Long-term monitoring of trait-like characteristics using ear-EEG

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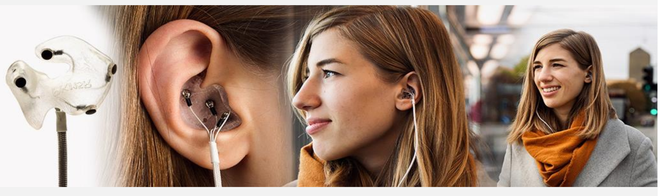
Conclusions

- Ear-EEG measures nocturnal trait-like characteristics at least as reliable as scalp-EEG.
- NREM 2 power spectrum as a neural characteristic show trait-like differences, including stability over time within individuals and systematic variation across individuals.
- These features may prove to be useful in early detection of neural degeneration.

Introduction

- This work investigates monitoring of neural signatures during sleep using a wearable device that records EEG from the ear (ear-EEG) [1].
- The study compares the intra- and inter-individual similarity to that from scalp-EEG [2].
- Changes in signatures has been associated with Alzheimer's disease and is of great interest for early detection and clinical management [3].

What is ear-EEG?



An ear-centered dry-electrode EEG recorder that enables acquisition in patient's everyday environment.

Materials and methods

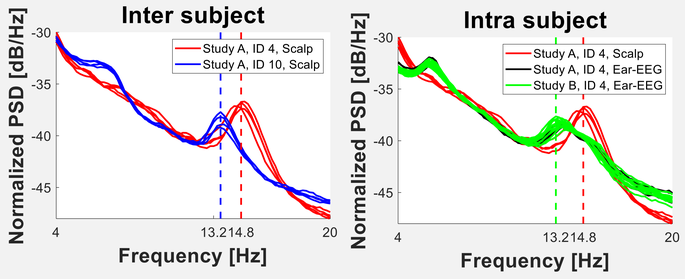
- Two-phased unattended in-home study (A+B): (A) 20 subjects for 4 nights, followed by (B) a delayed but continued monitoring of 10 subjects for 12 nights.
- Participants wore at the same time a partial PSG (EEG, EOG, EMG) and the ear-EEG system.

PSG | Ear-EEG

- PSG data were scored manually according to AASM, and ear-EEG data were scored automatically [4].

Grand average power spectra:

- Per night the grand average power spectra of NREM 2 were computed and log-transformed.



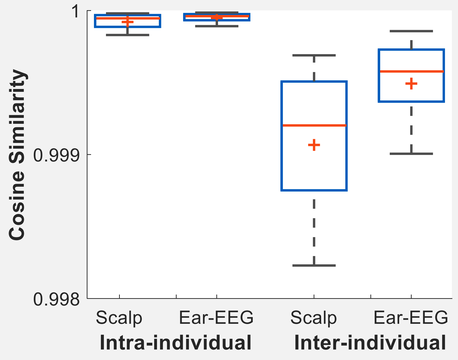
Intra- and inter-individual similarity:

- Cosine similarity were calculated between 5 & 20 Hz.

$$similarity = \cos(\Theta) = \frac{\boldsymbol{A} \cdot \boldsymbol{B}}{\|\boldsymbol{A}\|\|\boldsymbol{B}\|} = \frac{\sum_{i=5}^{20} A_i B_i}{\sqrt{\sum_{i=5}^{20} A_i^2}\sqrt{\sum_{i=5}^{20} B_i^2}}$$

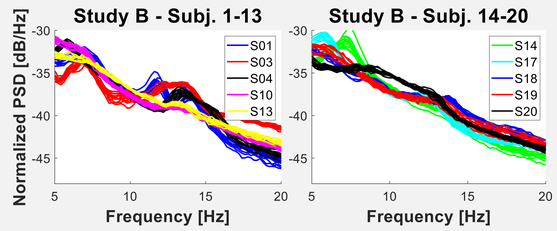
Results: Comparing scalp and ear-EEG

- Permutation tests indicate that mean intra-individual similarity is larger ($p>0.01$) than mean inter-individual similarity for both scalp & ear-EEG.

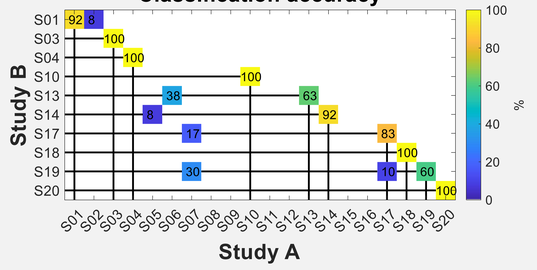


- Comparing the distributions of intra-individual similarities for ear-EEG and scalp-EEG, the observed mean difference is statistically significant ($p<0.05$), in favor of a more stable ear-EEG signature.

Results: Long-term ear-EEG stability



- Comparing ear-EEG signatures between A and B, considering nights from A as reference, all subjects from B were most similar with their own reference signature.



- Considering signatures from individual nights the accuracy paring subjects from A and B were 90.1% correct.

Acknowledgments

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Contact information

Please contact if you have a question, would like to comment, or need a live demonstration or presentation. We are open for research collaborations and co-development. I'm at **mrhe@uneeg.com**

Literature cited

[1] Mikkelsen et al., 2015. EEG Recorded from the Ear: Characterizing the Ear-EEG Method. *Front. Neurosci.*

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