Functional MRI task for efficient detection of subcortical activation

E. Katzav[1], T. Kushnir[2], Y. Itzchak[2], D. Manor[2]

[1]School of Physics and Astronomy, Tel Aviv University, Tel aviv, Israel, [2]Dept. of Diagnostic Imaging, MRI Unit, The Chaim Sheba Medical Center, Tel Hashomer, Israel

Purpose

To compare the quality of block and ramp designs of fMRI paradigms, with respect to activation of associative brain regions.

Methods

MR Imaging: fMRI data was acquired using a 3 Tesla system (Signa Horizon LX, GE) and a regular quadrature head coil, using a standard gradient-echo EPI TR/TE/flip angle: 3000/30/90°, spatial resolution: 1.9 x 1.9 x 5 24 slices. A high resolution, (256 x 256) anatomical T1 FLAIR image with identical localizer was also acquired. Tasks: In the masked prime task (based on ref. 1), clearly visible left- or right-pointing target arrows are preceded by briefly presented and subsequently masked prime arrows. Participants respond quickly with a left or right key-press to each target. Trials are either compatible (prime and target pointing in the same direction) or incompatible (prime and target pointing in different directions). Two experimental designs were implemented – a traditional block design and a ramp design (Fig. 1). In both cases, the variable parameter, affecting the response time, was the delay between the masked-prime and the target.

Data Processing: Activation maps were produced using SPM2 (Welcome Dept. of Imaging Neuroscience, London). For the block design the model consisted of two conditions: short and long delays, convoluted with hemodynamic response function (hrf) temporally adjusted with time-derivatives response. For the ramp design the parametric model consisted of a vector of the prime-target delays convoluted with hrf. Second level conjunction analysis was performed on 3 subjects to produce t-maps with a threshold level at a significance level of 0.001 (uncorrected).

Results

Block-designed task did not reveal any brain activity when comparing blocks of long and short delays. Motor area activity (of key press response) was mapped when comparing task blocks to resting periods. In contrast, the ramp design depicted extensive activation of caudate and thalamic regions (Fig. 2).

Conclusion:

Ramped variations of an effective parameter in a complex cognitive task can detect brain activation in regions undetectable by a conventional block design. The difference may originate from a better suitability of the ramp design to the non-white, correlated noise in the brain. Scan duration of the design can be reasonable also for less cooperative subjects.

References: 1. AR. Aron, F. Schlaghecken et al. Brain (2003), 126, 713-723.

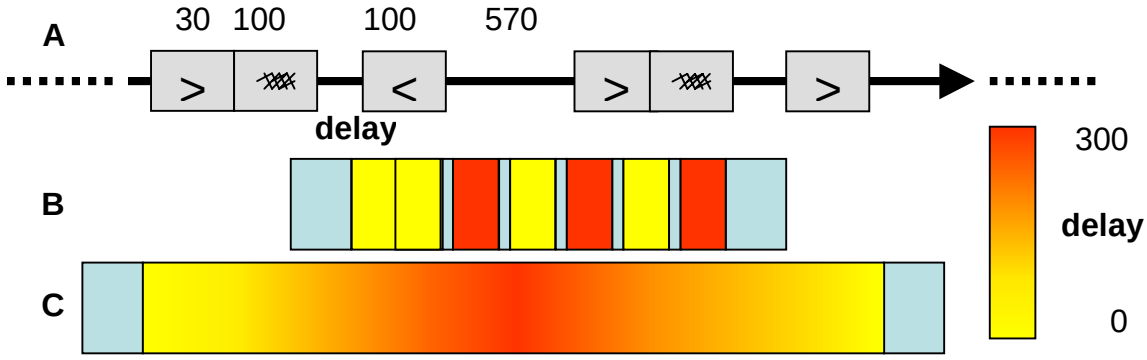

Figure 1. **Scheme of tasks.** A. detailed basic element: shapes and timing (ms) are displayed. B. Block design (192 s) with interchanging 0 and 300 ms delay blocks (16 basic elements in each) and baseline periods (magenta). C. Ramped design (330 s) with gradual increased and decreased delay.

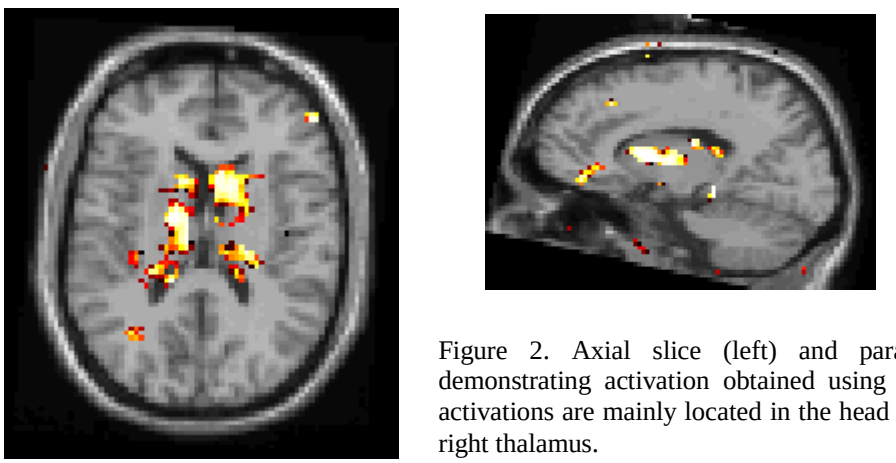

Figure 2. Axial slice (left) and para-sagital slice (right) demonstrating activation obtained using the ramp design. The activations are mainly located in the head and tail of caudate and right thalamus.