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Decoding single and paired phonemes using 7 T functional MRI

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Abstract

Brain-computer interfaces (BCI) can provide a means of communication for people suffering from locked in syndrome. Several studies have shown that motor programs related to individual phonemes are represented in detail in the sensorimotor cortex. This would theoretically allow BCI able to decode continuous speech by training classifiers using the activity underlying production of individual phonemes.

One way of determining cortical representation is high field functional MRI that samples the brain at high resolution without gaps. We assessed the decodability of trials with individual and paired phonemes (pronounced consecutively with one second interval) using activity in the sensorimotor cortex. Fifteen participants pronounced 3 different phonemes (/t/, /p/, /ə/) and 3 combinations of two of the same phonemes (/p/ /t/, /ə/ /t/, /p/ /ə) in a 7 T functional MRI experiment.

Individual and paired phonemes were classified using linear support vector machines (SVM) with a classification accuracy of 47% (17% chance level). To assess if it is possible to decode individual phonemes from the paired combinations of phonemes, classifiers were trained on single phonemes and tested on paired phonemes achieving a classification accuracy of 53% (33% chance level). A SVM searchlight analysis showed that phoneme representations are distributed across the ventral sensorimotor cortex.

Our study demonstrates that activity of isolated phonemes is present and distinguishable in combined phonemes with high field fMRI. These findings suggest that speech BCI with machine learning algorithms trained on individual phonemes may be a feasible strategy for intracranial electrode grids.