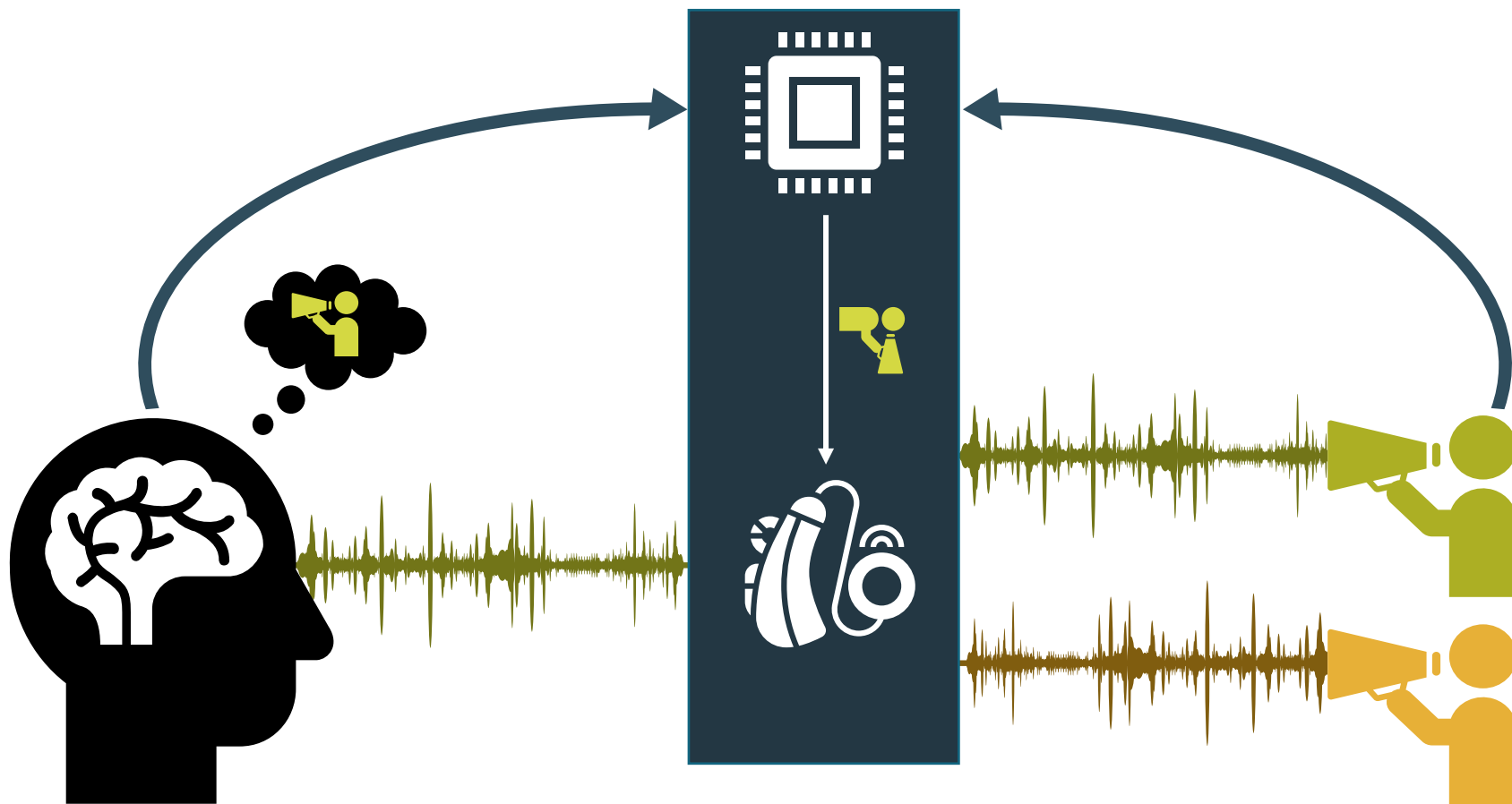


Auditory Attention Decoding:

