Introduction: One of the most well studied EEG responses is the visually induced event related spectral perturbation (ERSP) in the alpha/beta (8-25Hz) and gamma (30-80Hz) ranges, but functional significance of different EEG frequency bands remains a topic of debate (ref). To explore the functional significance of these bands, we conducted orientation and retinotopic tuning experiments on healthy humans subjects, using both EEG and BOLD FMRI separately. We then compared the EEG gamma and alpha/beta responses to the responses measured using BOLD FMRI, to better understand how the functional tuning of healthy human EEG alpha/beta and gamma rhythms relate to the spatial and hemodynamic responses measured using BOLD FMRI.

Methods: EEG signals were recorded using 64 channel BrainVision (Ref) EEG actiCap setup sampling at 500hz. Stimuli were constructed using PsychoPhysics Toolbox, and consisted of either 1) contrast sinusoidal vertical gratings that slowly rotated through 1-360degrees or 2) contrast sinusoidal annular gratings masked by a certain retinotopic configuration. Stimuli were epoched using EEGLAB (ref) and event-related spectral perturbation was computed for all stimulus configurations, yielding dB values in the alpha/beta and gamma range. BOLD FMRI signals were acquired on a 3T Philips Ingenia (ref) using multiband 6, for a TR of 750ms and resolution 3mm isotropic. All statistical tests were carried out in matlab (ref).

Results:

EEG/BOLD Orientation tuning:

EEG/BOLD Retinotopic tuning:

Conclusion: While both EEG gamma and BOLD prefer oblique over cardinal orientation gratings, the BOLD preferences is much higher for vertical over horizontal, while EEG gamma does not distinguish between vertical or horizontal. This is further evidence that the gamma rhythm measured using EEG may be independent of metabolic burden (ref), and be more a measure of widespread spatial synchrony (ref) which is supported by the oblique preference when viewing glass patterns. Retinotopically, alpha/beta, gamma, and BOLD all show stronger responses to lower visual field than upper visual field stimuli, but the EEG responses were much more attenuated than the BOLD. The much weaker EEG responses to upper vs lower visual field can be explained by both the further distance from the scalp, and smaller retinotopic size, of the lower visual field.