

CATEGORY-SPECIFIC NAMING DEFICIT AFTER EPILEPSY SURGERY IN THE LEFT TEMPORAL LOBE: FACT OR FICTION?

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SUMMARY

Objective. Object naming for specific semantic categories was assessed in a sample of 24 patients with left temporal lobe epilepsy. Testing occurred during preoperative clinical diagnostics and 6 months after surgery.

Background. Category-specific deficits constitute a naming disorder for living or nonliving objects or subsets of these categories (e.g. animals, fruits, tools) with relatively spared naming for other object domains. Theoretically, these deficits can provide insight into the storage of conceptual information in distinct brain regions.

Method. For the purpose of this study a test battery of 160 clipart illustrations was used. Object naming was registered for different sets of living and nonliving categories.

Results. Two patients with preoperative intact naming performance showed a specific naming deficit for living categories (food, animals) after surgery in the left temporal lobe.

Conclusions. Category-specific naming deficits comprise a potential negative side effect after surgery in the speech-dominant left temporal lobe. Based on the requirements for object identification it is hypothesized that the left temporal lobe represents a visual feature store sensitive for the identification of living objects.

INTRODUCTION

In epilepsy patients left anterior temporal lobectomy (LATL) often leads to deficits in visual confrontation naming ability. In recent studies, postoperative

naming decline has been confirmed at a few weeks (Saykin et al. 1995), 6 months (Hermann et al. 1994) and 1 year (Langfitt & Rausch 1996) after surgery. Risk estimates are not clear-cut and depend on the etiology (Davies et al. 1998), e.g. hippocampal sclerosis, the functional neuroanatomy (Schwarz et al. 2005), e.g. language organization, and epilepsy history (Bell et al. 2002), e.g. seizure onset. Generally, up to 60-80% of patients show a decline in naming performance after LATL (Davies et al. 1998, Bell et al. 2002).

In the last 25 years category-specific naming deficits have been reported in patients with Herpes simplex encephalitis (Warrington & Shallice 1984), Alzheimer's disease (Gonnerman et al. 1997), left hemisphere damage (Silveri et al. 1997), and lesions in the thalamus (Crosson et al. 1997). Typical for this disorder is a naming deficit for living or nonliving objects or subsets of these categories (e.g. animals, fruits, tools) with relatively spared naming for other object domains. Recently Tippett et al. (1996) reported a deficit for non-living objects in epilepsy patients after LATL. It should be noted, however, that in this study naming performance was assessed selectively after surgery without baseline testing.

Theoretical perspective

Several theories have been proposed to explain the representation of semantic categories in the brain. For visual object identification the question is how semantic concepts and superordinate categories are organized anatomically, and how these representations are affected by brain damage. Aside from conceptual differences, feature-type theories offer the most scientific benefit (Figure 1). The following aspects are relevant:

- Living objects are identified by salient visual features (e.g. color, form, spatial attributes). Nonliving objects are identified by visual features and specific functional properties (e.g. tools) (Warrington & McCarthy 1987).
- Semantic concepts for living objects (e.g. lion, dog, tiger) share large sets of interrelated visual features. Semantic concepts for nonliving objects (e.g. hammer, plane) are much more segregated with limited feature overlap (Gonnerman et al. 1997).
- Discrimination of objects from the same semantic category is performed by distinct visual and/or functional features (e.g. tiger, but not lion, has stripes) (Gonnerman et al. 1997, Moss & Tyler 2000).
- Semantic concepts with interrelated visual and/or functional features are resistant to damage. Semantic concepts with distinct features are sensitive to damage (Moss & Tyler 2000).

Concerning the representation of semantic categories in the brain two main approaches are generally taken into account. According to the first, semantic categories are organized in focal brain systems representing features for object identification (Warrington & McCarthy 1987). With this approach, category-specific deficits result from localized brain damage in a sensitive region with only limited negative effect for other categories. According

to the second, semantic categories are represented by complex activity patterns integrating information from multiple representation sites (de Almeida 1999). With this approach, objects and object categories are represented in a widespread format that encompasses multiple anatomical units.

