Time-frequency SPMs for MEG data on face perception:
Power changes and phase-locking

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Introduction

We conducted an MEG study with a paradigm used previously with ERPs and fMRI to isolate face perception [1]. Here we report time-frequency analysis of evoked and induced power, and phase-locking values (PLV), in sensor space. In a second abstract, we report distributed source localisation of the evoked M170 in normalised MNI space.

Methods

MEG data were sampled at 625Hz from a 151-channel CTF Omega system on 9 participants while they made symmetry judgments on faces and scrambled faces presented for 600ms. Epochs were created from -600ms to 1400ms. Five-cycle Morlet wavelets were used to calculate power and phase, from 5-45Hz, for each epoch from a subset of 32 channels (approximately uniformly distributed over the scalp). Across trials, power was averaged and PLVs were obtained from the phases (approximately 70 face and 80 scrambled trials per participant, mean RTs ~1400ms). To isolate induced power, the power of the average over trials was subtracted from the average power over trials. To avoid transients, maps were restricted from -100ms to 800ms, after frequency-specific baseline-correction from -200 to -100ms. Contrast maps of faces minus scrambled faces were obtained for power and PLV for each participant (averaged across channels). Power maps were transformed to magnitude (using a signed, square-root transform) to render their distribution more Gaussian. All maps were smoothed with a 2D Gaussian kernel of FWHM of 25ms and 5Hz, and then entered into SPM2 to construct 2D Statistical Parametric Maps (SPMs) of the T-statistic across participants testing for face-specific responses (final FWHM smoothness was 68ms x 12Hz).

Results

The mean magnitude map (Fig 1) and corresponding SPM{T} (Fig 2) show a power increase that was maximal at 186ms and 5Hz (though extending to 25Hz). An increase in phase-locking was also found in this frequency range, though occurring slightly earlier, maximal at 117ms (Fig 3). The SPM{T} for the induced power (Fig 4) showed less low-frequency power but a marked decrease maximal around 400ms at 45Hz (gamma); of small magnitude, but consistent across participants. This was not predicted a priori, but survived $p<.05$ after correction using Gaussian Field Theory [2].

Conclusion

Face perception involves an increase in both power and phase-locking from 100-200ms and 5-10Hz, suggesting that the evoked M170 reflects an increase in coherent neural activity, as well as (i.e, not only) phase-resetting of ongoing oscillatory activity [3]. There is also a later decrease in induced gamma power starting around 350ms, whose functional correlates are unknown.

References
1. Henson et al., 2003, Cerebral Cortex.
2. Kilner et al, in press, Neuroscience Letters.
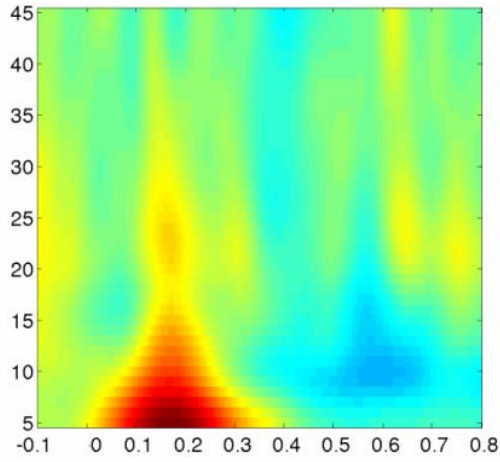3. Makeig et al., 2002, Science.

Fig 1. Magnitude map

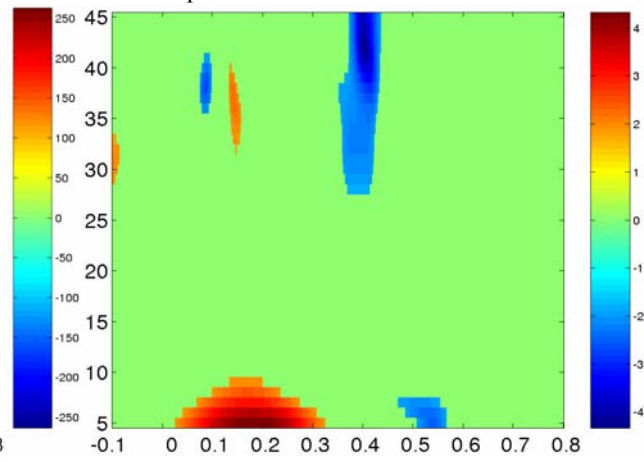Fig 2. SPM{T(9)} for magnitude, thresholded at p<.05 uncorrected
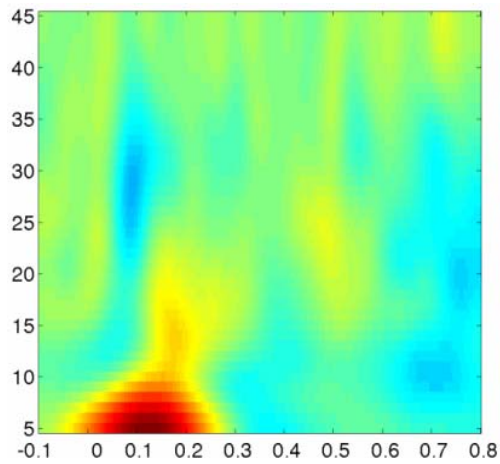

Fig 3. PLV map

Fig 4. SPM{T(9)} for induced magnitude, thresholded at p<.05 uncorrected (circled blob survives correction)