INVESTIGATING THE CONTRIBUTIONS OF NARROWBAND GAMMA AND BROADBAND GAMMA TO POSITIVE AND NEGATIVE BOLD RESPONSES

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INTRODUCTION

- Positive (PBR) and negative (NBR) haemodynamic signal changes (relative to baseline) to stimulus [1]
- Two frequency ranges within the gamma band
  - **Narrowband gamma** (NBG) 30-60Hz
  - **Broadband gamma** (BBG) 50-200Hz
  - Different neuronal source originations and stimulus contrast-level dependencies [2]
- Haemodynamic signatures of underlying NBG and BBG activity are not identical [3]

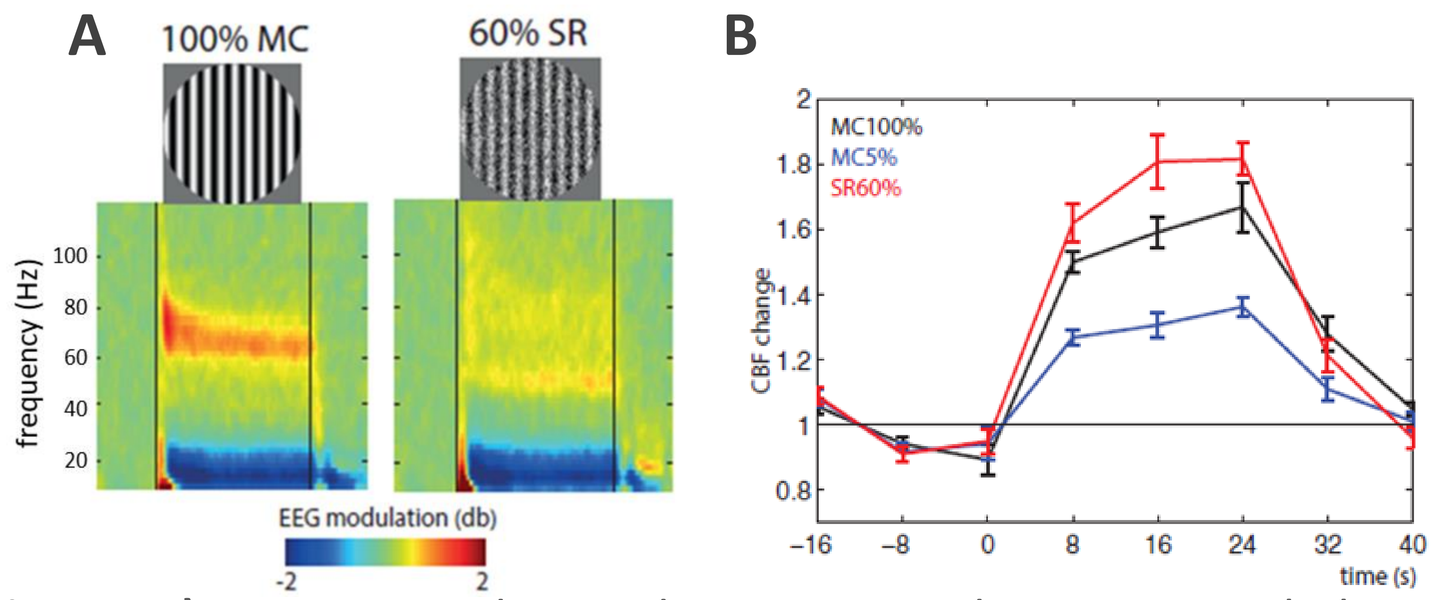


Fig. 1: A) Decomposed EEG data: increased NBG to Michelson contrast (MC - 100%) and suppressed NBG to spatially randomised grating (SR - 60%) **B)** BOLD measurements: SR - 60% indicates the highest metabolic demand [3]

AIMS

- Gaining better insights of neural correlates of PBR and NBR responses in sensory cortex
- Characterising gamma band with non-invasive imaging technique (MEG) in humans and their relation to fMRI signals