MATERIAL AND METHODS

We investigated for category-specific naming deficits a consecutive series of 24 patients with focal left (LATL) and right (RATL) temporal lobe epilepsy before and after epilepsy surgery. The patients' clinical data are given in Table 1. Patients were tested preoperatively during evaluation for surgical treatment of epilepsy and postoperatively 6 months after surgery. The following inclusion criteria were applied:

- (a) resection of the anterolateral temporal lobe and hippocampus;
- (b) speech dominance of the left hemisphere;
- (c) first-time execution of brain surgery.

Determination of speech dominance resulted preoperatively from intracarotid amobarbital testing with alternating selective anesthetization of the left or right hemisphere, and then speech and memory testing of the isolated, awake hemisphere.

For category specific naming ability an object naming test was developed that included a variety of living categories (animals, plants, body parts, food) and nonliving categories (tools, vehicles, buildings, articles of daily use). As stimulus material 160 color pictures were selected from a sample of clipart illustrations. The illustrations were presented on a computer screen in mixed form without any categorical order. The patients were instructed to articulate the first name that came to mind following object presentation. A naming attempt was labeled a failure if the patient response deviated from the target name either semantically or phonologically. Test performance resulted in an overall sum score and a sum score for the semantic category.

Table 1. Characteristics of patient groups. Values are mean and standard deviation (in parentheses). H: hippocampal sclerosis, T: tumor, G: gliosis, D: cortical dysplasia, VM: vascular malformation. All patients were right handed

	LATL	RATL
N	13	11
Age	35.4 (12.03)	33.6 (8.14)
Epilepsy onset	14.7 (11.24)	14.2 (5.76)
Etiology	H: 4 (30.8%) T: 6 (46.2%) G: 1 (7.7%) D: 1 (7.7%) VM: 1 (7.7%)	H: 3 (27.3%) T: 5 (45.5%) G: 1 (9.1%) D: 1 (9.1%) VM: 1 (9.1)

RESULTS

In the patient sample investigated two cases (H.K., B.E.) were identified with preoperative intact naming performance and selective impairment for living objects after LATL. The medical history of both patients is described in detail below.

Case H.K. (Table 2)

This is a 48-year-old, right-handed patient, with seizure onset at the age of 12. Video-EEG monitoring, MR imaging and electrocorticography localized the epileptic focus in the left anterior temporal lobe. Preoperative intracarotid amytal testing demonstrated left hemisphere speech dominance. Epilepsy surgery involved the anterior temporal lobe, including 45 mm of the inferior and middle temporal gyrus, 35 mm of the superior temporal gyrus (temporal tip as reference point) and the anterior 20 mm of the hippocampus. Histological examination revealed hippocampal sclerosis.

Table 2. Patient H.K. with naming deficit for fruits. 75% of the presented fruits were named incorrectly. SC: same category, OC: other category

Object stimulus (target name)	answer
STRAWBERRY	tomato
GRAPES	tomato
BANANA	tomato
CHERRY	tomato
ORANGE	lemon (SC)
MELON	pineapple (SC)
PLUM	cherry (SC)
LEMON	carrot (OC)
KIWI	no answer

Case B.E. (Table 3)

This is a 48-year-old, right-handed patient, with seizure onset at the age of 26. Video-EEG monitoring and MR imaging localized the epileptic focus in the left medial temporal lobe. Preoperative intracarotid amytal testing showed left hemisphere speech dominance. Temporal lobe resection involved 35 mm of the medial temporal gyrus (temporal tip as reference point) and the anterior 35 mm of the hippocampus. Histological examination revealed AV-angioma.

