BRAIN AREAS ATTUNED TO CHANGES IN THE PROSODIC FOCUS OF REPEATED SPOKEN SENTENCES – AN fMRI STUDY

M. Inspector[1], D. Manor[2], T. Kushnir[2], Y. Gogol[1], N. Amir[3], and A. Karni[1,2]

[1]Laboratory of Brain Imaging and learning, Haifa University, Haifa, Israel, [2]Dept. of Diagnostic Imaging, MRI Unit, The Chaim Sheba Medical Center, Tel Hashomer, Israel, [3]Communications Disorders, Sackler Faculty of Medicine, Tel Aviv University, Tel Aviv, Israel

Background:

The comprehension and disambiguation of spoken sentences is dependent on deciphering prosodic cues (i.e., intonation). One such cue, the prosodic focus of a sentence, is indicated by a high pitch accent on a specific word. This increases saliency or indicates novelty in specific discourse contexts. Our previous behavioral and fMRI study[1] demonstrated reduced repetition priming (RP) and repetition suppression (RS) by modulation of the pitch contour of repeated lexically identical words in a semantic categorization task; RS occurred in bilateral auditory and language processing areas, including A1. Here we investigated which brain areas are attuned to a change in the location of prosodic focus of previously heard sentences.

Aims:

to test the effect of a change in the prosodic focus location, in an auditory semantic categorization task of repeated spoken sentences, on behavioral measures and on neuronal activity in auditory/language processing brain areas, using fMRI.

Methods:

Subjects: Twelve healthy right handed students were enrolled for the study.

Behavioral paradigm: A set of 32 recorded Hebrew spoken sentences was repeatedly presented, outside the magnet (training phase). A semantic categorization task was requested with a fixed prosodic focus location in all the sentences. Participant's attention was not directed to prosodic attributes. An event related fMRI followed, with the same semantic categorization task but with the trained or novel sentences, with the trained or a new prosodic focus (test phase).

fMRI measurements: T2* weighted BOLD contrast (TR/TE 3000/35, FA 90°, SW 3 mm, 0.4 mm gap, FOV 22 cm, matrix 64X64, 3.4X 3.4 mm^2 resolution) images were acquired using 3T MRI (GE EXCITE 3 HD) and 8-channels head coil. fMRI data was analyzed using SPM5 and ROI analysis using Marsbar software.

Results:

Reaction time for semantic categorization of test phase sentences with the same lexical content as in the training phase (St) but with a changed prosodic focus (Pn) was significantly slower, and neuronal activity in bilateral anterior temporal cortex (ATC) and posterior margin of the right MTG (pMTG), was enhanced in comparison to the familiar sentences (StPt). The contrast between these conditions, in a group analysis, is shown in Fig. 1a, and in a ROI analysis (contrast normalized to the average activity in both hemispheres, fig 2). The contrast between lexically new sentences with new prosodic structure (SnPn) and lexically trained sentences with previously trained prosodic structure (StPt), demonstrated the same areas but with much stronger activation intensities (Fig. 1b).

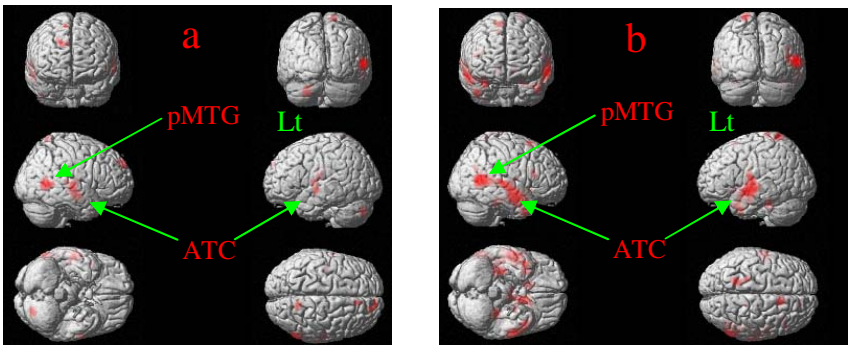

Fig 1: Clusters of significant activation (p = 0.01) a. StPn Vs. StPt, b. SnPn Vs. StPt. S –sentence, P prosody, t-trained/old, n – new.

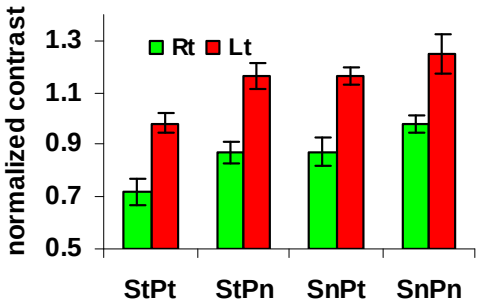

Fig 2: ROI analysis of 4 conditions in the Rt and Lt ATC.

Conclusions:

The results of the current study show that a change in the position of the prosodic focus resulted in a significant slowing of response times (RT) to target sentences, and in an increase in the BOLD signal (i.e., reduction in RS) in bilateral ATC, in left rolandic operculum, and in the right pMTG, *when familiar sentences with the new prosodic focus position were compared to familiar sentences with the prosodic focus unchanged*. As both syntactic structure and the lexical content of the target sentences was unchanged, ATC bilaterally is probably involved in the processing of multiple cues which are critical for sentence comprehension and disambiguation, including syntactic and prosodic cues. The right pMTG modulation, on the other hand, may reflect the processing of slow pitch variations that mark the prosodic focus.

References:

(1) M. Inspector et.al., ISMRM 15th Ann. Sci. Mtg, Berlin, Germany, p. 1817, (2007).