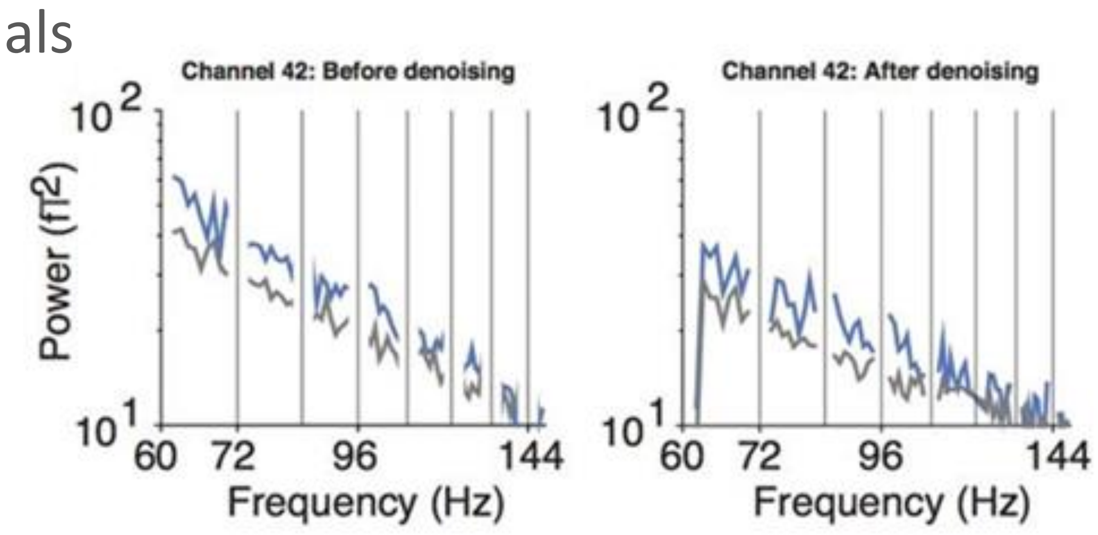


Fig. 2: Power spectra of recorded BBG with MEG to checkerboard stimulation [2]

METHODS

<table>
<tr><th colspan="3">EXPERIMENTAL PARADIGM</th></tr>
<tr><th>BLACK/WHITE CHECKERBOARD</th><th>BLACK/WHITE GRATING</th><th>AUDITORY DETECTION TASK</th></tr>
<tr><td>16 Hz</td><td>3cpd, 6Hz drift freq</td><td rowspan="3">1kHz beeps at 6Hz with 0,1,2 deviant +/- 50Hz tones</td></tr>
<tr><td colspan="2">Right/Left visual field stimulation</td></tr>
<tr><td>80% or 40% contrast-level</td><td>100% or 60% spatial randomisation</td></tr>
<tr><th>tasks</th><th>MEG</th><th>fMRI</th></tr>
<tr><td>visual 2 runs
auditory 1 run</td><td>6s ‘on’, 6s ‘off’
40 trials, 8mins each</td><td>6s ‘on’, 15s ‘off’
20 trials, 7mins each</td></tr>
</table>

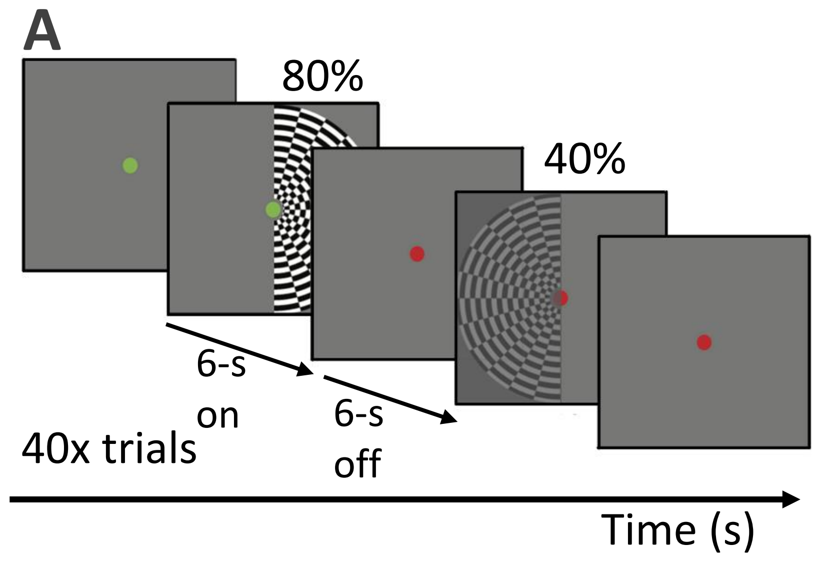
ACKNOWLEDGEMENT STEPHEN MAYHEW, PhD

REFERENCES

[1] Logothetis, N. K. (2002). The neural basis of the blood–oxygen–level–dependent functional magnetic resonance imaging signal. Philosophical Transactions of the Royal Society of London. Series B: Biological Sciences, 357(1424), 1003-1037.

[2] Kupers, E. R., Wang, H. X., Amano, K., Kay, K. N., Heeger, D. J., & Winawer, J. (2018). A non-invasive, quantitative study of broadband spectral responses in human visual cortex. PloS one, 13(3).

[3] Butler, R., Bernier, P. M., Lefebvre, J., Gilbert, G., & Whittingstall, K. (2017). Decorrelated input dissociates narrow band γ power and BOLD in human visual cortex. Journal of Neuroscience, 37(22), 5408-5418.



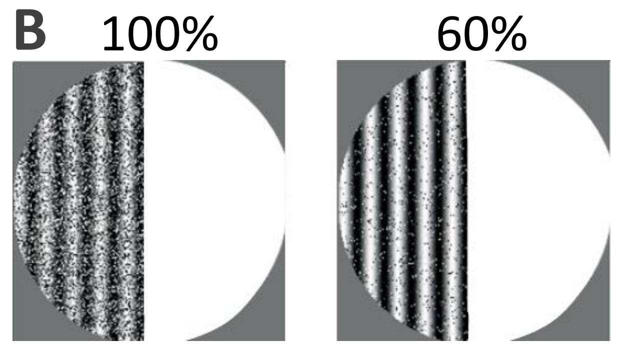


Fig. 3: A) Checkerboard stimulation on high and low contrast (modified) [2] **B)** High and low spatially randomised grating stimuli (modified) [3]

NOISE-POOL ALGORITHM

- Identifies 100 MEG sensors with lowest response to checkerboard
- Computes principal components for each 1-s epochs
- Projects out computed noise components from dataset

MEG DATA

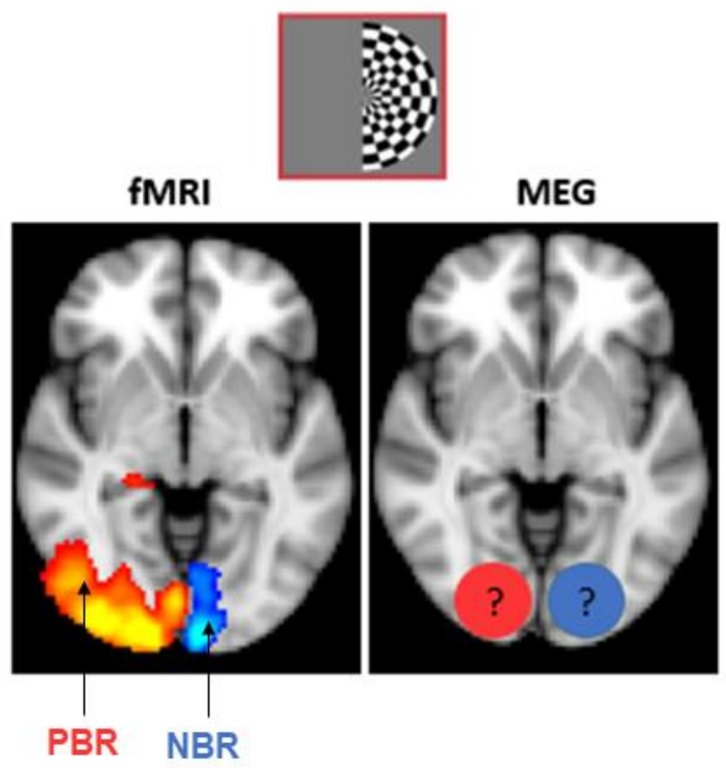
- Using FieldTrip Toolbox
- 6-s active / 6-s control
- 1-s epochs each blocks
- 4 frequency bands of interest (alpha, beta, NBG, BBG)
- LCMV beamformer

fMRI DATA

- Using FSL
- Preprocessing
- General Linear Models
- Z-statistics

Comparing the power of extracted time-courses of MEG data to the amplitude changes of PBR and NBR in visual cortex

EXPECTED RESULTS



fMRI

PBR contralateral activation

NBR ipsilateral deactivation

to right visual field stimulation

MEG

- Contralateral gamma event-related-synchronisation **(ERS)**
- Decreased alpha and beta power in both hemisphere
- Ipsilateral alpha, beta and gamma event-related-desynchronisation **(ERD)**
- Induced NBG to higher contrast-level - 80%
- Induced BBG to spatially randomised grating - 100%

DISCUSSION

- Replication and extension of Kupers et al., 2018 [2]
- Identification and manipulation of the interaction between the power of neural activity fluctuations and haemodynamic responses (PBR, NBR)
- Supporting the theory of different neuronal source originations and contributions of NBG and BBG to PBR and NBR [2][3]
- Alternative signal-to-noise ratio improvement of MEG recordings with denoising algorithm [2]