Introduction:
Stuttering is a disorder of speech in which an individual knows precisely what he wishes to say, but at the time is unable to say it because of an involuntary repetition, prolongation or cessation of a sound (World Health Organization, 1977, p. 202).

In recent years PET has opened new avenues in the search for the neurogenic causes of stuttering. Several differences in speech and language processing between normal subjects and subjects with stuttering were evident from these studies [1,2]. Although interpretation of the PET findings is not straightforward, the result largely confirm the cerebral dominance theory [3]. The hypothesis is that there is a lack of cerebral dominance for speech… in stutterers.

To the best of our knowledge, no fMRI studies on stuttering are available yet (Medline search) . The purpose of the present investigation was to examine the feasibility of fMRI in the study of stuttering.

Materials and methods:
Six subjects with normal speech and six with mild stuttering participated in this study. All were right−handed male. Subjects were positioned supine in the standard head−coil of a 1T MR system (Siemens Expert) for fMRI using BOLD contrast. We used EPI and 32 slices of 4mm thick and 0.4 mm interslice gap to cover the whole head. In−plane resolution was 4x4 mm. Repetition time for these 32 slices was 5 seconds.

A factorial block design paradigm was chosen in which the subjects had to read printed text. Text was either semantically meaningful or nonsense, reading was either silent or aloud. All subjects read the same texts in identical order.

A total of 480 volumes of fMRI data were acquired in each subject and submitted to statistical analysis using SPM96 (Welcome Department of Cognitive Neurology, London UK). Each data set was prepared using SPM96’s realignment, normalization and smoothing modules. A statistical analysis (SPM[z]) was performed separately for the normals as a group and the subjects with stuttering as a group. The level of significance was p<0.00001 (corrected p−value). Contrasts studied were 1) language, e.g. semantic text versus nonsense text during silent reading, aloud reading and global (combined) and 2) speech, e.g. aloud reading versus silent reading with semantically meaningful text, nonsense text and global.

Results:
Analysis of the realignment plots from the SPM96 software showed acceptable head displacement during scanning for all subjects, and therefore all were included in the group analyses.

Several group differences between normals and subjects with stuttering were apparent from the data. The most striking results are reported here. During speech, in contrast to the normal group, the subjects with stuttering showed no activation of the superior temporal gyri and temporal poles with semantically meaningful text while little but definite activation was present in these regions with nonsense text. Less activation was also evident in the cingulate gyrus and the cerebellum whereas activation in the primary rolandic motor areas was similar in both groups.

In the language contrasts, Broca’s area was more strongly activated in subjects with stuttering than in normals but the posterior superior temporal gyrus (Wernicke) only showed in normals. Activation of the middle temporal gyrus and temporal pole was unilateral left sided in the normals and strongly bilateral in the group with stuttering.

Discussion:
Head displacement can be a serious problem when studying subjects with stuttering because of the frequent synkinesias. The subjects with stuttering in this study were selected such that almost no synkinesias were to be expected. Although scanner noise can be a problem, the use of ear plugs and mufflers reduces this noise and allows subjects to hear their own voice during scanning.

The results of this study indicate different neural processing of speech and language in people with mild stuttering. Less activation in the primary auditory cortex in subjects with stuttering might indicate a faulty feedback mechanism for speech, less activation in the cingulate might point to problems with speech initiation and the bilateral activation in the middle temporal gyri and temporal poles to different semantic processing.

This pilot study indicated that fMRI is possible in subjects with stuttering and indicates several differences in activation.

References: