Magnetoencephalography-based brain connectivity fingerprinting: single subject and twin pair identifications

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Background: The objective of the study was to investigate whether functional brain connectivity ‘fingerprints’ as measured with magnetoencephalography (MEG) can identify individuals. If genetics contributes to this prediction then genetically related subjects such as monozygotic twins, should also be identifiable as pairs.

Methods: We examined 32 pairs of cognitively intact monozygotic twins older than 60 years of age from the NTR-EMIF-AD PreclinAD study. Five minutes eyes-closed resting-state MEG data were recorded and source-reconstructed to the centroids of 78 regions of the AAL atlas. Functional connectivity between pairs of brain regions was computed in 5 frequency bands with Amplitude Envelope Correlation (AEC) and Phase Transfer Entropy (PTE). Spearman’s correlation coefficients were computed as a similarity measure between every combination of connectivity profiles (upper triangular part of the connectivity matrix) and then converted into distance scores. A shared component was removed from the matrices using singular value decomposition in order to ….. The multi-class single subject identification problem was analyzed with the ‘one against all’ technique. The area under the curve (AUC) of the average receiver operating characteristic (ROC) curve across each comparison was used to assess performances. The analyses were repeated for twin pair identification.

Results: Subjects (42 female) had an average age of 68.13±7.87 years. We found that AEC in alpha and beta bands had the highest AUC values for both the single subject (100% for both) and the twin pair identification (89.2% and 88.1%, respectively). AUC of alpha and beta PTE were also high for single subject (92.2% and 99.0% respectively) and twin pair identification (81.9% and 86.6% respectively). In the other frequency bands performances ranged from 79.0% to 100% for single subject identification and 58.2% to 85.0% for twin pair identification.

Conclusions: We conclude that MEG functional connectivity patterns can be used as fingerprints to reliably identify individuals. Moreover, monozygotic twin pairs could reliably be identified, suggesting that AEC and PTE connectivity patterns are genetic traits. These results show that MEG based connectivity fingerprints are highly specific to individuals, genetic, and may thus explain genetic variation in behavior or psychopathology.