Time-resolved analysis of event related fMRI during language comprehension at word and sentence level

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Introduction

Neuronal activation during language comprehension at word and sentence level was assessed using event-related functional magnetic resonance imaging (fMRI). We present an improved time-resolved analysis to investigate the effect of increasing linguistic demand on the blood oxygenation level dependent (BOLD) response.

Materials and Methods

Sixteen healthy participants performed three reading tasks of increasing linguistic demand in event-related fMRI, and indicated response by a button press. A two-parametric boxcar function was convolved with a fix hemodynamic response function (HRF) and fitted to the event-related average (ERA) BOLD signal to estimate the delay and duration of neuronal activation of each voxel and each participant. For the group average a voxel was considered active when a successful fit was possible in at least half of subjects. Additionally, a general linear model (GLM) analysis was performed.

Results

Activations of the time-resolved analysis closely correspond to the GLM analysis. A volume of interest (VOI) analysis revealed that the delay of the BOLD response increases with linguistic demand, and from visual area over left inferior frontal gyrus (IFG), housing Broca's area, to motor area. In contrast, the duration of the BOLD response increases with linguistic demand but does not differ between areas.

Conclusions

The presented time-resolved analysis of er-fMRI data illustrates the flow of cerebral activations at high temporal and spatial resolution. This additional temporal information complements statistical information from general linear model analysis.

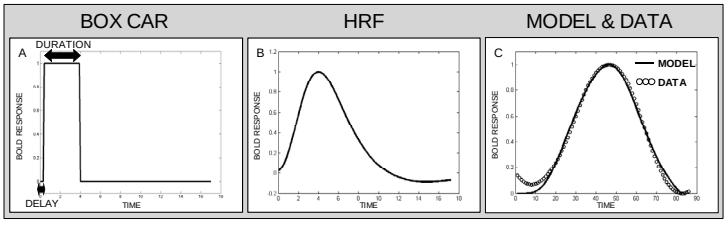

Figure1: The principle of the presented time-resolved analysis is to fit a boxcar function (A) convolved with a hemodynamic reference function (B) to the event-related average BOLD response (C). This procedure estimates the delay and duration of the BOLD response for each voxel of each subject (Example voxel of one subject in motor area TAL X 41, Y –30, Z 57).

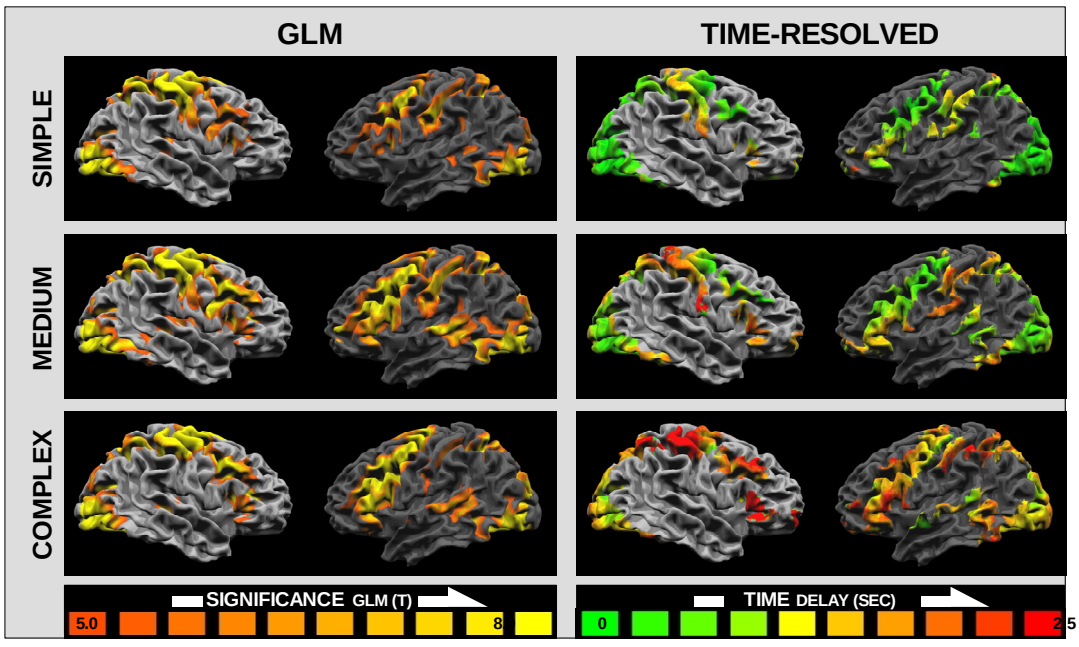

Figure 2: General linear model (GLM) analysis (left column) and time-resolved analysis (right column) for the three experimental conditions. Both analysis methods show similar activations. The left column illustrates the significance of activations while the right column indicates the temporal flow of activations. The delay of the BOLD response increases with linguistic demand, and from visual area over left inferior frontal gyrus (IFG), housing Broca's area, to motor area.