# Modelling Grand Averaging in EEG Signals for Individuals with BCI control
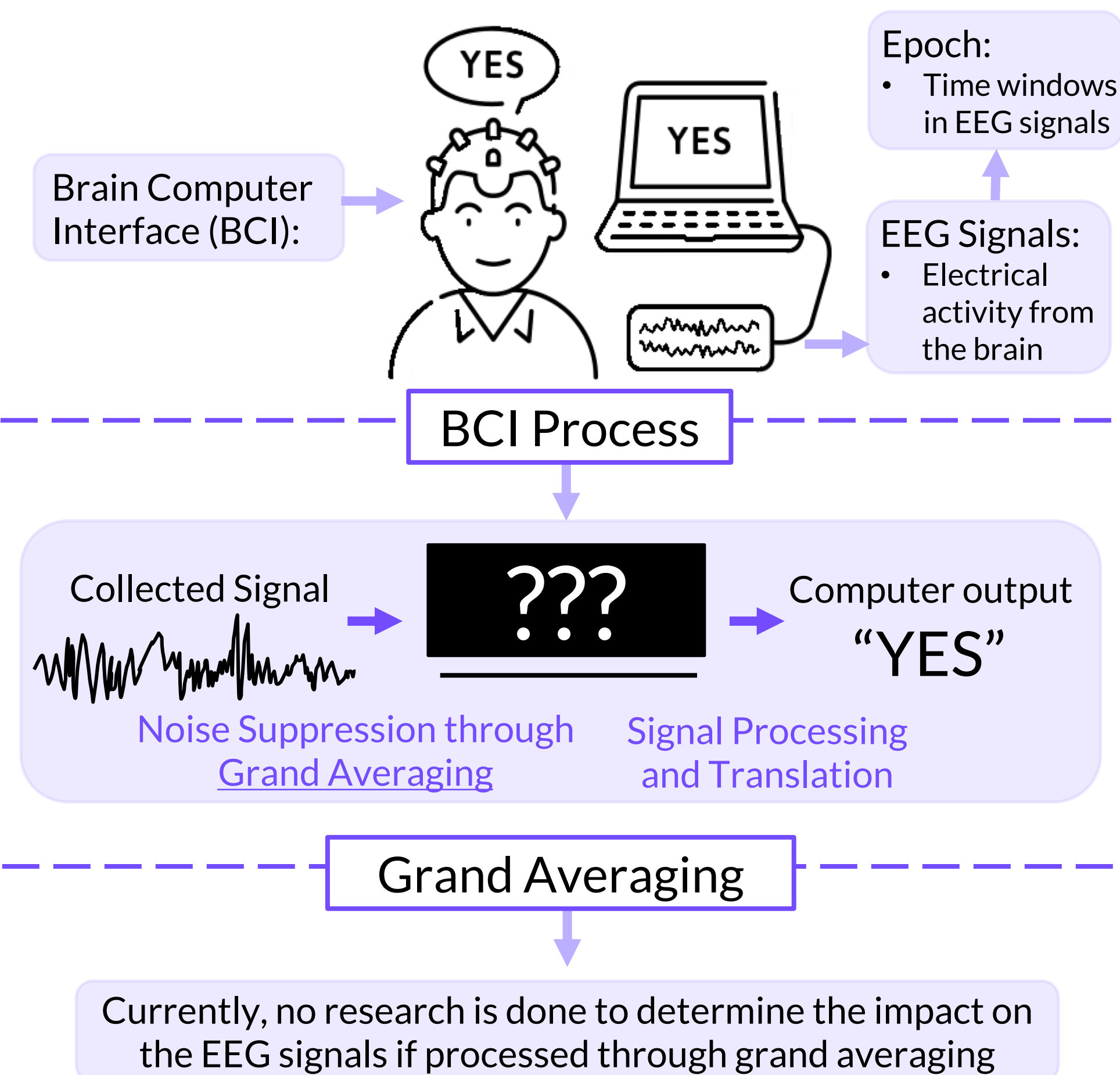
