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Exploring cortical connectivity of visual prosthesis users: A resting state study

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INTRODUCTION & AIM

Electrophysiological studies of cortical activity have revealed organizational and functional differences in the cortex of blind individuals compared to those with normal vision. The nervous system optimizes this reorganization to adapt to the new sensory modalities that individuals rely on in their daily lives. A cortical visual prosthesis can restore visual sensations to blind individuals through the generation of phosphenes, which aim to provide them with information about their surroundings. In this context, our study aims to characterize the cortical changes that result from the use of a vision neuroprosthesis.

METHOD

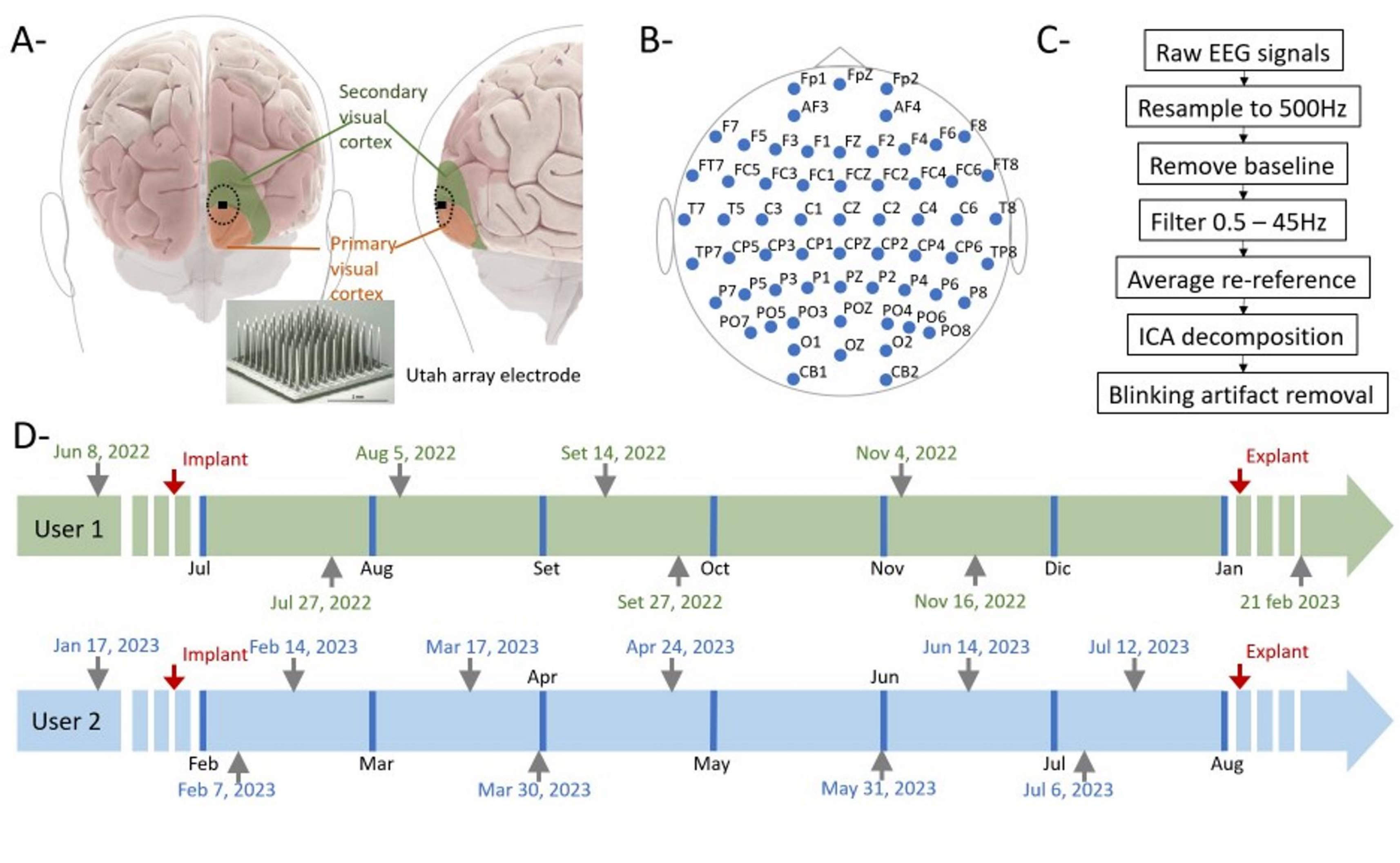

Fig. 1 Experimental Design. A) The approximate area where the UEA was implanted in both participants. B) Placement of the EEG recording electrodes. It's important to note that the Fp1 position was excluded from the analyses due to significant noise and artifacts detected in the signal during recordings. C) Procedure used to eliminate blink-related artifacts. D) Timeline and the specific days when resting-state EEG recordings were obtained.

