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**Sparse Higher Order Partial Least Squares for
Brain Decoding Using Electrocorticography Data**

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We propose new statistical methodology for the brain decoding problem using electrocorticography (ECOG) data. This is large, high dimensional, neuroimaging data with complex dependencies between variables. We seek to accurately classify patient stimuli using a novel tensor decomposition that exploits the structure inherent to ECOG data. To this end, we introduce the Sparse Functional Higher Order Partial Least Squares method for classification and dimension reduction. To evaluate the effectiveness of our method we compare the classification accuracy achieved using the Sparse Functional Higher Order Partial Least Squares method with common machine learning and classification methods. In addition to accurately identifying patient stimuli, our method identifies relevant regions of the brain and their respective activation times showing that our method is competitive for classification tasks while being much more interpretable than existing statistical methods for analyzing ECOG data.