ways in which various surgical approaches affected postoperative language function were critically addressed (7), but there was surprisingly little controlled outcome data with which to answer these questions. As a consequence, more outcome information began to appear. Saykin and colleagues elegantly demonstrated the specificity of word finding problems following left anterior temporal lobe resection, and the authors found that better language outcome was associated specifically with earlier age of onset of epilepsy and absence of early risk factors for epilepsy—one of the more reliable findings in the field (8). There have been no randomized clinical trials comparing language outcome of patients who underwent language mapping with those who did not undergo mapping, but collaborative multicenter studies have demonstrated that postoperative word finding problems can be observed, regardless of the surgical approach used (9,10). Overall, epilepsy surgery centers are increasingly proactive in defining the degree of risk associated with various surgical approaches, in identifying patient factors associated with increased risk, and in investigating surgical modifications that may reduce identified risk. But, the ability of the patient to perform classic confrontation naming tasks has been a primary theme and focus of concern.

It is in this context that Hamberger and colleagues entered the field with a completely fresh perspective. They drew attention to the perplexing fact that it is common to find patients who complained bitterly of word finding problems in their conversational speech, yet these same patients do not exhibit impairments on traditional tests of visual confrontation naming (11). The issue, the authors thought, might require a different assessment approach. In prior publications, Hamberger and Seidel first developed and tested a new way to assess what they termed “auditory naming” ability (12), which is the ability of a patient to name an object based on a brief description or definition (e.g., “the instrument that measures temperature is called a _____”). They hypothesized that perhaps this format might be a more representative (or ecologically valid) approach, and indeed, performance on the new task was more closely related to patient complaints of day-to-day word finding problems than was traditional visual confrontation testing. Most interestingly, Hamberger and colleagues reported that there appeared to be a different anatomical representation between the ability to name an object based on a brief description and the ability to name using traditional visual confrontation naming. In the human temporal lobe, auditory naming sites were more likely than visual naming sites to be represented in the anterior temporal lobe, that is, in regions that might be excised in a standard resection (13,14).

However, following these initial findings, the fundamental issue of what the identified auditory naming sites actually represented remained to be determined. They could represent a noncritical node in a widely distributed neuronal system, and

their resection could be without effect. Conversely, they could represent a critical site, and their resection could have meaningful adverse consequences, resulting in postoperative word finding problems. The need to address this issue led to the publication under review. The standard of practice for mapping is to identify and avoid resection of those sites where electrical stimulation impairs visual confrontation naming ability, which was the process followed by Hamberger et al. in this paper. Auditory naming sites are rarely routinely mapped and resections typically take place without their consideration. Following the standard of practice, Hamberger et al. spared all identified visual naming sites but auditory naming sites were resected in some but not all patients. The surgical patients were administered three tests to assess visual and auditory naming, including the Boston Naming Test, preoperatively and 1 year later. The results indicate that resection of auditory naming sites had clear consequences; specifically, their resection increased tip-of-the-tongue phenomena and/or decreased performance on naming tasks. Thus, auditory naming sites matter.

A number of factors have been found to be reliably associated with a decline in visual confrontation naming in the absence of mapping, including later age of onset of epilepsy, absence of hippocampal sclerosis, and characteristics of the words that have been “lost,” such as their age of acquisition; many of these factors were not associated with declines in auditory naming in the Hamberger et al. paper. However, the number of subjects studied was modest in size, and the statistical power was not high. Another interesting question is the fate of auditory naming in standard resections that are not associated with changes in visual confrontation naming performance, as a result of optimized patient selection and surgical technique (15). But, those are tasks for the future. Overall, Hamberger and colleagues have provided a series of investigations that yield new information regarding a clinically significant problem that has proven resistant to solution over the years. These findings will continue to be of theoretical interest, improve patient care, and encourage investigation by others—what a combination.

by Bruce Hermann, PhD

References

1. Lezak MD, Howieson DB, Loring DL, Hannay HJ, Fischer JS. *Neuropsychological Assessment* (4th ed). New York: Oxford University Press, 2004.
2. Devinsky O, Perrine K, Llinas R, Luciano DJ, Dogali M. Anterior temporal language areas in patients with early onset of temporal lobe epilepsy. *Ann Neurol* 1993;34:727–732.
3. Luders H, Lesser RP, Hahn J, Dinner DS, Morris HH, Wyllie E, Godoy J. Basal temporal language area. *Brain* 1991;114:743–754.

4. Ojemann GA, Schoenfield-McNeill J. Activity of neurons in human temporal cortex during identification and memory for names and words. *J Neurosci* 1999;19:5674–5682.
5. Schwartz TH, Devinsky O, Doyle W, Perrine K. Function-specific high probability “nodes” identified in posterior language cortex. *Epilepsia* 1999;40:575–583.
6. Engel J Jr. (ed). *Surgical treatment of the epilepsies* (2nd edition). New York: Raven Press, 1993.
7. Ojemann GA, Sutherling W, Lesser RP, Dinner DS, Jayakar Saint-Hilaire J. Cortical stimulation. In: J Engel Jr, ed, *Surgical treatment of the epilepsies* New York: Raven Press, 1993:399–414.
8. Saykin AJ, Stafiniak P, Robinson LJ, Flannery KA, Gur RC, O'Connor MJ, Sperling MR. Language before and after temporal lobectomy: specificity of acute changes and relation to early risk factors. *Epilepsia* 1995;36:1071–1077.
9. Hermann BP, Perrine K, Chelune GJ, Barr W, Loring DW, Strauss E, Trenerry MR, Westerveld M. Visual confrontation naming following left anterior temporal lobectomy: a comparison of surgical approaches. *Neuropsychology* 1999;13:3–9.
10. Davies KG, Risse GL, Gates JR. Naming ability after tailored left temporal resection with extraoperative language mapping: increased risk of decline with later epilepsy onset age. *Epilepsy & Behavior* 2005;7:273–278.
11. Hamberger MJ, Tamny TR. Auditory naming and temporal lobe epilepsy. *Epilepsy Res* 1999;35:229–243.
12. Hamberger MJ, Seidel WT. Auditory and visual naming tests: normative and patient data for accuracy, response time, and tip-of-the-tongue. *J Int Neuropsychol Soc* 2003;9:479–489.
13. Hamberger MJ, Goodman RR, Perrine K, Tamny T. Anatomic dissociation of auditory and visual naming in the lateral temporal cortex. *Neurology* 2001;56:56–61.
14. Hamberger MJ, Seidel WT, Goodman RR, Perrine K, McKhann GM. Temporal lobe stimulation reveals anatomic distinction between auditory naming processes. *Neurology* 2003;60:1478–1483.
15. Wyler AR. Recent advances in epilepsy surgery: temporal lobectomy and multiple subpial transections. *Neurosurgery* 1997;41:1294–1301.