

# SEMANTIC MEMORY IS MORE IMPAIRED IN DOMINANT THAN IN NONDOMINANT TEMPORAL LOBE EPILEPSY



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## Introduction

Bilateral damage to the anterolateral temporal cortex (LTC) leads to impairment in semantic memory (SM). This has been demonstrated in the neurodegenerative disorder Semantic Dementia. A study with postencephalitic patients demonstrated that bilateral structural lesions produce impairment, which correlates with the extent of damage (Schmolck et al. 2002). To determine the contribution of the dominant versus the nondominant LTC for SM, we are studying patients with intractable temporal lobe epilepsy (TLE) before and after anterior temporal lobectomy (ATL).

The term Semantic Memory was introduced by Endel Tulving in 1972 to differentiate the memory for lexical knowledge, which is the vast amount of information we acquire and store about our environment throughout our lifetime, from distinct events defined by a temporal and spatial context (episodic memory). While bilateral damage to the hippocampal formation causes severe impairments in episodic memory (eg. Squire et al., 2004), it does not cause impairment of language comprehension or semantic memory. In contrast, more extensive bilateral temporal lobe damage, including damage to the lateral temporal cortex, impairs the ability to give definitions of common animals and objects (Schmolck et al., 2002). In a prior study, we showed that there is a direct relationship between the degree of impairment on tests of semantic memory and the extent of LTC damage (Schmolck et al., 2002). Also, severe neurodegenerative atrophy of the lateral inferotemporal cortex (Semantic Dementia, or Temporal Variant of Fronto-Temporal Dementia) causes deterioration of semantic knowledge (e.g. Hodges et al. 1992; Garrard et al. 1997; Murre et al. 2001).

There are only limited data concerning the effect of longstanding TLE or epilepsy surgery on semantic memory. In a large cohort of left anterior temporal lobectomy (ATL) patients, there was a significant decline in confrontation naming, and more extensive lateral surgical resection was associated with a higher risk of subsequent impairment (Herrman et al., 1999). Auditory Naming (which gives semantic information to elicit a response) causes more impairment than confrontation naming and may be highly specific to the difficulties experienced by TLE patients clinically (e.g. Bell et al., 2003). Difficulties that go beyond the retrieval of object names after left ATL have also been found (e.g. synonym judgment; Glosser and Donofrio 2001). One study assessed semantic memory in TLE patients before surgery using a definition paradigm, and found significant impairments. However, due to the relatively small sample size, predictors could not be identified (Bell et al. 2001). Our goal is to compare semantic memory in left versus right TLE patients, and the impact of surgery on both groups. In addition to this cross-sectional approach, we also have a prospective study arm comparing semantic memory before and after surgery in the same patient cohort.

## Study Goals (ongoing study)

1. Do temporal lobe epilepsy patients have semantic memory deficits?
  - A. Do patients with dominant temporal lobe foci have greater deficits than patients with non-dominant foci?
  - B. What are the predictors or risk factors for impairment, such as age of seizure onset, length of seizure disorder, age at seizure intractability, or type and number of seizures?
  - C. Will a detailed analysis of patient responses give a better characterization of the nature of the semantic deficits?
2. Does anterior temporal lobectomy have an independent effect on semantic memory in temporal lobe epilepsy?
  - A. If there is an effect, is it different in magnitude between dominant and nondominant anterior temporal lobectomy?

## Participants

We are studying patients with intractable left or right temporal lobe epilepsy (TLE) being evaluated for anterior temporal lobectomy (ATL), or patients that have had the surgery within the last 2 years. Patients are recruited from the Baylor Comprehensive Epilepsy Center and the DeBakey VA Hospital. In the prospective study arm, we examine patients before and after ATL. Here we are reporting results from 27 patients: 9 presurgical TLE and 18 ATL patients (13 nondominant TLE, 14 dominant TLE) and 8 control subjects. (16 Males, 11 Females, Age 18 – 56 (mean 35.5), FIQ 70 – 127 (mean 90.8), age of seizure onset 1-35 years (mean13); Non-dominant Pre N = 3; Non-dominant Post N = 10, Dominant Pre N = 6; Dominant Post N = 8).

