Localization of cortical areas involved in conscious processing during binocular rivalry using MEG

K. Sandberg[1, 2], B. Bahrami[1], G. R. Barnes[3], M. Overgaard[2], G. Rees[1].
[1]Institute of Cognitive Neuroscience, University College London, London, United Kingdom.
[2]Cognitive Neuroscience Research Unit, Hammel Neurorehabilitation and Research Center, Hammel, Denmark.
[3]The Wellcome Trust Centre for Neuroimaging, University College London, London, United Kingdom.
Correspondence: Kristian Sandberg, krissand@rm.dk

Background

The neural correlates of consciousness have been examined with many different designs. One of the most popular has been employing binocular rivalry (BR) as it allows alternations in conscious content while keeping the physical stimulus constant. BR occurs when a different image is presented to each of a participant's eyes (figure 1). During the presentation, the participant perceives only one of the images at a time, and the perceived image switches back and forth every few seconds. Using the BOLD signal from V1, V2, and V3, Haynes and Rees (2005) have demonstrated that it is possible to predict the conscious experience of a participant during BR with and accuracy of around 85%. The goal of the present experiment is to examine which level of accuracy can be obtained using MEG data in a similar source based prediction analysis. The first step, however, is locating the relevant sources on which to base the prediction analysis. The preliminary results of our source analysis will be presented here.

Methods

10 participants were presented with a green face to the left eye and a red/black grating to the right (figure 1). Stimuli were approximately 2 degrees of visual angle, and they were presented within an annulus consisting of randomly oriented lines to optimize perceptual fusion. Stimuli were frequency tagged in 2 sessions and displayed normally in 2 different sessions. Here, report findings only from the non-tagged stimuli. Participants viewed the BR stimuli for 10 trials of 60s per session. During presentation, they reported the perceived image by pressing one of two buttons. Participants used their right hand to report on half of the trials and their left hand on the other half. We report findings from right hand trials only.

The neuromagnetic activity of the participants was recorded at a sample rate of 600 Hz using a 275-channel CTF MEG scanner. The data was epoched around the subject's report and divided into two conditions, face (the subject reported seeing a face) and grating (the subject reported seeing a grating). We used a beamformer for our source localization. The beamformer constructs a spatial filter that maps the MEG channel data to each source location. At each source location we then constructed power spectra for each condition and compared between these two multivariate spectral distributions using Hotelling's T test.

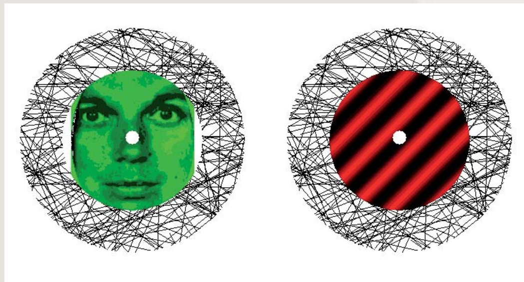
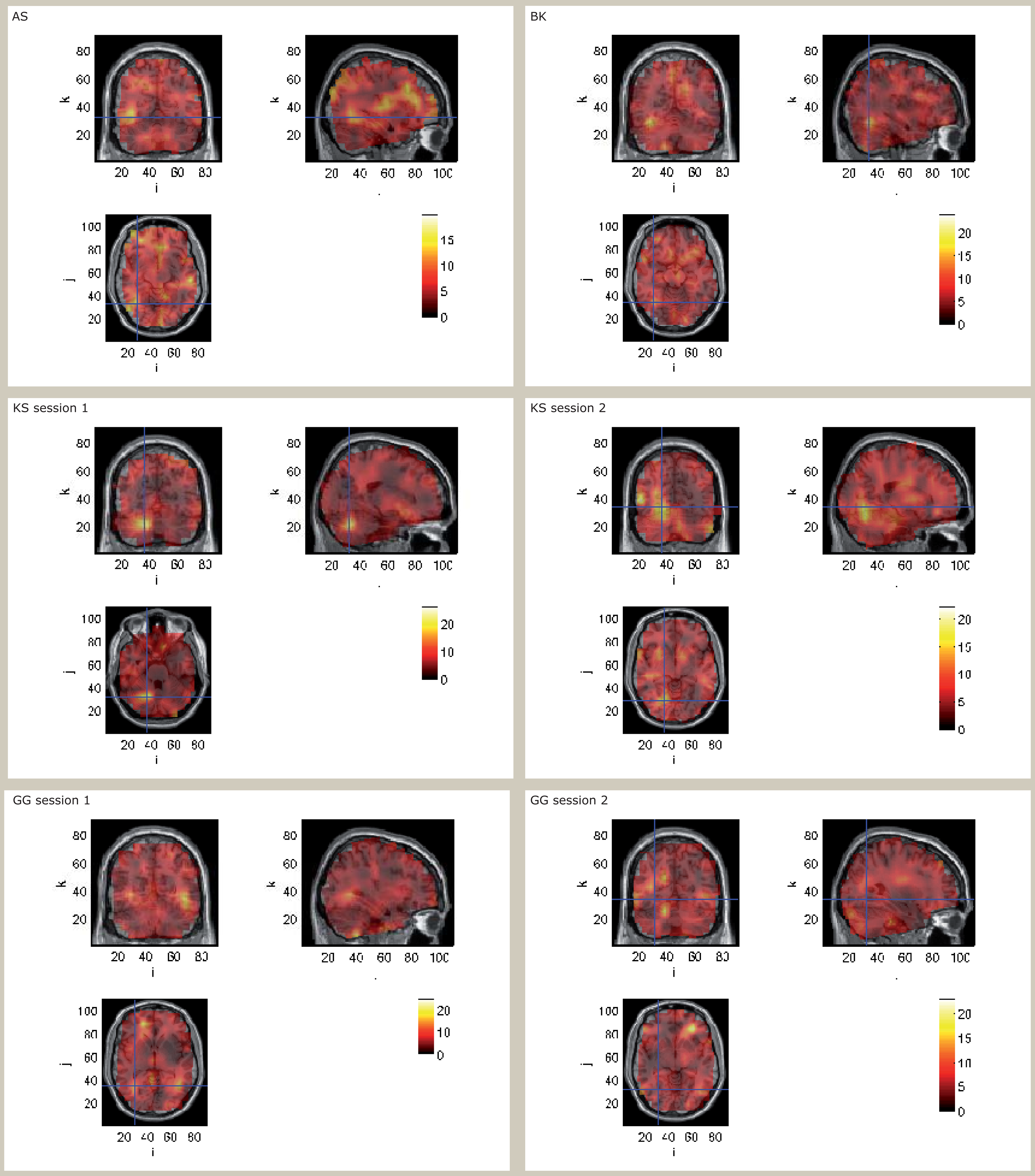