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## Background
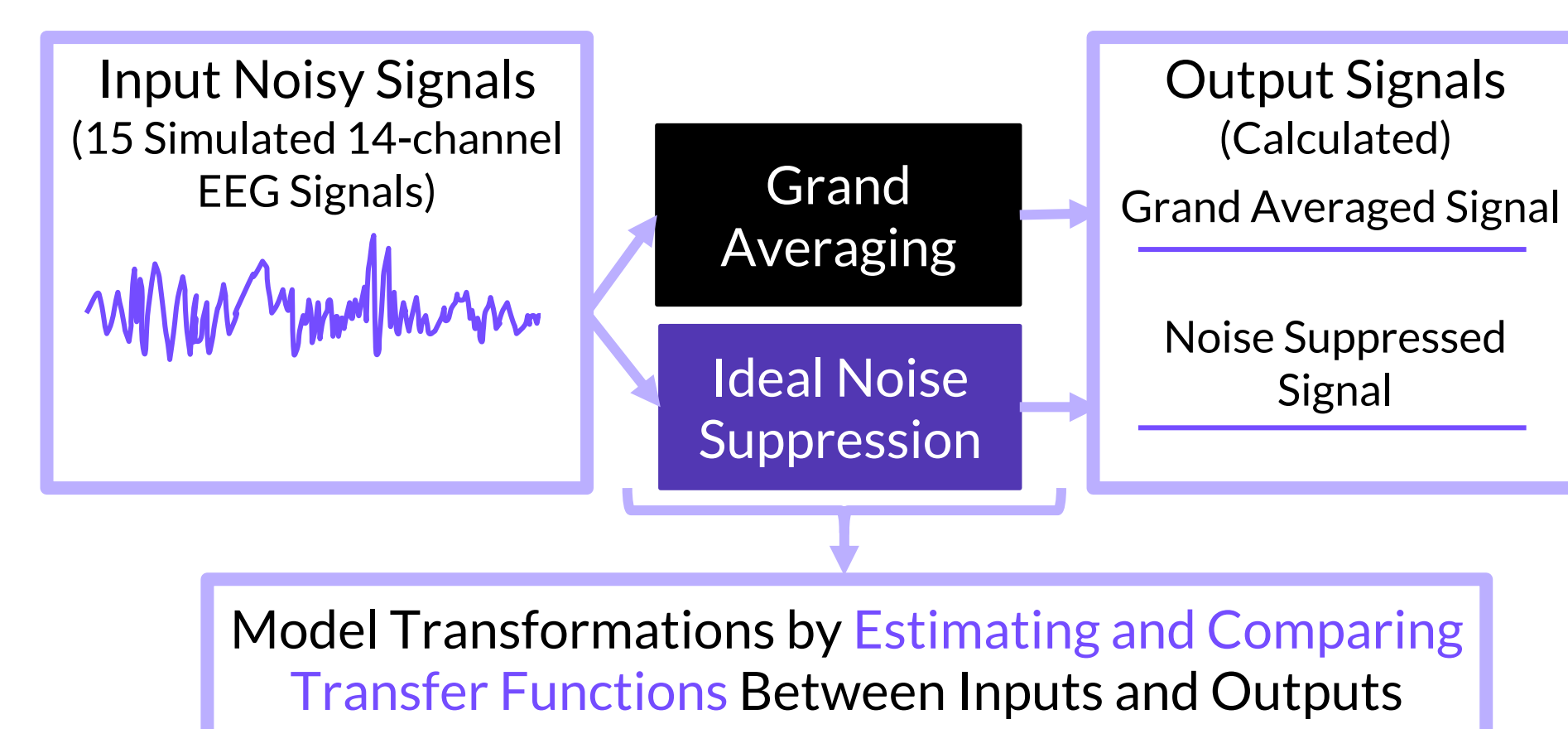