## Materials

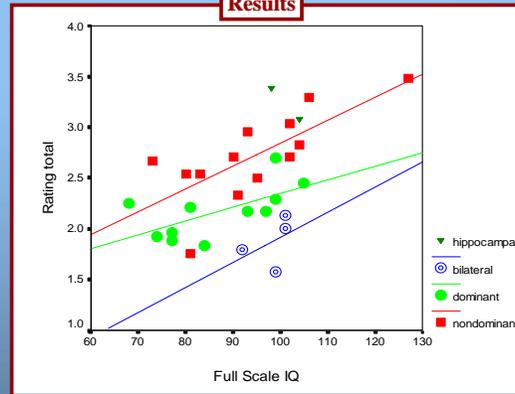
**Semantic Test Battery**  
A selection of materials are used as described in Hodges, Patterson et al. (1992), Hodges, Salmon et al.(1992), and Garrard et al.(1997). There is also a test variation intended to minimize the effects of anomia (Definition to Picture). All tests are based on the same line drawings (Snodgrass & Vanderwart, 1980) of 24 animals and 24 objects (or their names). Reported here are results from the Definition to Picture task.

## Methods: Definition to Picture

“I am going to show you the picture of something and ask you to describe it to me in as much detail as possible. Try to imagine that you are describing it to someone who has never seen or heard of such a thing. Tell me everything that is important about it. You have one minute for each item.”



## Results



Figures 1 and 2: Definitions were given a quality Rating (0-4). ANOVA with IQ as a covariable revealed a significant effect of group: dominant TLE patients performed significantly worse than nondominant patients, who performed worse than controls. Both TLE groups, however, performed better than a group of 4 patients with bilateral LTC lesions ( $p < 0.001$ ).

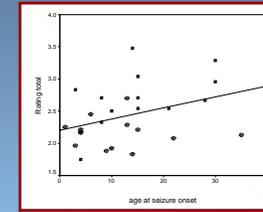
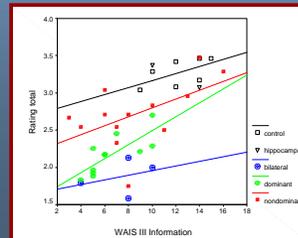


Figure 3: Earlier age of TLE onset was associated with more severe deficits.

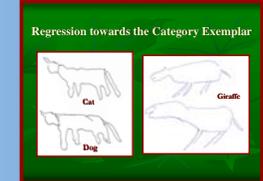
## Examples:

L TLE (swan): Most are white, have feathers and a beak. They lay eggs and come from eggs. They have two legs. They are beautiful white feathered creatures.

L ATL (ostrich): It has long legs and a long neck. It has a lot of feathers. It is brown and black. People feed them in zoos. They are easily scared and eat a lot off the floor.

Bilateral temporal pole lesions (owl): He is a bird. He hoots a lot and is in a tree. He guards an area, if anything comes around he can hoot to let the other animals know. They use them now for clocks, they come out on the hour and make timing.

Alzheimer's Disease (owl): Writes OWL. - I cannot draw it. Ex: Ok, tell me what it is then. It's a bird that eats bugs. It dives into the water and eats fish. It is white. It flies during the day.



## Discussion

1. Patients with TLE, both before and after ATL, have difficulty compared to controls defining common animals and objects.
2. Unilateral, dominant LTC lesions produce more severe deficits than non-dominant lesions, and bilateral lesions are the most profound.
3. Thus far, the only significant impact of surgery is on naming to picture in dominant ATL (data not shown here), which has been previously described (Hermann et al. 1999).
4. There is a strong effect of IQ on the ability to provide high quality definitions. ANOVAs for group effects were done with IQ as a covariable, and yielded a significant effect of group.
5. Earlier onset of TLE is associated with more severe difficulties; this suggests a failure in the acquisition of semantic knowledge, apart from any breakdown of semantic knowledge.
6. TLE patients could not give succinct and detailed definitions of more difficult items; the pattern observed was qualitatively similar to the one we find in patients with bilateral lesions, as well as in patients with neurodegenerative disease affecting the LTC.
7. Our goal is to add additional prospective patients to better ascertain the effects of surgery on semantic function.

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