RESULTS & DISCUSSION

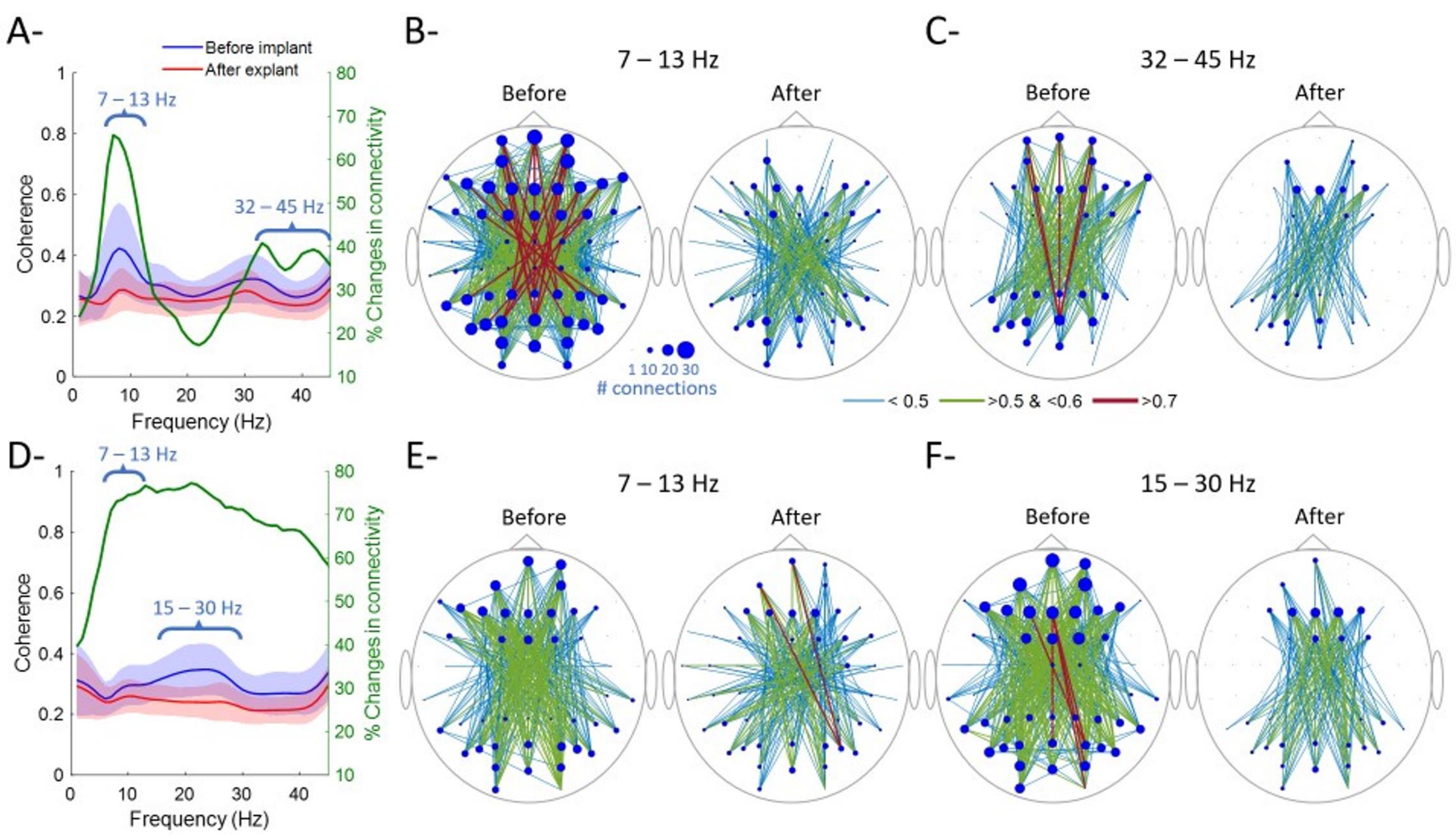

Fig. 2 Changes in global connectivity in resting state in User 1 and User 2. A and D: Average coherence of all possible combinations for both users (blue line: Before implantation, red line: after explantation, green line: percentage change). B, C, E and F: Global connectivity patterns in different bands for the two users.