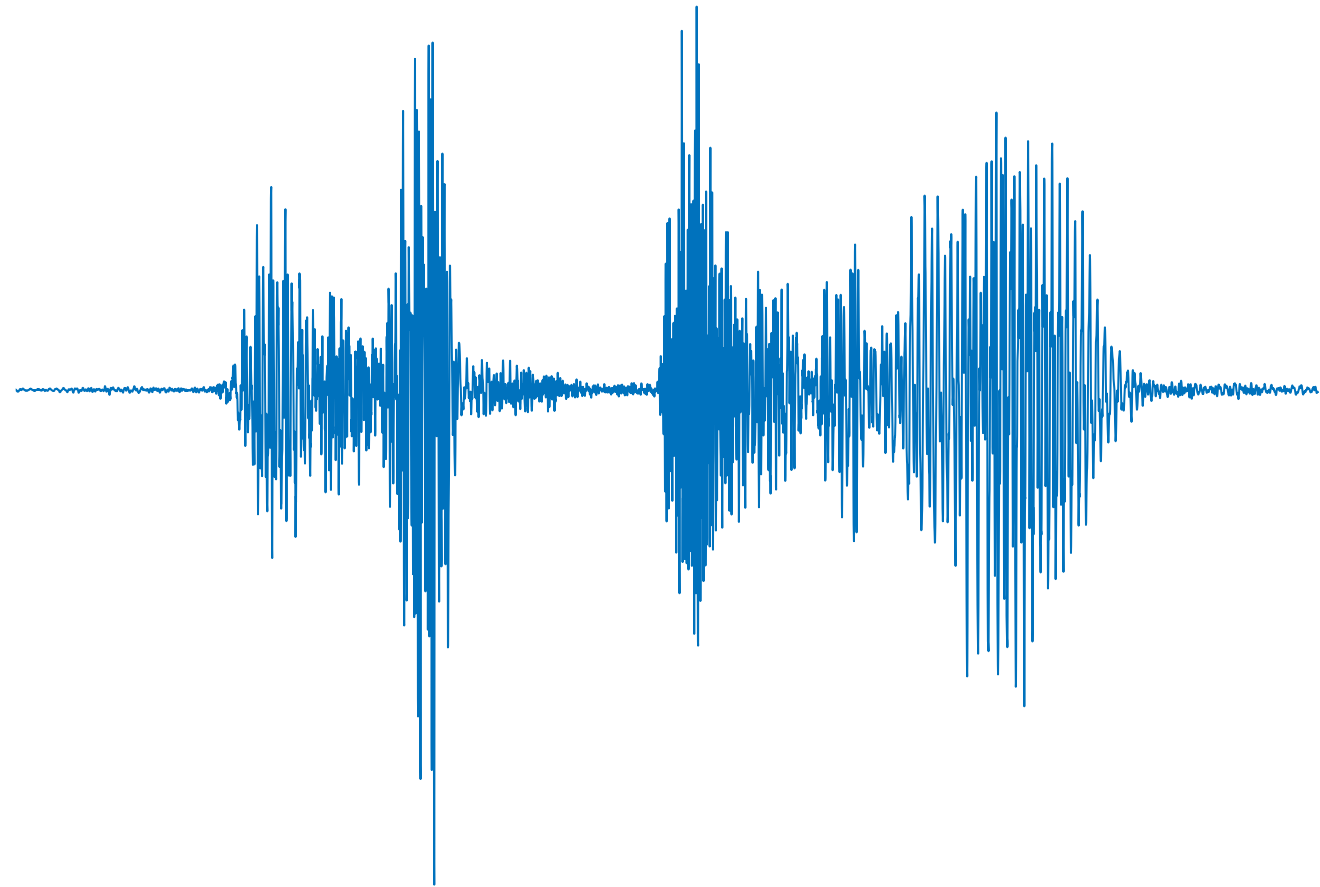
How to predict to whom someone wants to listen from brain signals

