 DOI: 10.3217/978-3-85125-962-9-62

Ultra-high-density electrocorticography recordings of the human sensorimotor cortex

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Introduction: The combination of high spatial and temporal resolution with limited invasiveness makes electrocorticography (ECoG) an important method in the study of neural implants. To optimize ECoG-based brain-computer interface (BCI) control while minimizing implantation risk, we aim to determine the optimal balance in cortical coverage versus electrode density. To do so, it is necessary to record from multiple neuronal ensembles simultaneously in great detail. This is made possible by the ultra-high-density (UHD) grids (0.9 mm pitch) produced by Cortec Neuro. To assess the advantages of UHD ECoG, we compared its signal quality to conventional high-density (HD) ECoG (3 mm pitch).

Material & Methods: We recorded from the human sensorimotor cortex during sleeping (n=2) and awake (n = 4) brain surgeries, for 5-15 minutes. Data was recorded with Cortec UHD grids (see Fig. 1), in most cases (n = 5) combined with simultaneous HD recordings (PMT or AdTech). During awake surgeries, the participants performed speech or hand movement tasks**.**

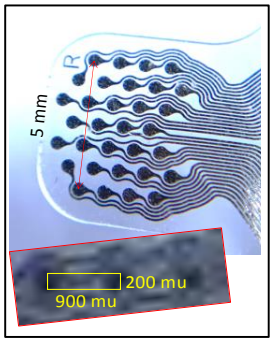

Figure 1*. Dimensions of the Cortec ultra-high-density grid.*

Results: Visual inspection of the raw signals and power spectra shows that about 60% of the UHD electrodes appeared noisy compared to other electrodes in the same grid. We observed no significant difference between the power spectra of the UHD and HD grids (mean and standard deviation of the ten best channels). When computing the correlation of the mean high-frequency band (HFB) power signals (65-95Hz) between non-overlapping windows of 10s, we noted very high correlation between time windows, for both UHD and HD grids, suggesting stable signals over time. We quantified the extent to which each electrode recorded independent signals by computing the correlation of HFB power between electrode pairs for every 10s of data, and then averaging over time windows for all equidistant pairs [1]. Correlation values between UHD electrode pairs did not decrease with distance, while this clearly was the case for HD electrode pairs, either indicating the presence of correlated noise in the UHD recordings or recording of common signal due to e.g. volume conduction. Lastly, UHD electrodes also displayed highly spatially selective responses to task onset and offset, indicating clear distinction between adjacent electrodes.

Discussion: Overall, the signal quality of UHD and HD grids proves to be comparable. The results indicate that the electrodes of UHD grids record spatially distinct signals, despite the presence of shared features in the recordings.

Acknowledgements: The authors would like to thank the participants, without whom this research would not have been possible.

References:

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