Introduction
In past years much research has been dedicated to the specification of the neuroanatomic sites engaged in language processing, in particular those associated with phonological and lexico-semantic processing. A variety of tasks have been employed, ranging from reading or repeating a presented word to judging specific aspects of word form or meaning. Results from these studies demonstrate that the language system is a widely distributed network. Therefore, due attention must be given to task selection when language areas are to be mapped. A number of studies with visual word presentation have reported strong activity in the fusiform/inferior temporal-occipital gyrus and in recent study investigating with the neural substrate of picture naming this region is discussed in terms of semantic processing. Since patients considered for neurosurgery often display difficulties in picture naming we used a picture-word matching task aimed at assessing regions involved in language processing.

Methods
Subjects: Ten right-handed healthy volunteers (age range: 21-44), five males and five females, participated in the study.

Materials and Procedure: The study comprised two decision tasks: a linguistic (target) task and a non-linguistic (control) task. In the target task subjects were presented a drawing of a common object together with a printed word. The word, printed under the line drawing, could either be the name of the depicted object or the name of a semantically related object. The selected objects were balanced with respect to the prototypicality of the printed object name. The control task consisted of pairs of random line drawings, difficult to verbalize; they were taken from Kimura’s Recurring Figures Test and presented in a vertical array. An A-B block design was used; a block of 20 target task items was followed by a block of 20 control task items. There were four target task blocks and four control task blocks. All stimuli appeared at a rate of one every 1.5 seconds. Thus, a total of 80 images per slice location were acquired during 8 alternating periods of 30 seconds. Subjects responded by button press whether the printed word was the name of the depicted object or whether the two figures were identical or not. To control for this motor component of the task a green button had to be pressed with the right index finger in case of a match and a red button with the left index finger in case of a mismatch. Accuracy of response and reaction times were measured. The releases of a new stimulus item was not controlled by button press.

All imaging was performed on a 1.5 Tesla scanner (General Electric, Milwaukee) using the standard product head coil. Functional BOLD-images were obtained in 30 contiguous axial planes covering the entire brain. The parameters of the gradient-echo single-shot EPI sequence were: TR=3s, TE=45ms, Flip Angle=70°, slice thickness 5 mm, imaging matrix 128 x 96 and in plane resolution 2.5 mm x 2.5 mm. To correct for residual motion, functional images were first realigned using an automated image registration algorithm (3) and subsequently spatially filtered with a 4mm Gaussian blurring kernel. To build activation maps, voxel intensities over time were compared to an idealized response function calculating Spearman rank-order correlation coefficients and subsequent transformation to t-statistics. Only voxels with t-values corresponding to a significance level of p < 0.001 were considered as activated areas. Functional maps were overlaid onto corresponding T1-weighted images obtained in the same session for anatomical reference. For group analysis, functional t-maps were transposed to Talairach-space using an automated 3D linear transformation algorithm (4).

Results and Discussion
In both the target task and the control task no differences in response accuracy were found between matches (same condition) and mismatches (different condition). No statistically significant differences were found when matches in the target task were compared with matches in the control task. Likewise, no statistically significant differences were found between mismatches in the two tasks, suggesting that the two tasks are comparable with respect to processing demands. Response latencies were somewhat longer in the target task but the difference did not reach significance.

Activation in the target task was compared with activation in the control task. The target task produced significant activation in several brain regions of the dominant hemisphere, including the middle and inferior frontal gyri, the superior parietal lobule, the middle temporal gyrus, the precuneus and the lingual and fusiform gyri. A particular finding of our study was the bilateral activation of the lingual and fusiform gyri, emphasizing the important role of the posterior part of the brain in language processing.

This last finding in normal volunteers was further tested using the same task in a 31-year old patient harboring a tumor in the posterior part of the left temporal lobe. Activation was only found in the right fusiform/inferior temporal-occipital gyrus. Response accuracy was strikingly low in the mismatch condition, as predicted by experimental neuropsychological evidence. The paradigm thus proves to have clinical implications.

References