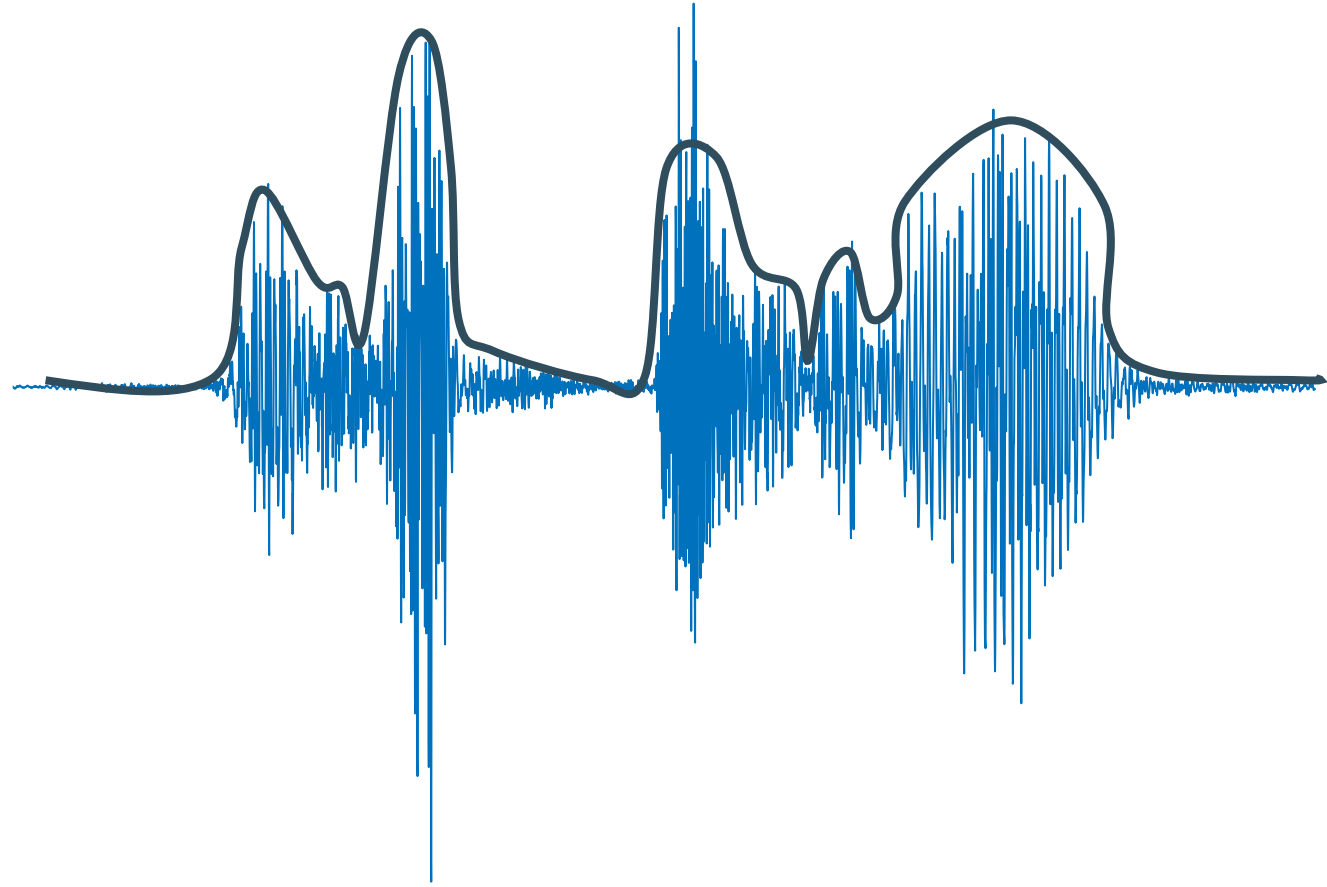
Nicolas Heintz

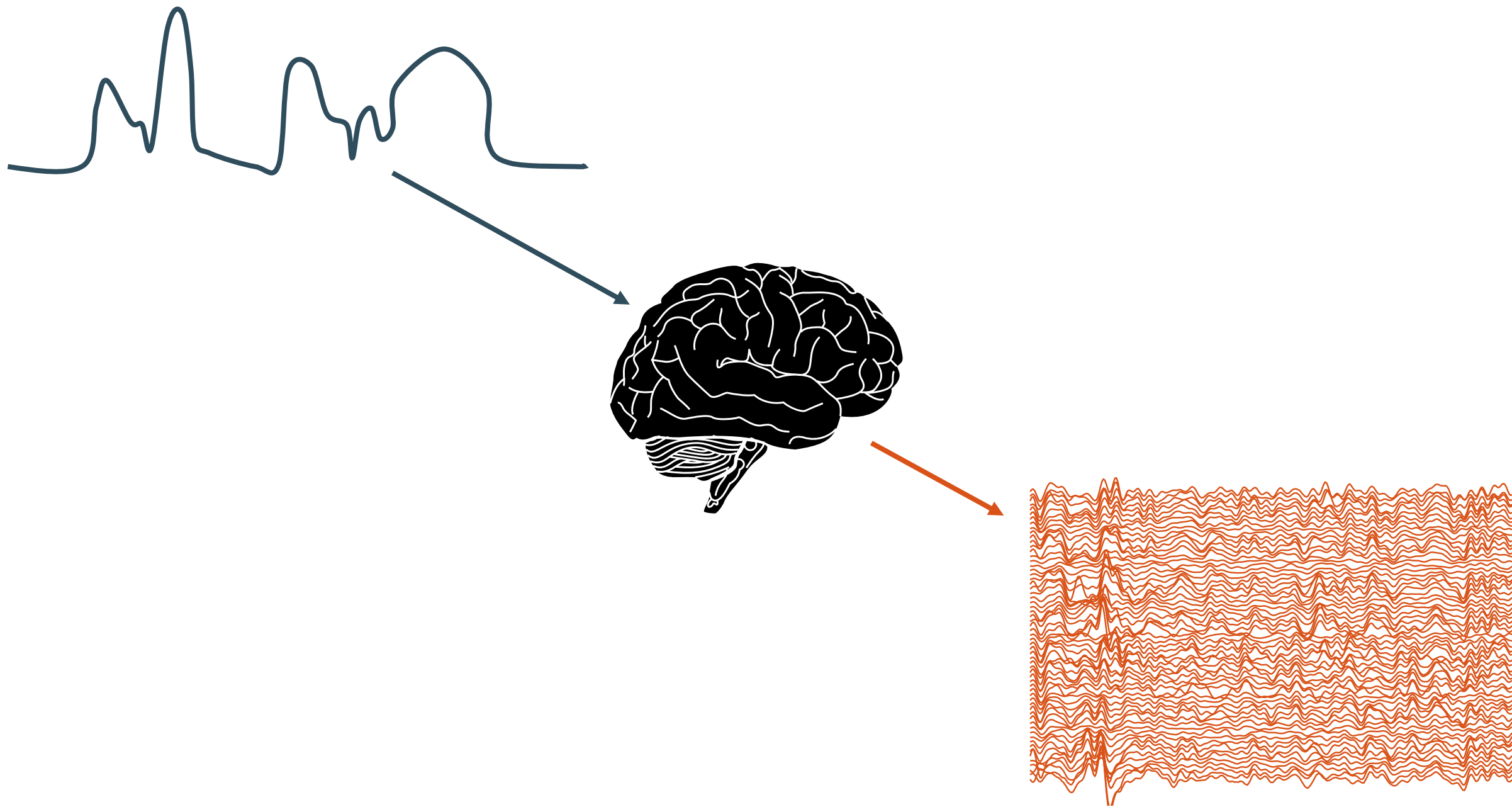




