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Introduction

While there has been much interest in the effect of temporal lobe epilepsy (TLE) and anterior temporal lobectomy (ATL) on episodic memory and naming, other cognitive domains with anatomical ties to the temporal lobes have been studied in much less detail. Examples are social cognition, which is tied to the amygdala, and semantic memory, which is anatomically most closely related to the temporal pole and lateral temporal cortex (eg Murre et al., 2001). Impairment in either of these cognitive domains will have a significant impact on a patient's social and professional functioning.

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. On the other hand, 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 have shown that there is a direct relationship between the degree of impairment on tests of semantic memory and the extent of damage to the lateral temporal cortex, LTC (Schmolck et al., 2002). Also, severe neurodegenerative atrophy of the lateral inferotemporal cortex (Semantic Dementia, or Temporal Variant of Fronto-Temporal Dementia) is known to cause 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) has been found more impaired than confrontation naming, and suggested to 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 directly addressed the question of 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 to explore 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 more severe deficits than patients with non-dominant foci?
 - B. Can we identify predictors or risk factors for impairment such as age at seizure onset, length of seizure disorder, age at seizure intractability, type and number of seizures?
 - C. Can we characterize the nature of the semantic deficit further by a detailed analysis of patient responses?
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) who are being evaluate 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 our prospective study arm, we are examining patients before and after ATL. That study is ongoing, and here we present preliminary results from 40 patients. So far, all patients were given the Naming to Picture test, and 29 completed the Naming to Definition Test. 26 patients were given the Definition to Picture Test (13 Males, 13 Females, Age 18 – 56 (mean 35.9), FIQ 70 – 127 (mean 92.4), Non-dominant Pre N = 5; Non-dominant Post N = 9, Dominant Pre N = 6; Dominant Post N = 6).

Materials

Semantic Test Battery

We use a selection of the materials described in Hodges, Patterson et al. (1992), Hodges, Salmon et al. (1992), and Garrard et al. (1997), as well as 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).

1. Naming to Picture



Controls	Non-dominant Pre	Non-dominant Post	Dominant Pre	Dominant Post
N = 8	N = 9	N = 12	N = 9	N = 9
98.7%	92.8%	93.7%	87.0%	74.3%

2. Naming to Description (Auditory Naming)

What do we call a small green animal that leaps around ponds?

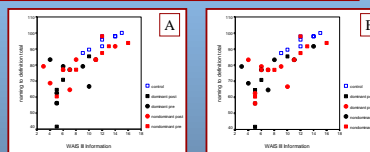
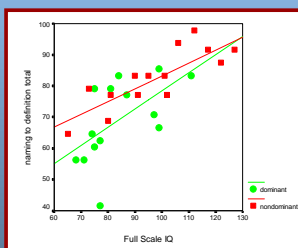


Figure 1: For both Naming to Description and Definition to Picture, performance was strongly correlated with measures of IQ. Here, the percentage of correctly named items is plotted against Full Scale IQ. ANOVA with IQ as a covariable revealed a significant effect of group, in that dominant TLE patients performed worse than nondominant TLE patients.

Figures 1A and B: Here, the percentage of correctly named items is plotted against a measure of verbal IQ. Both TLE groups performed worse than healthy controls. (A) again demonstrates the effect of side (dominant patients in black and (B) demonstrates the marginal effect of surgery (surgical patients in black).

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3. 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."

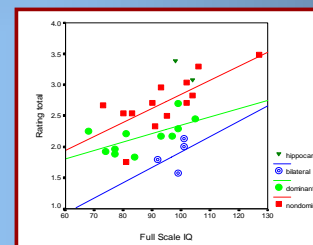
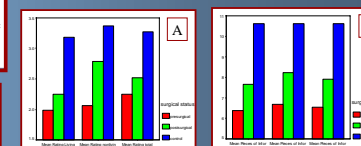
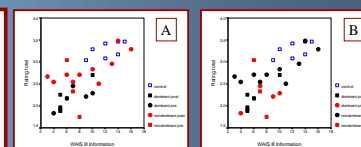
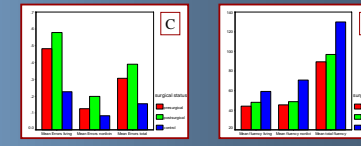


Figure 2: Definitions were given a quality Rating (0-4). ANOVA with IQ as a covariable revealed a significant effect of group: dominant TLE patients performed worse than nondominant TLE patients, and both performed better than patients with bilateral temporal lesions.

Figures 2A and B: Here, the percentage of correctly named items is plotted against a measure of verbal IQ. Both TLE groups performed worse than healthy controls. (A) again demonstrates the effect of side (dominant patients in black and (B) demonstrates the effect of surgery (surgical patients in black). In this task, surgical patients performed better than non-surgical patients (p < .05).



Figures 3A-D compare performance of pre-surgical and surgical patients as well as controls. Surgical patients received higher ratings (A) and gave more details (B). The number of errors also increased slightly (C). Surgical patients were more fluent than non-surgical patients (D). Due to this constellation of findings, we believe that the mildly superior performance of the surgical patients on this task is due to a nonspecific effect of improved fluency (less seizures, less medication).



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.TLE - swan)

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 of the floor. (L.ATL - ostrich)

Deterioration of the semantic network

- Intrusions from related objects – boundaries between concepts become "fuzzy"
- Loss of Core Concept
- Simplification towards the Category Exemplar – i.e. "generic bird"

Discussion of Preliminary Results

In this cross-sectional study, patients with TLE, both before and after ATL, had difficulty compared to controls on naming and defining common animals and objects. Patients with dominant TLE had significantly more problems than patients with non-dominant TLE. The only significant impact of surgery we have identified thus far was on naming to picture in dominant ATL, which has been previously described (Herrmann et al. 1999). However, our prospective study will provide firmer conclusions regarding the impact of ATL on semantics.

In this group, postsurgical patients performed worse on naming tasks but better on the definitions task; this is likely to be due to a nonspecific effect of improved fluency (less AEDs and less seizures) since error rates did not differ.

Patients before and after ATL could not give succinct and detailed definitions of more difficult items; the problems observed were qualitatively similar to the ones described in patients with bilateral lesions, as well as in patients with neurodegenerative disease affecting the LTC.

The addition of more study patients will help to answer additional study goals.