Introduction

Reliable brain activity synchronization between subjects induced by naturalistic stimuli such as movies has recently been increasingly reported (Hasson, N., et al. 2004). Previous MEG studies reveal that some time-dependent frequency power correlated between subjects, but investigated frequencies are confined at very low frequency bands (Lankinen, S., et al. 2014) or specific frequency points on the spectra (Chang, T., et al. 2015). These findings imply the need for new methods that measures subject similarity, especially for high frequency bands, which differ more on fine temporal structure between individual subjects. We made a hypothesis that representational similarity analysis provides a powerful tool for understanding better how subjects are similar in naturalistic movie viewing. We also explored if similarity of movie scene representations was robust measure on 3D movie based on the previous findings that stereopsis adding to the naturalistic led to an increase in synchronization between subjects (Gaebler, B. S., et al. 2014).

Methods

Stimulus

- Movie: Under the sea, two clips both in 2-D and 3-D (5 min)
- Data acquisition and time-frequency analysis
- Whole head MEG data, pre-processed for noise removal (SSP & ICA)
- Hilbert transform plus band-pass filter
- Inter-subject correlation and amplitude-adjusted Fourier transform (AAFT)
- Permutation test to estimate the distribution of mean pair-wise correlation

Comparison of Classification and inter-subject representational similarity

- 10 1-second data samples are drawn from each scene.
- Leave-one-out cross validation of Linear Discriminant Analysis (LDA) classification
- Mean pair-wise correlation of representational dissimilarity matrix.

Results

- Our single-trial classification method achieved high prediction accuracy and reasonable scene classification structure.
- Low frequency bands (delta, theta, alpha) showed strong inter-subject correlation, while high frequency bands showed higher classification accuracy and higher inter-subject representational similarity.
- 3-D movie showed higher ISRS than 2D movie in low gamma and beta band.

Summary Results

- High frequency bands and low frequency bands show very different mechanism in subject similarity.
- Inter-subject representational similarity is robust in detecting subject similarity for higher frequency bands.
- Low gamma and beta bands play important roles in stereopsis-dependent increase in subject classification similarity.

Conclusion

Acknowledgement

Acknowledgement

Supported by Natural Sciences and Engineering Research Council (NSERC) of Canada funding to F.R. Farivar.

Figure 1. Significant level of ROI based mean pair-wise correlation in different frequency bands

Z-score showed significant level of mean pair-wise correlation in each region of interest in visual areas. Error bars show standard error of the mean estimated by permutation with amplitude adjusted Fourier transform (AAFT).

Figure 2. Significance level of vertex-wise mean pair-wise correlation in different frequency bands

Figure 3. Movie scene classification results

Figure 4. Whole-brain classification accuracy and inter-subject representational similarity across frequency bands

In left panel, classification prediction accuracy for different frequency bands are shown in 2D movie and 3D movie. The chance level is 8.33%. In the right panel, inter-subject representational similarity value is calculated based on each subject's representational dissimilarity matrix (RDM). Mean pair-wise correlations are calculated for the lower triangle of the RDM. Error bars represent the SEM estimated by permutation.