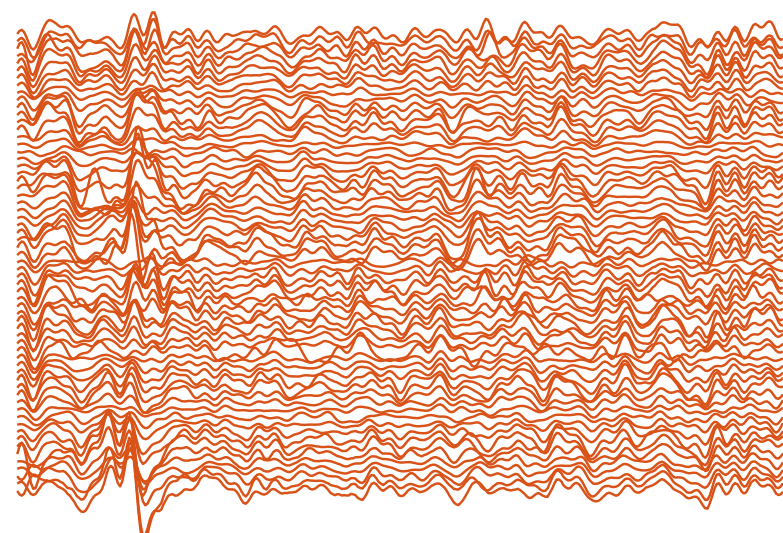
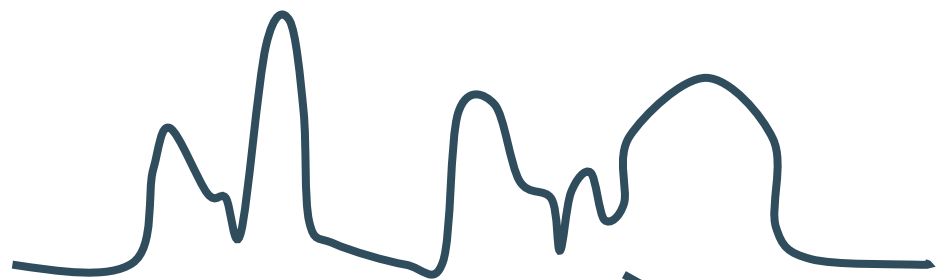
To which **speaker** is the subject listening?



