

Effective Connectivity between OFA and FFA during face perception: DCM of evoked MEG, EEG and fMRI

Abstract No:

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Authors:

R Henson¹, D Wakeman¹, C Phillips², j rowe³

Institutions:

¹MRC CBU, Cambridge, United Kingdom, ²Cyclotron Research Centre, University of Liege, Sart Tilman, Liege, Belgium, ³Cambridge University, Cambridge, United Kingdom

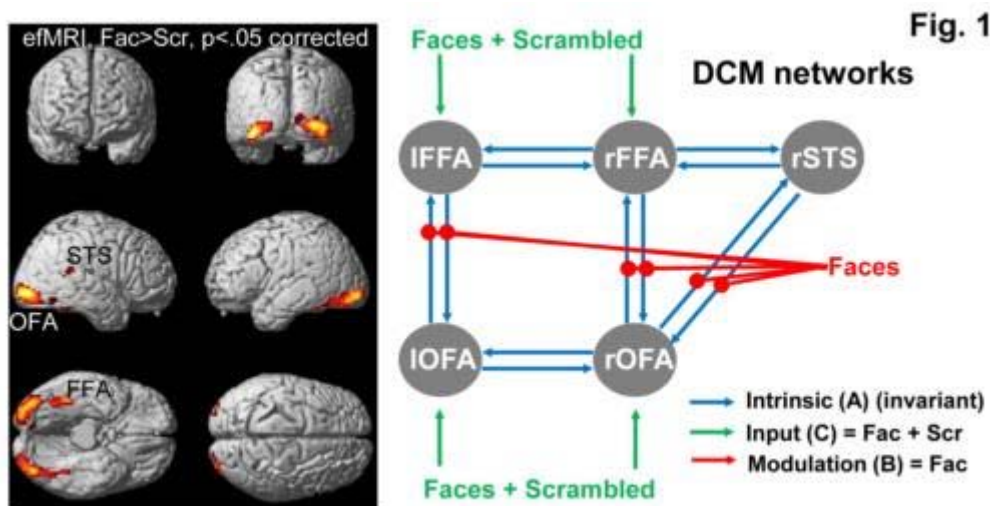
Introduction:

Although the fusiform and occipital face areas (FFA and OFA) show increased activity for face relative to non-face stimuli, it is not fully established whether this effect of face perception reflects changes in the communication (effective connectivity) between these regions. We applied Bayesian model comparison of families of Dynamic Causal Models (DCM; [1]) with different directed graphs between 5 regions of interest (left and right OFA and FFA, plus right STS) to evoked data from fMRI, and from source-reconstructed MEG+EEG. We found both convergent and divergent results across fMRI and M/EEG concerning the locus of driving input and whether forward and/or backward connections between OFA and FFA were modulated by face perception. The divergence was explained by simple simulations.

Methods:

18 participants made 2 visits to the MRC CBU, during which data were acquired from either T1, EPI, FLASH and DWI sequences on a Siemens 3T Trio MRI system, or from 102 magnetometers, 204 planar gradiometers and 70 electrodes on an Elekta Neuromag VectorView MEG system. Participants made left-right symmetry judgments on a random sequence of famous, unfamiliar and phase-scrambled faces (300 of each), presented for ~900ms every ~3000ms (each stimulus was repeated once, but this distinction, and the famous vs unfamiliar distinction, were ignored here; for further details, see [2]). These multimodal data are freely available from ftp://ftp.mrc-cbu.cam.ac.uk/wakemandg_hensonrn/ (as part of a BioMag 2010 competition). The fMRI data were analysed in SPM8, using OFA, FFA and STS ROIs defined by the group-level faces > scrambled, FWE-corrected T-contrast (Fig. 1). The M/EEG data were source-reconstructed with a minimum L2-norm fusion in MNE, using individual cortical surfaces and BEMs based on T1 and FLASH images, after which evoked timecourses from 0-400ms were extracted using a new method to minimize cross-talk between ROIs, and subjected to DCM for evoked LFP data in SPM8.

