Functional and structural connectivity in face-processing: MEG, EEG, fMRI, MRI and DWI data

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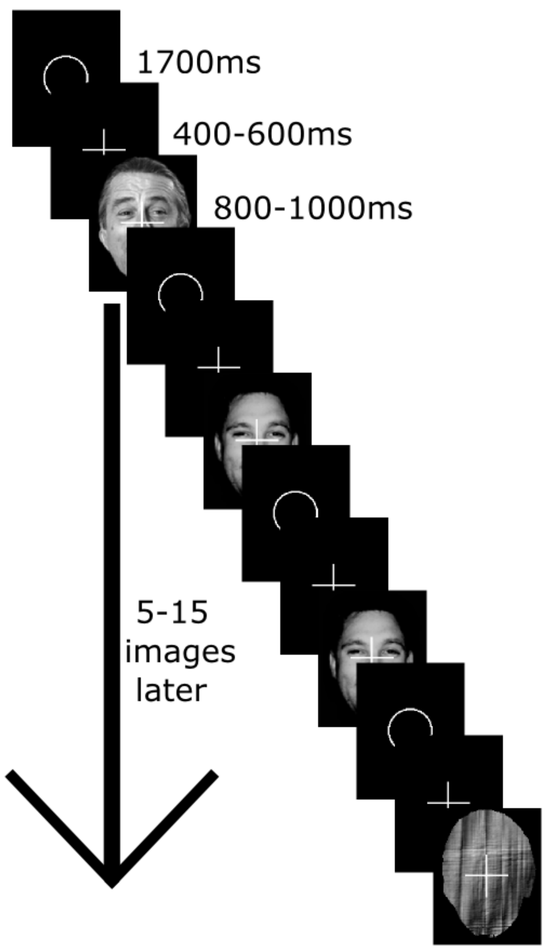
Introduction

The spatial and temporal neural correlates of human face-processing have been well-studied with haemodynamic and electrophysiological techniques; however, less is known about how such processing is supported by changes in connectivity between key brain regions like the Occipital Face Area (OFA), Fusiform Face Area (FFA) and Superior Temporal Sulcus (STS) [1]. We present a dataset, which utilizes this network for developing, comparing, contrasting, and integrating different measures of structural and functional connectivity. The data present a rich environment for a variety of cognitive questions e.g. how do the FFA and OFA interact during perception of a face, recognition of a familiar face, and following recent exposure to a face. Does the STS (social attention) affect the FFA and frontal cortices in order to respond to the familiarity of the face.

Experimental Design



19 Participants (8F 11M)

2 sets of pictures of each individual (1 for MEG & 1 for MRI)

150 Famous
150 Unfamous
150 Scrambled

Left Right Symmetry Task
Button Presses
Counter Balanced

Post-Hoc Behavioral test to see which faces participants recognized

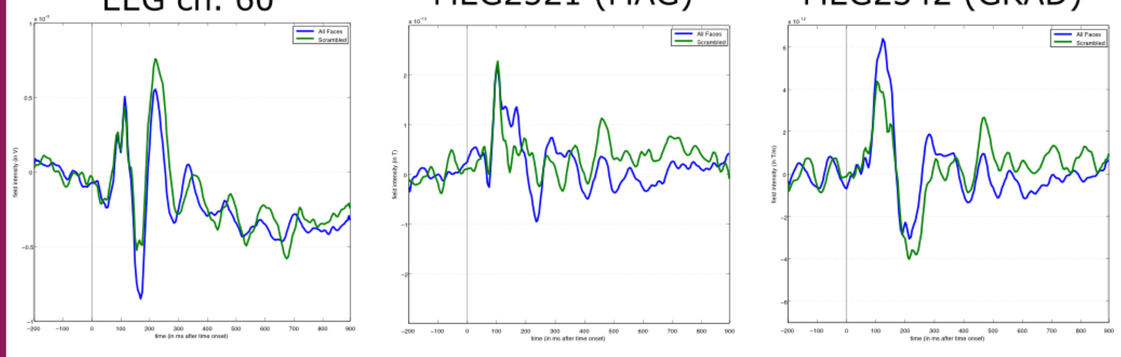
MEG & EEG

306 channel MEG
Elekta Neuromag Vectorview (Helsinki, FI)

