Listening to the Scanner: Modulation of Auditory Perception During Visuo-Motor fMRI

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Objective

Research participants in fMRI data acquisition hear the loud gradient sounds made by the MRI scanner. What happens to the brain activity subserving this listening during those (perhaps the majority of) fMRI tasks which do not explicitly present auditory stimuli?

Methods

We used independent component analysis (ICA), which is a data-driven multivariate technique based on the covariance paradigm, aiming to estimate the functional activity without reference to an experimental protocol. Whole-brain fMRI data from Mostofsky *et al.* [1] acquired from 24 participants (males and females) performing a "Go-NoGo" paradigm, which called upon participants selectively to inhibit a prepotent motor response to rapidly presented visual stimuli, were motion corrected, slice timing corrected, spatially smoothed and normalized by SPM2 [2]. These preprocessed data were then entered into group spatial ICA [3,4] to yield chronoarchitectonically identified areas [5] with associated time courses. Data model complexity was estimated as the mean of Minimum Description Length and the Akaike's Information Criterion for each subject and groups of subjects, respectively. The estimated components were ranked according to their temporal variance in a pre-defined region of interest (ROI) in auditory cortex: Brodmann areas (BA) 41 and 42. The ROI mask was defined using WFU PickAtlas [6]. The centroids of the significant clusters of activation/deactivation were labeled to anatomically organize findings by means of the Talairach Daemon (TD) database [7].

Results

Analysis using the GLM (successful responses and errors) revealed activity in contralateral sensorimotor cortex, bilateral cerebellum, and supplementary motor area (SMA) for "Go," and in pre-SMA for "NoGo" (Fig. 1). In ICA decomposition, the spatial map of the component contributing the most variance within the ROI (the "auditory component") displayed activity predominantly in auditory cortex (but of spatial extent larger than the ROI), as well as deactivation (i.e., signal decreases) in visual areas (Fig. 2). The time course of this "auditory component" showed transient activation correlated with paradigm's rest periods (Fig.3).

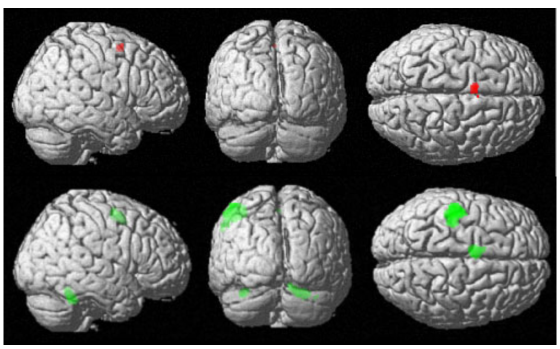

Fig. 1 – *Results of GLM analysis of "Go" (bottom) and "NoGo" (top) using visuo-motor regressors.*

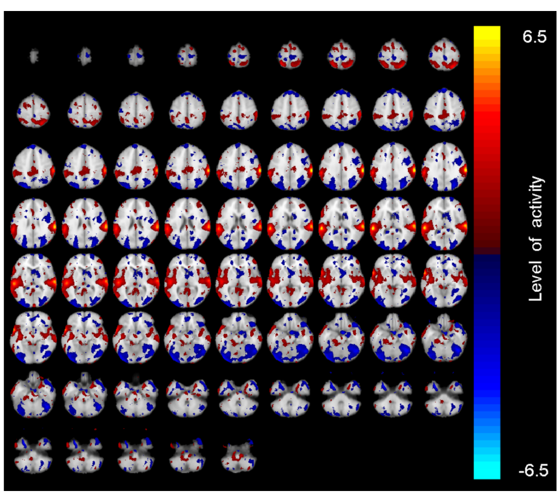

Fig. 2 – *Map of the most energetic mean estimated independent component in ROI by Group ICA.*

Conclusions

These results are consistent with attentional modulation of auditory perception, or the subjective experience that participants are more aware of scanner noise when not working on the task. For clinical studies comparing populations, the general linear model (GLM) could be augmented with an appropriate "auditory regressor" modeling this behavior, which could provide an additional statistical parametric map reporting on between-group differences in brain activity.

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References

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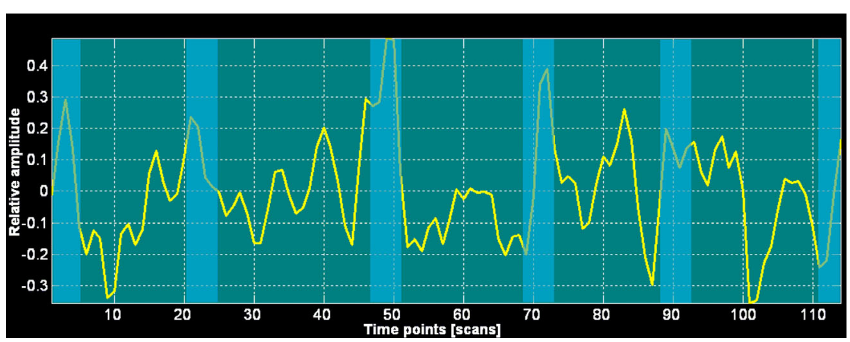

Fig. 3 – *Time course of the most energetic component in the auditory cortex which shows transient activation during rest periods (blue stripes).*