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Speech decoding performance is influenced by perceiving auditory feedback or not: Implications for locked-in individuals

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Introduction: Recent developments in speech BCI technology have demonstrated its potential to restore communication in individuals who have lost the ability to produce intelligible speech by translating neural signal modulations associated with (attempted) speech into computerized speech [1, 2]. For the accurate production of speech sounds by able-bodied people, auditory feedback plays an important role, evidenced by the fact that speech output is directly affected when feedback is altered or absent. Importantly, individuals with locked-in syndrome (LIS) are unable to produce speech and articulator movements, and therefore lack auditory feedback. The question remains if the speech decoding performance levels reported recently for less severely impaired individuals can be attained by people with LIS as well. Here, we investigated if and how speech decoding performance differs in the presence and absence of auditory feedback.

Material, Methods and Results: High density electrocorticography (ECoG) grids were subdurally placed on the left SMC in three epilepsy patients. These participants completed two speech tasks, in which they were instructed to produce a sequence of seven syllables. In the first task they could hear themselves speak, while in the second their auditory feedback was masked by pink noise. After preprocessing the ECoG data and extracting the HFB power (65 – 95 Hz), electrodes with a significant increase in HFB power during speech compared to rest were identified by computing R2 values. Then, a support vector machine classifier was applied to the speech trials following a nested cross-validation approach to determine decodability of the brain signals in both tasks. A leave-one-group-out approach was applied, where on every fold one instance of each of the seven syllables was left out as test data. Decoding accuracies were compared between tasks.

Results showed that for both tasks, all participants displayed widespread SMC engagement during speech production. Decoding accuracies for all participants were well above chance, ranging between 36% - 62% (chance level 11%). There was a consistent difference in decoding accuracy between the two tasks, where each participant displayed significantly lower performance in the task with masked feedback compared to the task in which auditory feedback could be perceived.

Conclusion: The perception of auditory feedback during speech production influences speech decoding performance. This finding stresses the need to validate speech BCI performance with participants who are unable to produce any speech movements and sounds.

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