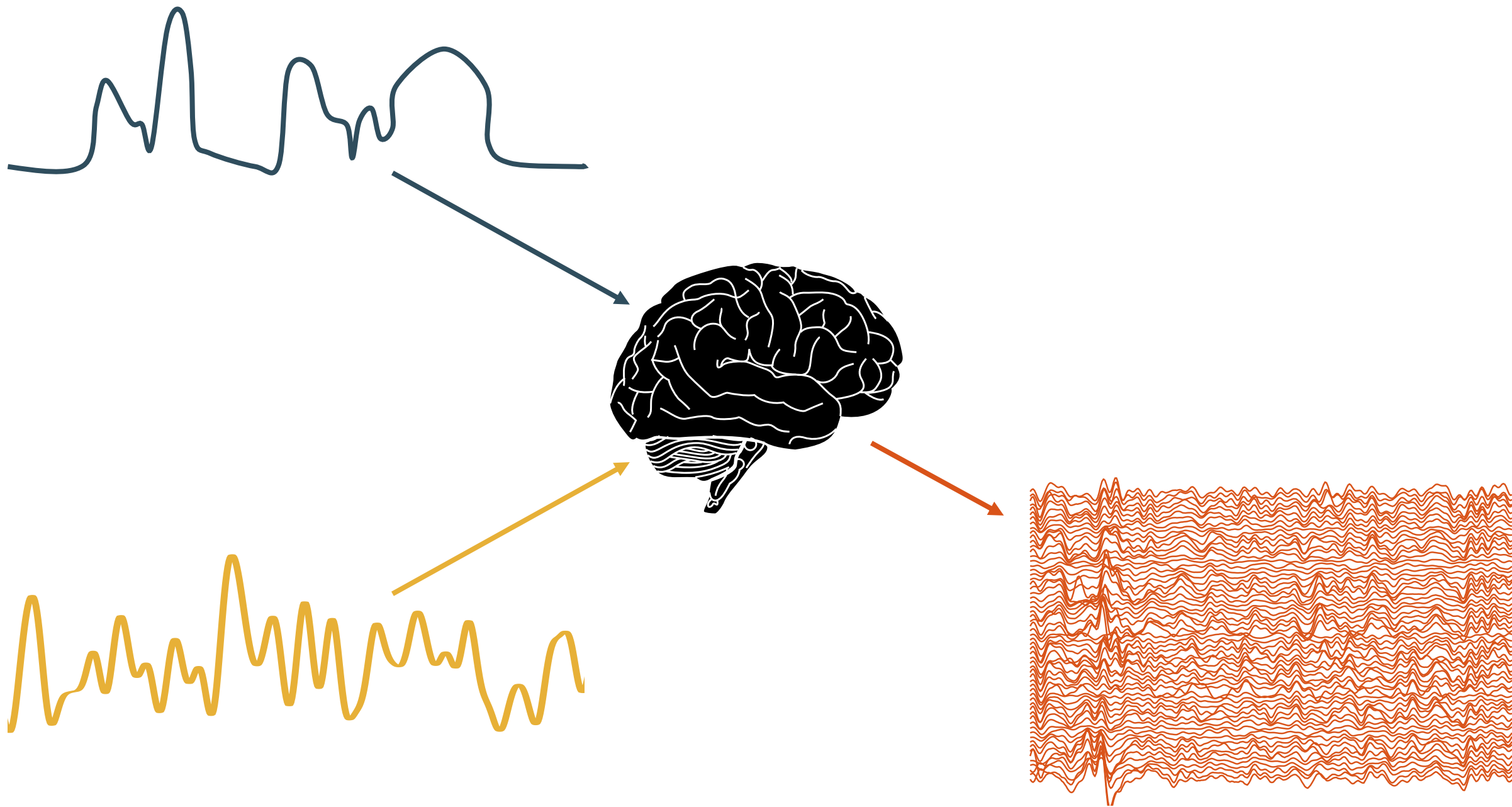


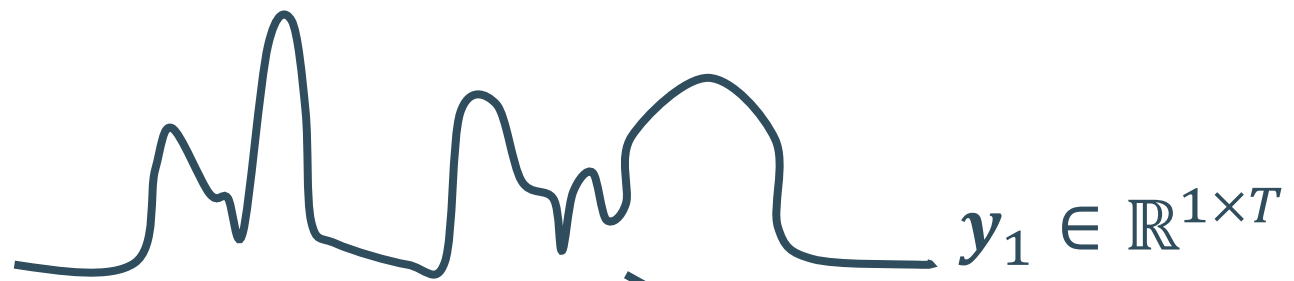


EEG tracks the envelope of the speaker

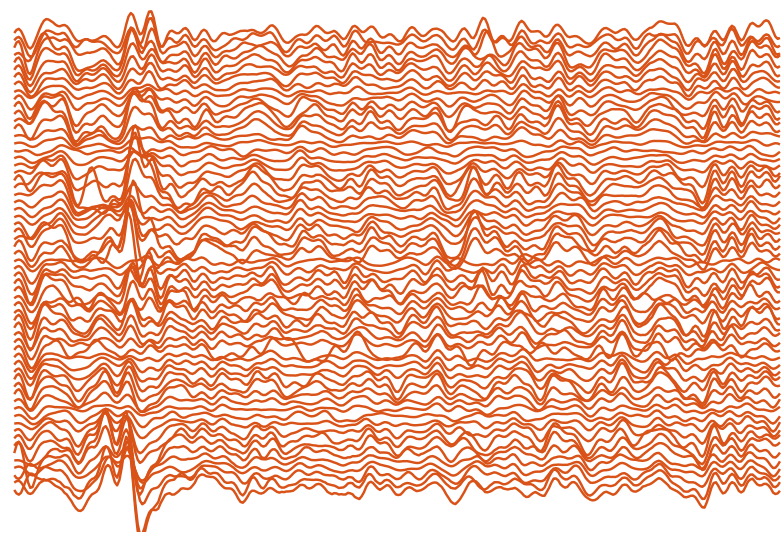


EEG tracks the envelope of the attended speaker more than the envelope of the unattended speaker



