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Evidence from an fMRI Experiment for the Minimal Encoding and Subsequent Substantiation of Predictive Inferences¹

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Abstract

In an event-related fMRI-experiment reading during a supposed inference generation period was compared to explicit reading. In a subsequent verification task, the verification of inference and explicit statements were compared. The results show systematic but minimal inference processing during encoding (BA 9) and supplementary activities of text related processes, additional inferencing, and situational elaborations when verifying inference as compared to explicit statements.

Introduction

Which brain areas are involved in predictions during reading and which areas in the subsequent utilization of predictive inferences in a verification task? While predictive inferences are supposedly only represented as part of the situation model, the sentences of a text are additionally encoded as text information (Schmalhofer et al., 2002). Previous fMRI experiments have shown involvement of the prefrontal cortex in establishing text coherence (Ferstl & von Cramon, 2001) and in generating inferential bridges (Mason & Just, 2004).

Experiment

In an event-related fMRI-experiment we investigated 1) the reading during a supposed inference generation period (see Table 1, words 13-18) in comparison to explicit reading and 2) the subsequent verification of the respective statement. (e.g. "wine spilled"). Four versions of texts were constructed so that the same statement constituted an explicit, a paraphrase, an inference or an incorrect statement. The collected data were analyzed by SPM2.

Table 1: Sample text material and test statement

Title: Air Travel
Words 1-12 (all conditions): While the flight attendant served the passenger a full glass of wine
Words 13-18 (explicit): turbulence caused the wine to spill.
Words 13-18 (paraphrase): turbulence caused the wine to splash.
Words 13-18 (inference): turbulence occurred which was very severe.
Words 13-18 (control): the plane was at cruising altitude.
Test statement: wine spilled

13 students from the University of Osnabrueck participated. 108 reading passages and subsequent tasks were presented:

The 4 experimental conditions with 18 trials each as well as 18 filler and 18 non-word trials. A trial lasted 27 seconds. Data were collected by a 1.5 Tesla Siemens Sonata scanner.

Results and Discussion

During reading of words 13-18, the comparison between the inference versus the explicit condition showed the medial frontal gyrus (L + R BA 9, 63 Voxels) to be active. For the statement verification, the contrast between the inference and explicit conditions showed three clusters predominantly in the left prefrontal cortex to be differentially active, as can be seen from Figure 1. For more details see Table 2.

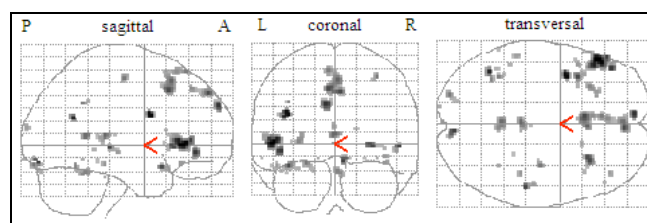


Figure 1: Statement Verification: Inference versus explicit

This experiment confirms previous behavioral results showing minimal predictive inferencing during encoding. It involves the medial frontal gyrus (bilateral). During verification, areas which can be attributed to semantics, inferencing and situational elaborations were observed.

Table 2: Statement Verification: Inference versus explicit

Location of Activated Areas	Z	Voxels
1. Cingulate Gyrus / Superior Frontal Gyrus Medial Frontal Gyrus (L + R BA 8; L BA 6, 32)	3.8	125
2. Medial Frontal Gyrus (L + R BA 9; L BA 6, 8)	3.8	67
3. Inferior Frontal Gyrus (L BA 10, 44, 45, 46, 47)	4.2	168

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