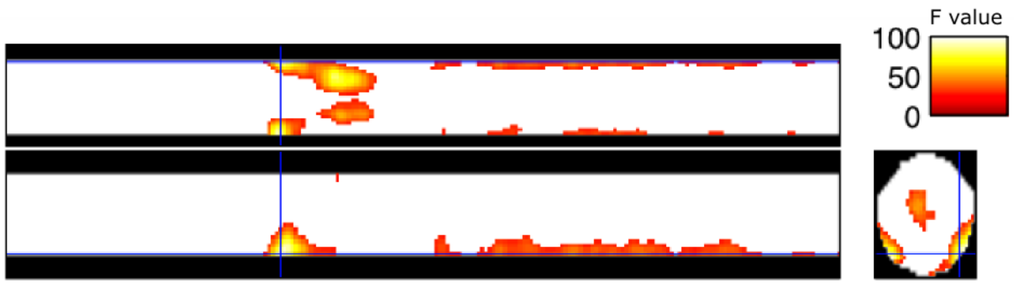
70 channel EEG + 2 EOG + 1 ECG

1100 Hz sampling rate; 350Hz lowpass filter; and no highpass filter

EEG ch. 60 | MEG2521 (MAG) | MEG2342 (GRAD)

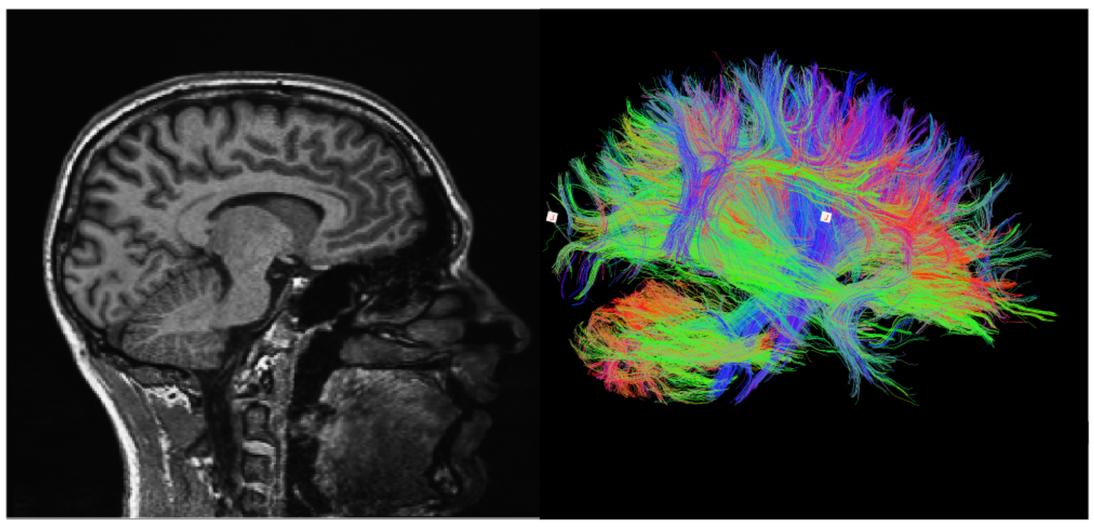


3D Sensor X Time SPM -200 to 900ms



Here we show an F- contrast for Faces vs Scrambled, utilizing a sensor x time statistical parametric map (SPM) of the average, evoked EEG data.