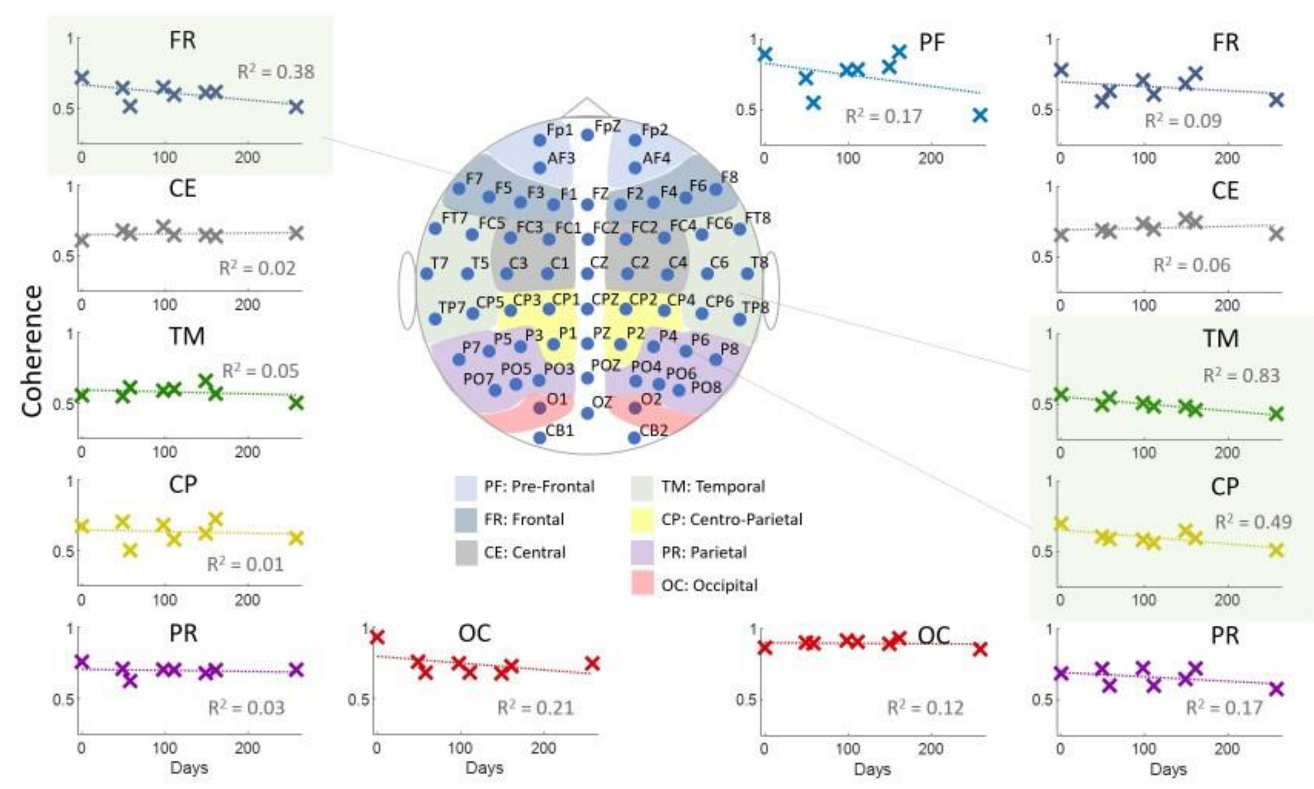

Fig. 3 User 1 coherence analysis in the alpha band (7-13 Hz) within predefined cortical sections. It reveals changes reveals linear and decreasing trends in spectral coherence values in the 7–13 Hz band in the left frontal (FR, $R^2 = 0.32$), right temporal (TM, $R^2 = 0.78$), and right parietal central (CP, $R^2 = 0.43$) regions over time.

