MODELLING BOLD RESPONSE IN AUDITORY CORTEX WITH BALOON HEMODYNAMIC MODEL

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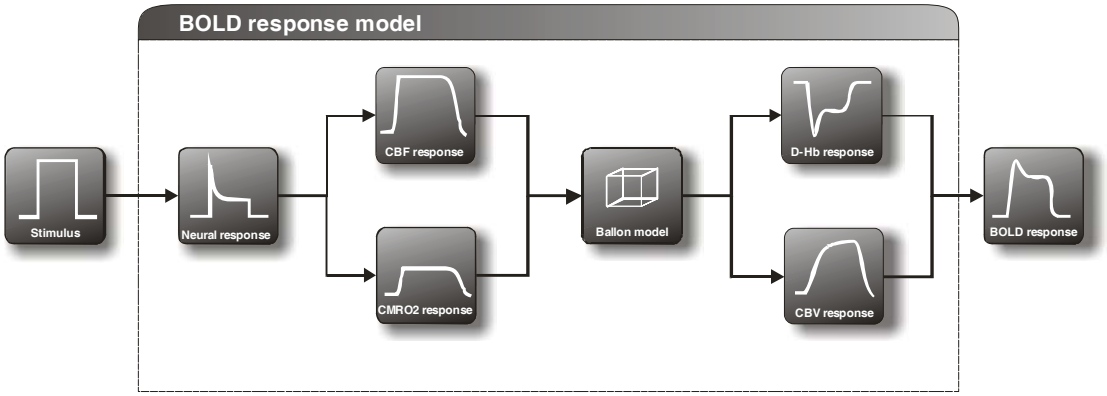
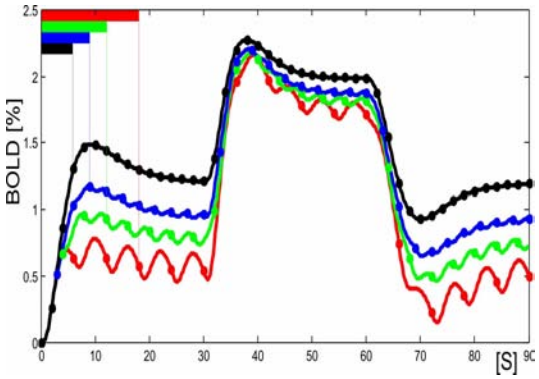
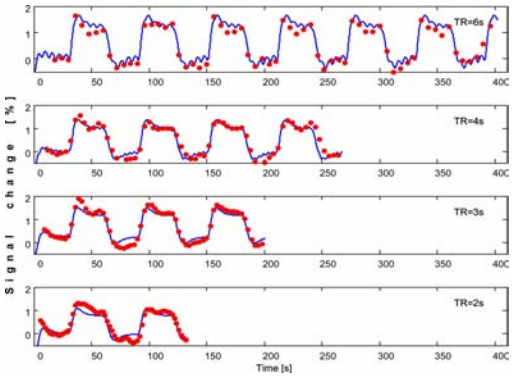
Objectives: To examine two possible application types of the balloon model [1]: forward problem where relations between model parameters and their influence on the modeled BOLD response are in interest, and the inverse problem where the fit of the experimental BOLD responses with parameters within a reasonable physiological range is performed. An inverse application of the model was used to model and quantify the level of impact of the Echo Planar Imaging (EPI) sequence noise on BOLD response in primary auditory cortex (A1).

Methods: A complete hemodynamic model that linked applied stimulus to the resulting BOLD response was created in SIMULINK environment (Mathworks, USA) as shown on Fig.1a. The input to the model (driving function) was connected to chain of the following blocks: 1) neural response block, 2) neurovascular coupling block, 3) balloon model, 4) dynamic susceptibility contrast (DSC). A 30-s block type acoustic syllabi stimulus was presented to each of the 20 healthy subjects (16 males and 4 females; 19 right-handed and one left-handed; mean age 23.6 ±0.7) and four functional scans were acquired with variable TR equal 2, 3, 4, and 6s. After standard preprocessing in SPM2, the raw BOLD signal intensities from left and right A1 regions were averaged to form a Mean Regional Response (MRR), spanning the entire length of the experiment, as described in [2]. The MRRs were forward and inverse analyzed with described model.



Results: The forward application of balloon model (Fig.2) shows evaluation of the BOLD signal from base line with 0.2 s time resolution. The dots represent sampling time instants adequate for each run. The color bars in the upper corner correspond to time period equal to the first three images, which have to be discarded due to T1 effects. The inverse application of the model (Fig.3) provided a good fit (solid lines) to the measured group's MRRs (marked by dots).





Conclusions: The cortical responses as measured by MRR changes indicate that auditory evoked responses are altered in association with the level of EPI noise exposure. Moreover, the standard measures of BOLD signal based on spatial extent of activation (F-score, T-score) can not predict quantitatively the magnitude of these changes evoked by the scanner noise itself. An approach based on Mean Regional Response may allow quantitative or semi-quantitative analysis of functional activations in human auditory cortex..

References: 1) Buxton 2004, 2) Bogorodzki 2005