Structural MRI



MPRAGE 1mm iso 64 direction 2mm iso DWI (13/19)
Additionally we have:
5° Multi-echo FLASH (7e) 30° Multi-echo FLASH (7e)

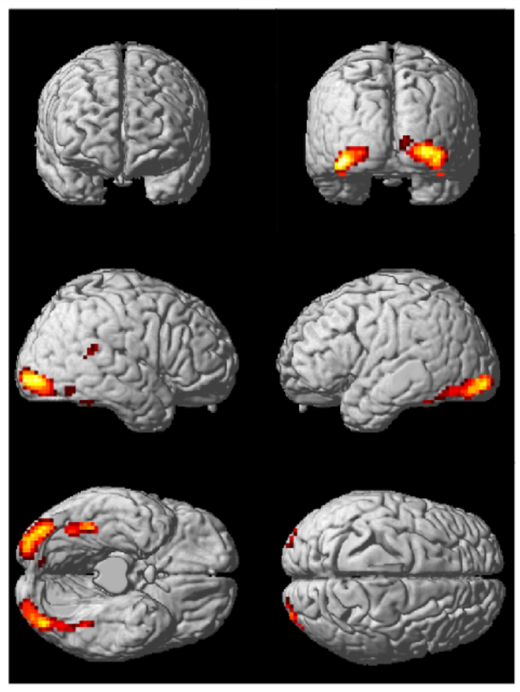
functional MRI

Identical paradigm with embedded 20s "fixation" blocks

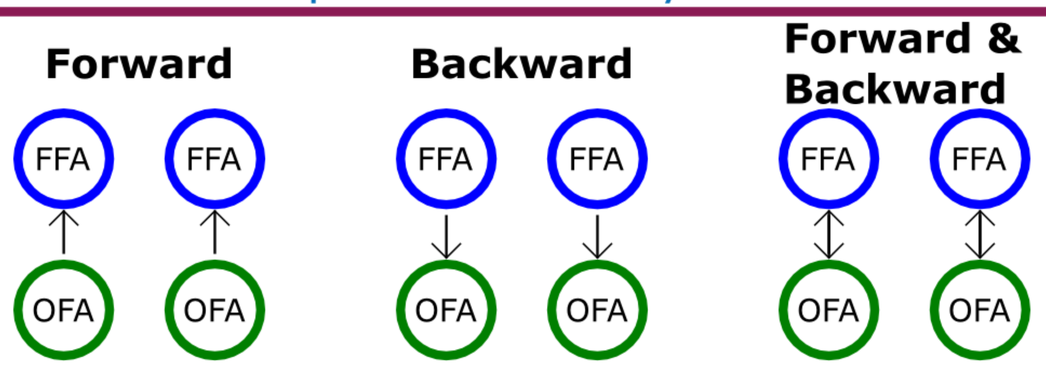
3mm iso gradient echo EPI

33 slices 2s TR
whole brain coverage

The figure to the right shows the results for the T contrast of Faces > Scrambled
FWE corrected at p <0.05



Example Connectivity Models



A preliminary Dynamic Causal Modeling (DCM) analysis of the connectivity within these three models in fMRI in one participant showed the Backward Model had the highest model evidence when comparing All faces to Scrambled images, while preliminary DCM analysis of the MEG data (Magnetometers) showed the Forward Model had the highest model evidence.

The study design allows a wide range of models (beyond these simple examples) to be tested including asymmetric models [2].

Discussion

This dataset can be a very valuable tool and will hopefully be a useful resource not only to the MEG community, but also to the wider community of Cognitive Neuroscientists. It presents a clear well studied paradigm [1,2,3] with several distinct nodes, such as bilateral Occipital Face Area (OFA), bilateral Fusiform Face Area (FFA), and right Superior Temporal Sulcus (STS). This paradigm has even been explored with connectivity analysis using Dynamic Causal Modelling of induced responses in a study [4]. Activity in these nodes have been shown to vary with the different conditions included in this paradigm.

References:
[1] J. V. Haxby et al. The distributed human neural system for face perception. Trends in Cognitive Sciences, 4(6):223–232, 2000.
[2] B. Rossion et al. A network of occipito-temporal face-sensitive areas besides the right middle fusiform gyrus is necessary for normal face processing. Brain, 126(11): 2381–2395, November 2003.
[3] R. N. Henson et al. Electrophysiological and haemodynamic correlates of face perception, recognition and priming. Cerebral Cortex, 13(7):793–805, 2003.
[4] C.C. Chen et al. Forward and backward connections in the brain: A DCM study of functional asymmetries. NeuroImage, 45(2):453–462, April 2009.

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