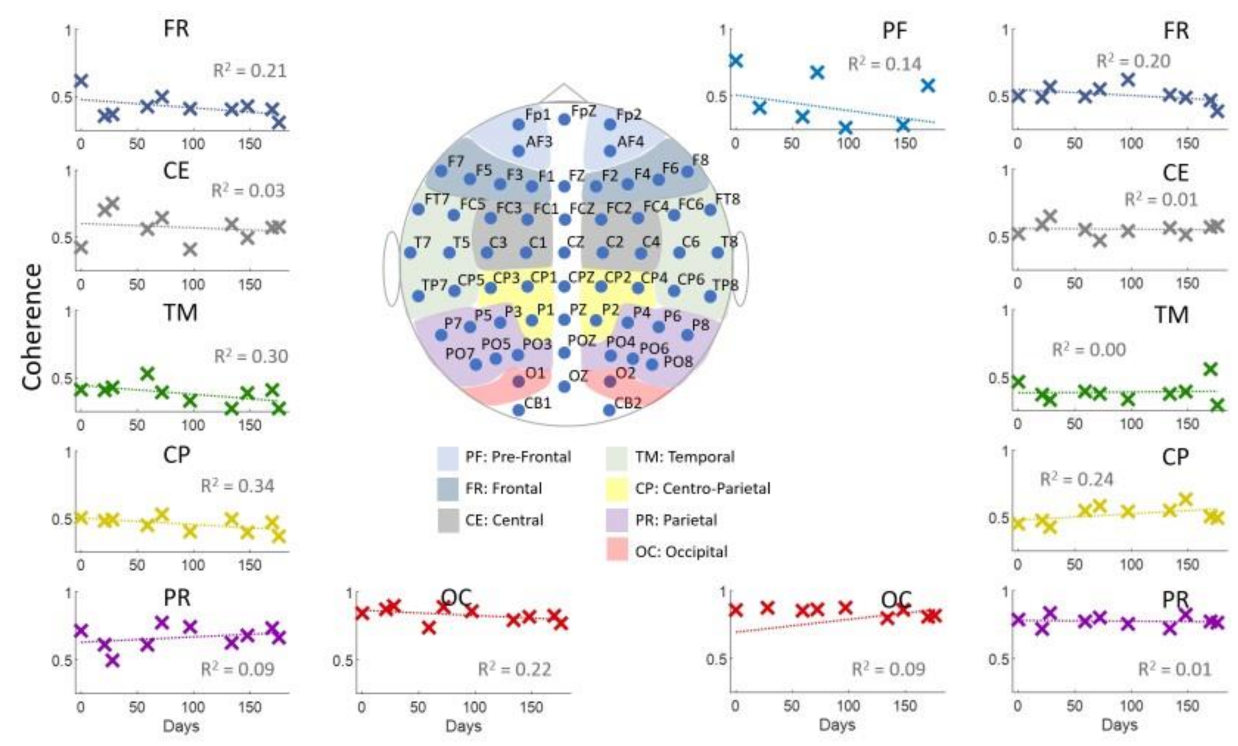

Fig. 4 User 2 coherence analysis in the beta band (15-30 Hz) within predefined cortical sections. Significant trends were observed in the left temporal (TM) ($R^2 = 0.30$) and left parietal central (CP) ($R^2 = 0.34$) regions, both showing decreasing trends