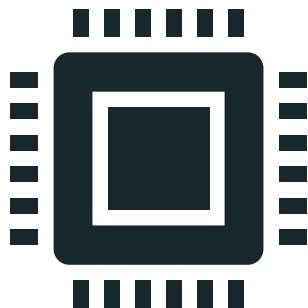


$$X \in \mathbb{R}^{C \times T}$$

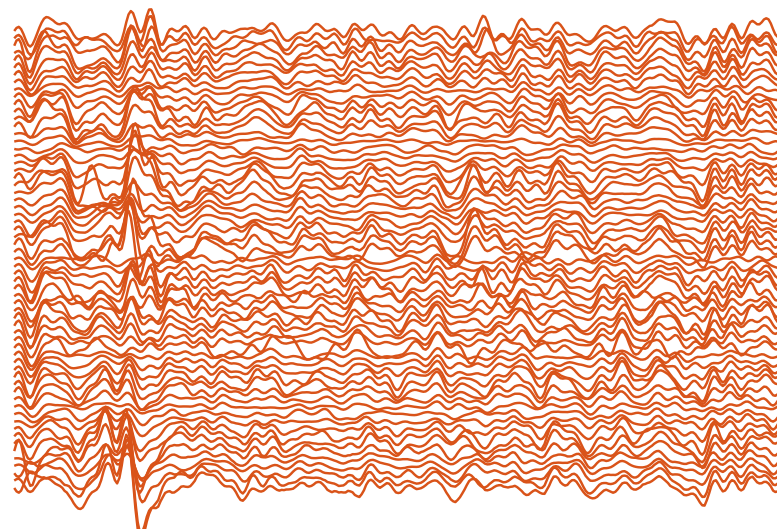




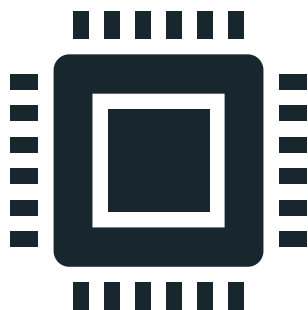
$$\mathbf{y}_1 \in \mathbb{R}^{1 \times T}$$



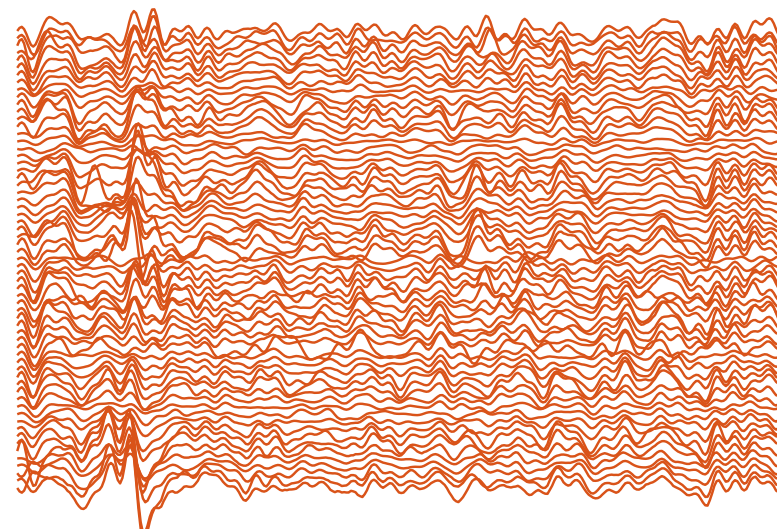
$$\mathbf{X} \in \mathbb{R}^{C \times T}$$