Figure 1: Binocular rivalry stimuli used in the experiment. The green face was presented to the left eye of the subject and the red/black grating to the right. Subjects perceived only one image at a time, perceptual switches every few seconds.



Figur 2. Result of the source localization analysis. Images show the cortical areas regions in which activity is modulated by percept (face versus grating). Data is presented from four subjects (AS, BK, KS, and GG). For subjects KS and GG, data from two sessions are presented. A common area, possibly FFA, is found for all subjects. Images are left-right reversed.

Preliminary results:

Figure 2 presents the result of our source localization for four subjects (subjects AS, BK, KS, and GG). For all subjects, data from one session (approximately 40 face reports versus 40 grating reports) is used to create the image. For subjects KS and GG, data from two sessions are presented in order to compare the localization of the sources within subjects. For all subjects, data in the frequency band 25-35Hz recorded from 200ms before to 800ms after button press was used for the analysis.

Although many sources were found for some subjects, the most consistently found source is the one indicated on the images. This location corresponds to the location of the fusiform face area (FFA). Results can be compared to FFA as identified during BR by Sterzer and Rees (2008) (figure 3).

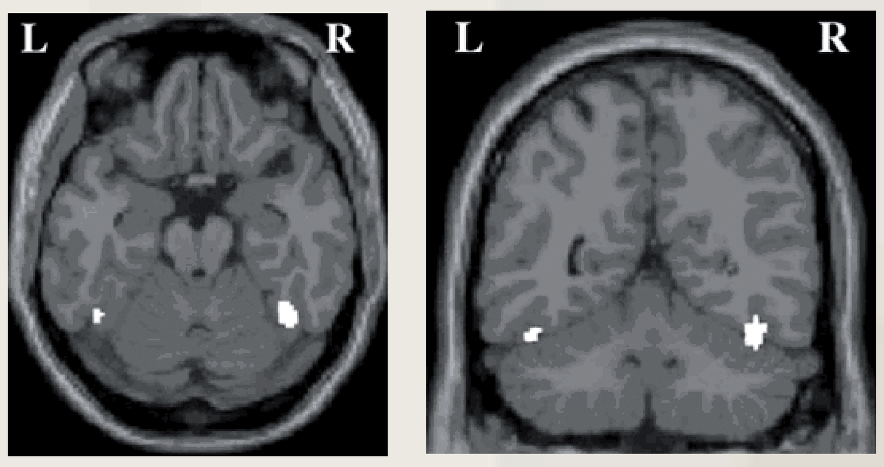


Figure 3: FFA as located by Vuilleumier et al (2001)

Next steps

- Confirm that perception during BR modulates FFA activity consistently, and with statistical significance, for all subjects/sessions with a larger input for the beamformer (computer memory has so far limited the input to 2x60 trials).
- Optimize frequency band.
- Perform multivariate prediction analysis in source space.
- Examine whether prediction can be based on the visual transient alone (i.e. on activity a few hundred ms around the button press).

References

Haynes, J. & Rees, G. (2005). Predicting the stream of consciousness from activity in human visual cortex. Current biology, 5, 1301-1307.
Sterzer, P. & Rees, G. (2008). A neural basis for percept stabilization in binocular rivalry. Journal of cognitive neuroscience, 20(3), 389-399.