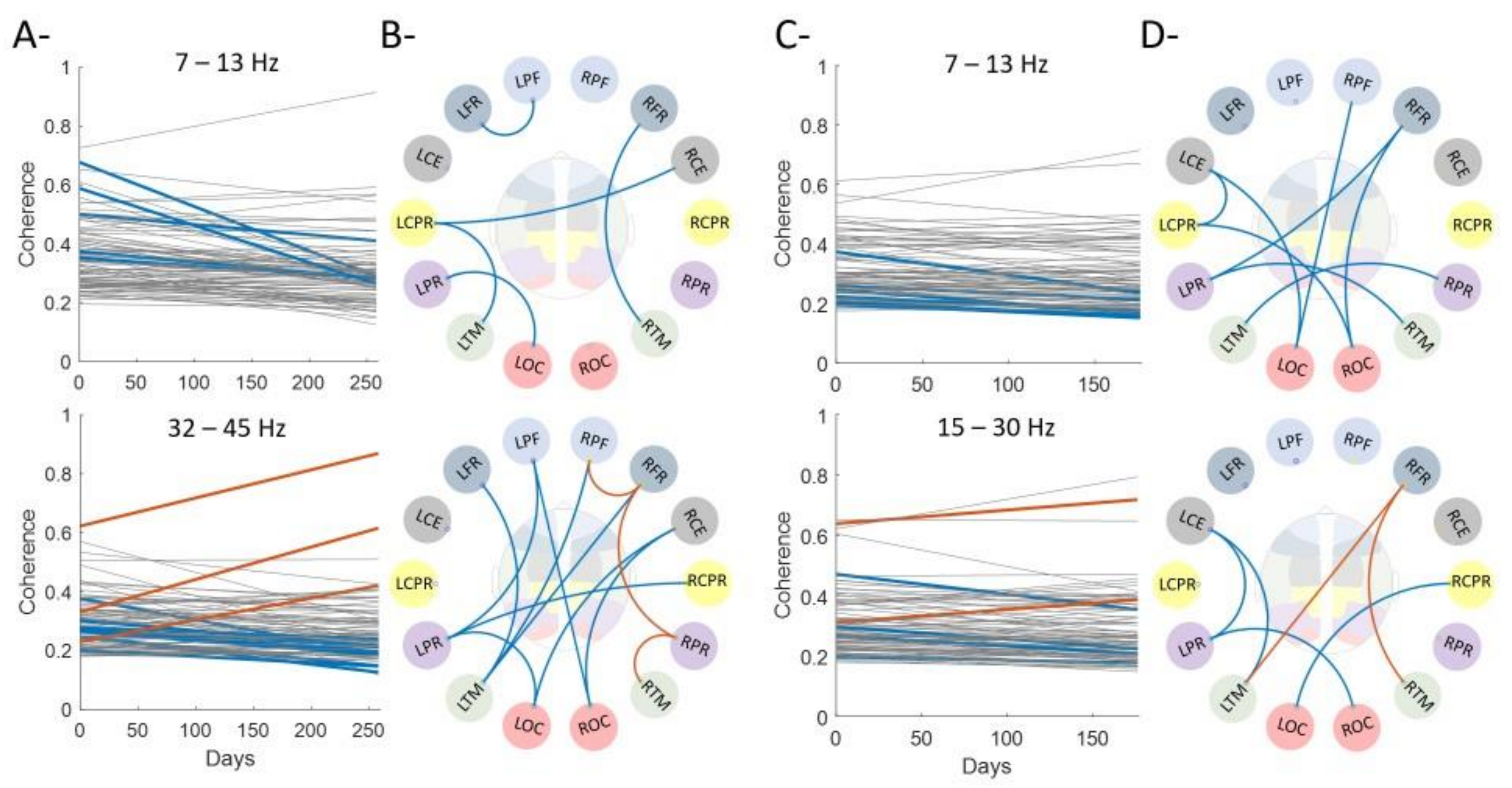

Fig. 5 Connectivity between cortical regions over time assessed for both User 1 (A, B) and User 2 (C, D). A and D: Linear fits between coherence values of all possible pairs of combinations between pre-established cortical regions (91 pairs in total), blue solid lines represent significant linear trends ($R^2 > 0.5$), gray lines do not show significant trends ($R^2 < 0.5$), and warm lines represent positive incremental linear. B, D: Connectograms showing connections between regions with significant decreasing linear trends(blue curved lines) or increasing linear trends (warm curved lines).

CONCLUSION

These preliminary results revealed that cortical connectivity in the resting state significantly changes with the use of the vision neuroprosthesis, tending in some cases towards cortical patterns similar to those of non-blind individuals.