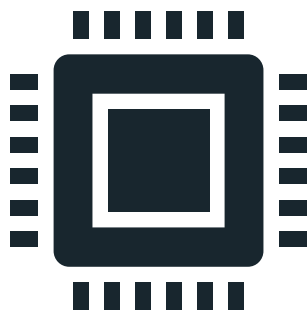
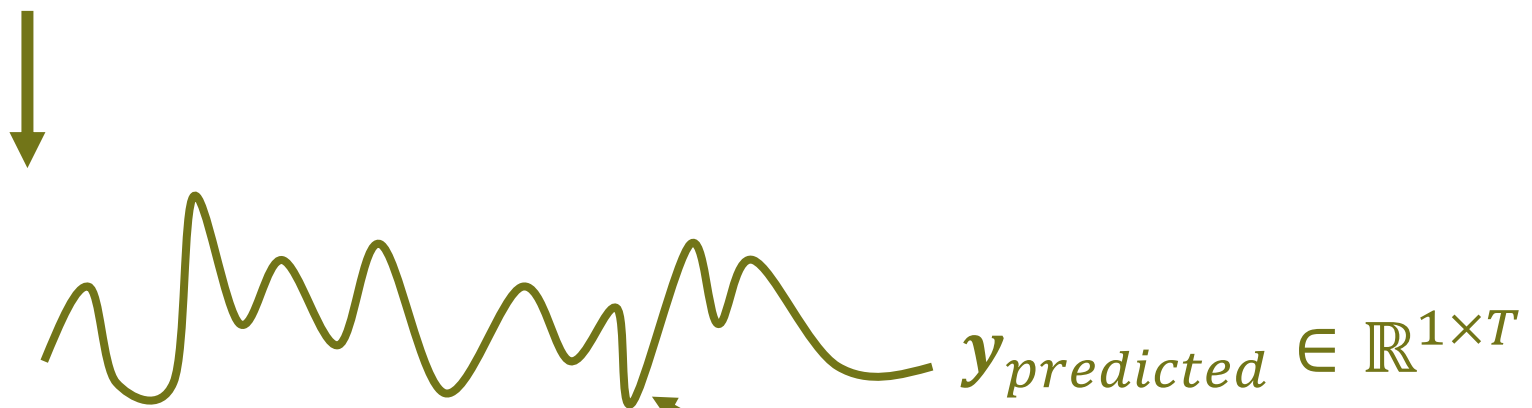
$y_{predicted} \in \mathbb{R}^{1 \times T}$



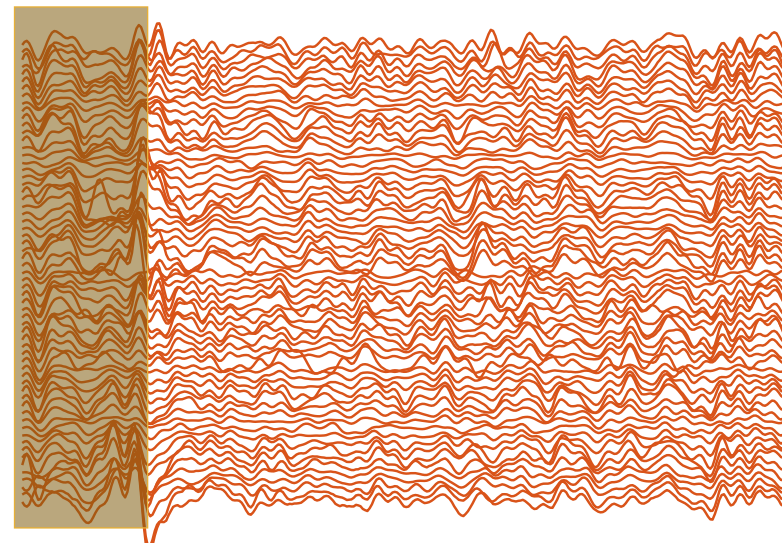
$X \in \mathbb{R}^{C \times T}$

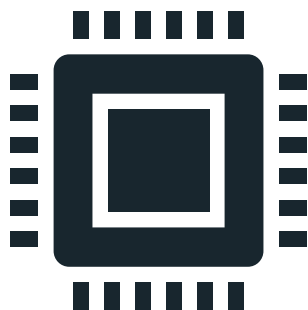
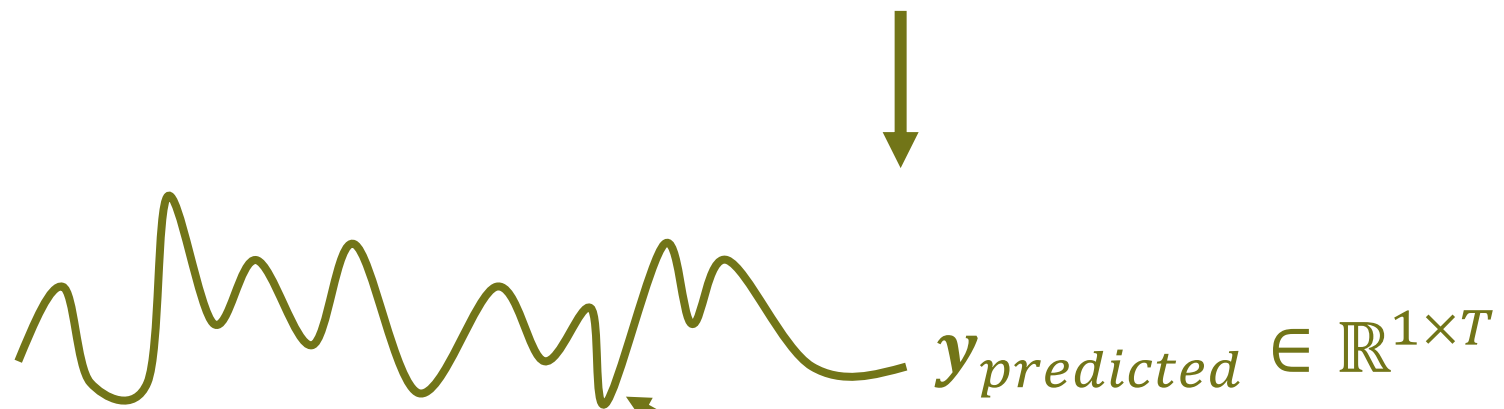


