

# RESEARCH PAPER #2 REFERENCE:

Neural synchrony in the pain connectome predicts chronic pain severity and interactions with mental health outcomes: A transdiagnostic study using magnetoencephalography and multivariate modeling

## RESEARCH FOCUS:

- Aimed to understand the neural mechanisms underlying chronic pain & its correlation with mental health issues like anxiety, depression & PTSD
- Used MEG scans to assess neural synchrony, applying PLSR to predict chronic pain severity & its interaction with mental health symptoms

## PARTIAL LEAST SQUARES REGRESSION

- PLSR is useful for high-dimensional data like MEG, where there are more measurable properties than the number of recorded instances
- Finds components that maximize covariance between the predictors (X) & targets (Y)

## NOTES ON PLSR:

- when there is TOO STRONG CORRELATION between explanatory variables, the model will suffer from collinearity

$$Y = \text{intercept} + f_1 + f_2$$

\ /  
features

↓  
Model coefficients are not reliable;  
thus, there will be more errors

- To solve the problem of collinearity, we COMBINE the features/variables into a **PRINCIPAL COMPONENT**

$$Y = \text{intercept} + PC_1$$

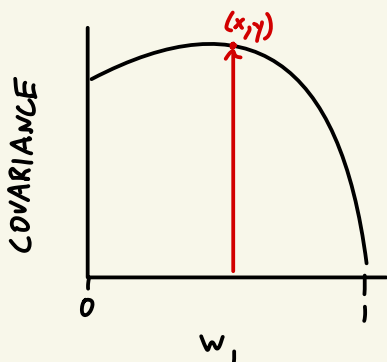
$$PC_1 = w_1 \cdot f_1 + w_2 \cdot f_2$$

$$w_1^2 + w_2^2 = 1$$

weights

→ We need to find weights that also maximize the prediction of the dependent variable

• To do this, we use algorithms like SIMPLS



↓  
An algorithm finding the optimal weights

→  $y_1$  is the maximum covariance, which we then use as the  $w_1$

→ By using  $w_1^2 + w_2^2 = 1$ , we can solve for the weights involved

→ Now we can perform regression to find the slope & intercept

$$Y = \text{Intercept} + \text{Slope}(PL_1)$$

→ We can then use cross validation to test & find the root mean squared error of predictions, based on different numbers of components

→ We should use as few components as possible resulting in the smallest error possible

## RESEARCH RESULTS:

- There is correlation between the neural synchrony in the pain connectome with chronic pain severity & mental health symptoms
- Suggests the potential for MEG-based neural synchrony measures acting as biomarkers for chronic pain
- The Beta Band was the strongest predictor of chronic pain severity & independent mental health symptoms
- The Theta Band shows a correlation between pain severity & anxiety
- The Gamma Band shows similar brain patterns in pain, depression & PTSD

## IMPLEMENTATION RESULTS:

- PLSR models had a much higher predictive accuracy, even with training data with noise
- while building the library, I realized the importance of optimizing machine learning models hyperplanes & optimizing the covariance