Table 3. Patient B.E. with naming deficit for animals. 41% of the presented animals were named incorrectly. *SC*: same category, *SUPC*: superordinate category, *DOM*: object domain

Object stimulus (target name)	answer
ZEBRA	horse (SC)
DONKEY	horse (SC)
TURTLE	snail (SC)
GIRAFFE	camel (SC)
FLY	wasp (SC)
PENGUIN	flamingo (SC)
BEAR	ice bear (SC)
FLAMINGO	swan (SC)
OWL	bird (SUPC)
CROCODILE	animal (DOM)
SPIDER	no answer

In both patients after LATL selective impairment for living objects was noted. In patient H.K. the error rate increased from 4 naming failures at baseline testing to 12 naming failures after LATL (increment: 200%). With 9 naming failures, a category-specific naming deficit for fruits was found: 4 different fruits were incorrectly identified as a tomato (Table 2). In patient B.E., the error rate increased from 6 naming failures at baseline testing to 22 naming failures after LATL (increment: 266%). With 11 naming failures, a category-specific naming deficit for animals was found. With 9 naming failures an additional deficit for food (staple foods, vegetables, fruits) was found. This corresponds to an error rate of 29% for food. Although overall naming ability decreased in both patients, no systematic trend was found for other categories. After surgery both patients were seizure free.

DISCUSSION AND CONCLUSIONS

Category-specific naming deficits comprise a potential negative side effect after surgery in the speech-dominant left temporal lobe. Our results give evidence for a functional and structural dissociation between the processing of living and nonliving objects. Due to the fact that only 2 out of 13 of the LATL patients showed category-specific naming deficits for living objects, it is doubtful that temporal lobe regions represent semantic categories in its entirety. Rather, it is likely that the temporal lobe represents visual feature aggregates vital for the identification of living objects.

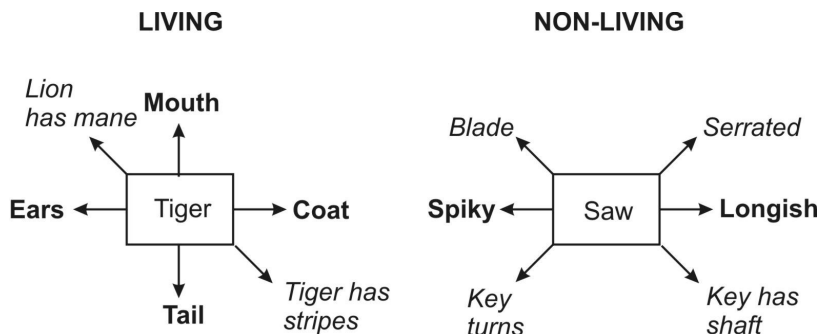


Figure 1. Semantic representation of living objects (animals) and nonliving objects (tools). Animals share large sets of interrelated visual features. Tools have limited feature overlap and are specified by distinct visual and functional features. Shared object features (in bold), distinct object features (in italics)

Animals such as lions and tigers share a majority of their visual attributes (Figure 1). It is the activation of distinct core features (e.g. tiger *has stripes*) that facilitates identification of objects with interrelated features. In this respect category-specific naming deficits for living objects constitute a discrimination deficit for objects with similar semantic structure. This deficit is characterized by a failure to name objects of the same category without affecting superordinate concept assignment (e.g. identification of animals as such). Potential failures include the use of words semantically related to the target name (e.g. lion and tiger) or verbal description of object features.

Further studies in patients with temporal lobe lesions should elaborate the relationship between general naming ability and the naming of semantic categories. Since nonliving objects are characterized by fewer overlapping features, one might expect that nonliving categories are more vulnerable to brain damage. On the contrary, however, our findings show relatively spared naming ability for nonliving objects after LATL. Based on other studies (Martin et al. 1996, Okada et al. 2000) the identification of nonliving objects involves an extended neuronal network with stronger involvement of the frontal lobe. Therefore, naming failure for nonliving categories is only expected with relatively widespread damage involving also extratemporal regions.

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