Problem 1: the brain is not infinitely fast

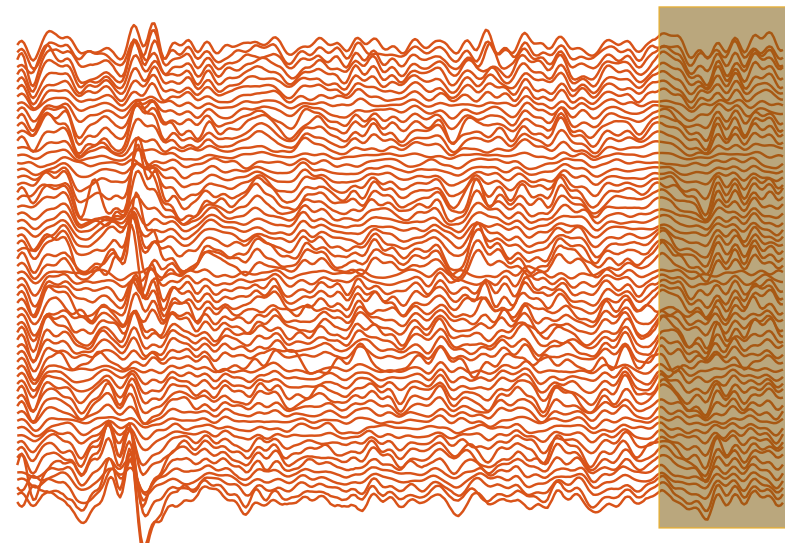


$X \in \mathbb{R}^{C \times T}$





$X \in \mathbb{R}^{C \times T}$



Problem 2: how to go from EEG to predicted speech

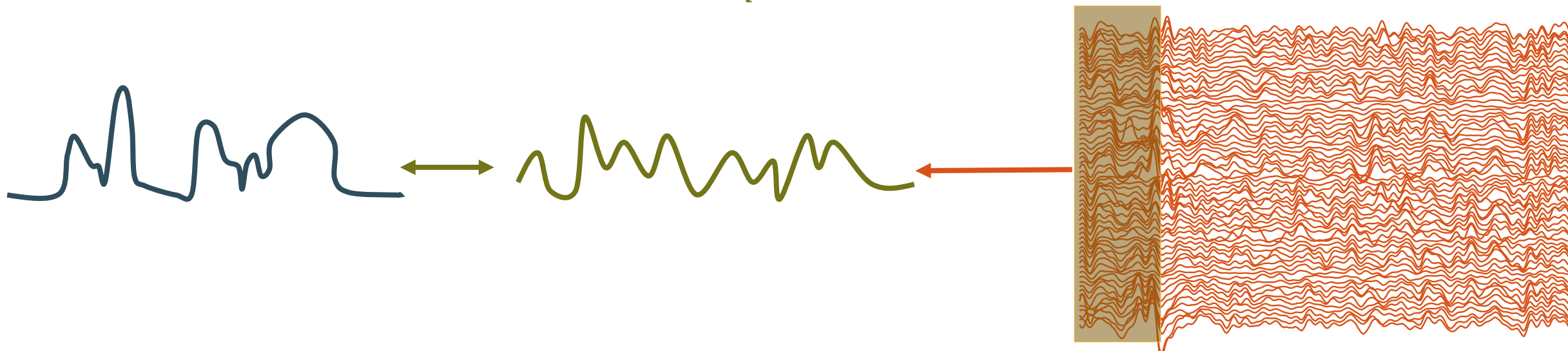
Linear Least Squares: works surprisingly well!

$$\hat{\mathbf{d}} = \arg \min_{\mathbf{d}} \|\mathbf{d}^{\top} \mathbf{x}(t) - \mathbf{y}_1(t)\|_2^2$$

$\mathbf{y}_1(t)$

$\mathbf{d}^{\top} \mathbf{x}(t) = \mathbf{y}_{predicted}(t)$

$\mathbf{x}(t)$



Problem 3: how to decide which speaker is attended

EEG tracks the envelope of the attended speaker more than the envelope of the unattended speaker

EEG tracks the envelope of the attended speaker more than the envelope of the unattended speaker

Our model is specifically trained to reconstruct the attended speech

$$\text{correlation}(\mathbf{y}_{\text{predicted}}(t), \mathbf{y}_1(t)) > \text{correlation}(\mathbf{y}_{\text{predicted}}(t), \mathbf{y}_2(t))$$