9 DCM models were fit for each modality, factorised by 2 families of 3 members in which 1) driving input (Faces+Scrambled vs baseline; C matrix in DCM) was to bilateral OFA, bilateral FFA or both, and 2) modulatory input (Faces only; B matrix in DCM) was to forward (OFA->FFA/STS), backward (FFA/STS->OFA) connections, or both.



Results:

Treating participants as a random effect [3], family-level inferences were made on the free-energy approximation to the log-model-evidence for each model [4]. The M/EEG data (Fig. 2) clearly favored the family of models with driving input to OFA (middle panel), while there was reasonable (exceedance probability $> .8$) evidence for the family with modulatory input of both Forward and Backward connections (right panel). The fMRI data (Fig. 3) again favored the family with driving input to OFA only (middle panel), consistent with the M/EEG data. However, there was insufficient evidence to favor models with either Forward or Backward modulatory inputs (right panel). The latter result can be explained by the fact that transient ($< 2s$) modulatory inputs in DCM have negligible effects on the neural response (at least when using the default prior expectations for DCM parameters; Fig. 4).

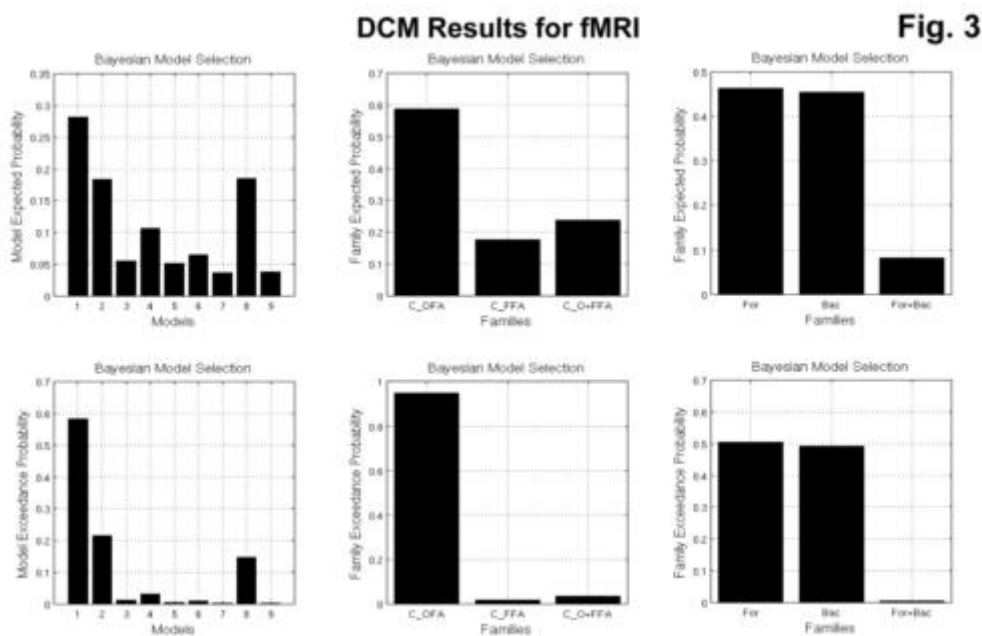
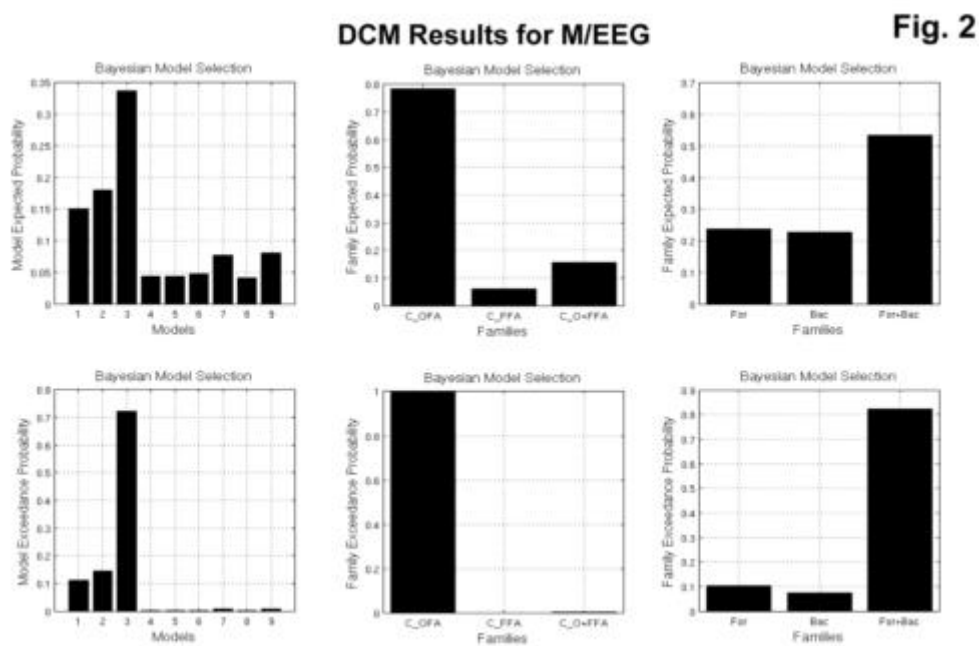
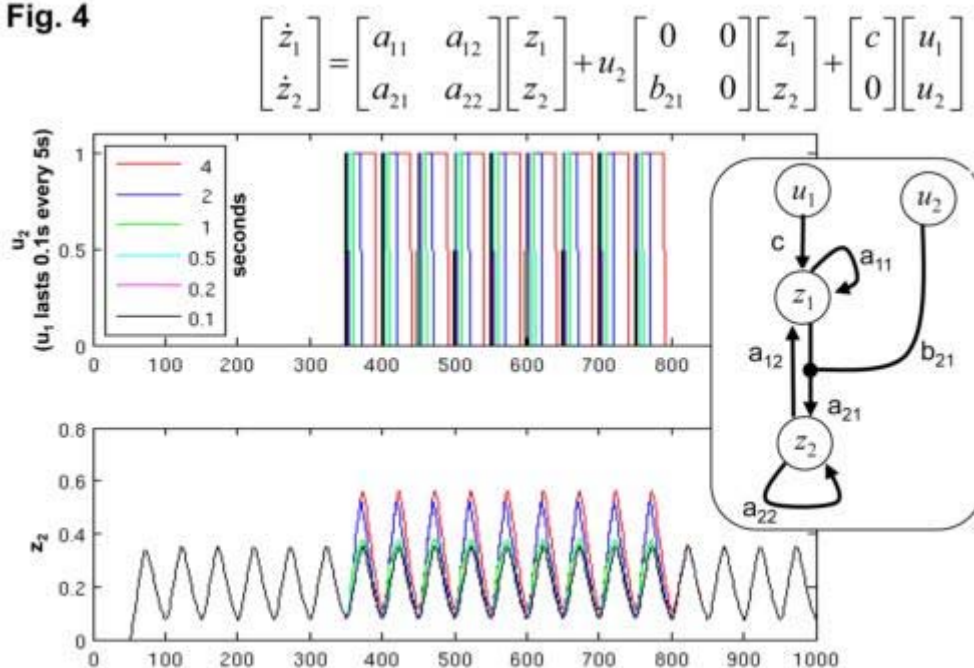


Fig. 4



Conclusions:

Despite their different underlying neural dynamical models [5], DCM for fMRI and DCM for evoked M/EEG responses converged in suggesting that the driving input of Faces and Scrambled faces versus baseline enters the network at the OFA, before reaching FFA and/or STS, with no evidence for an independent input to the FFA, as some have suggested [6]. Furthermore, the differences in evoked M/EEG responses to Faces (relative to Scrambled faces) seem to reflect increases in both forward and backward connectivity between OFA and FFA/STS. There was no support for the latter claim from the fMRI data, but this is because transient changes in connections are difficult to detect using a simple bilinear approximation to neural dynamics in DCM for fMRI.

Modeling and Analysis Methods:

fMRI Connectivity and Network Modeling

Abstract Information

References

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