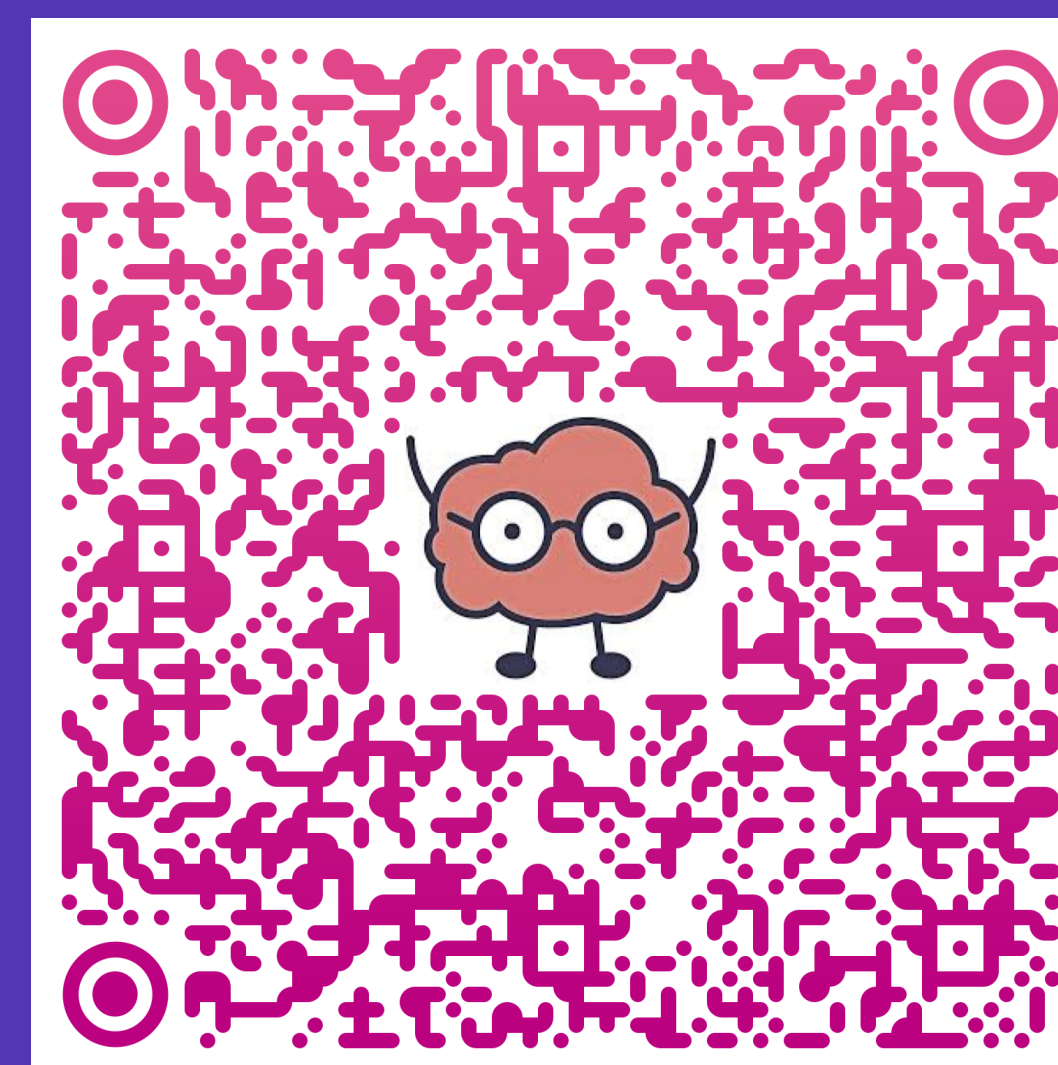Brain Computer Interface (BCI):

Epoch:
- Time windows in EEG signals

EEG Signals:
- Electrical activity from the brain

**BCI Process**

Collected Signal → **???** → Computer output "YES"

Noise Suppression through Grand Averaging

Signal Processing and Translation

**Grand Averaging**

Currently, no research is done to determine the impact on the EEG signals if processed through grand averaging

## Objective

Compare ideal noise suppression and grand averaging in EEG signals collected through BCIs

## Method

Input Noisy Signals (15 Simulated 14-channel EEG Signals)

Grand Averaging

Ideal Noise Suppression

Output Signals (Calculated)

Grand Averaged Signal

Noise Suppressed Signal

Model Transformations by Estimating and Comparing Transfer Functions Between Inputs and Outputs
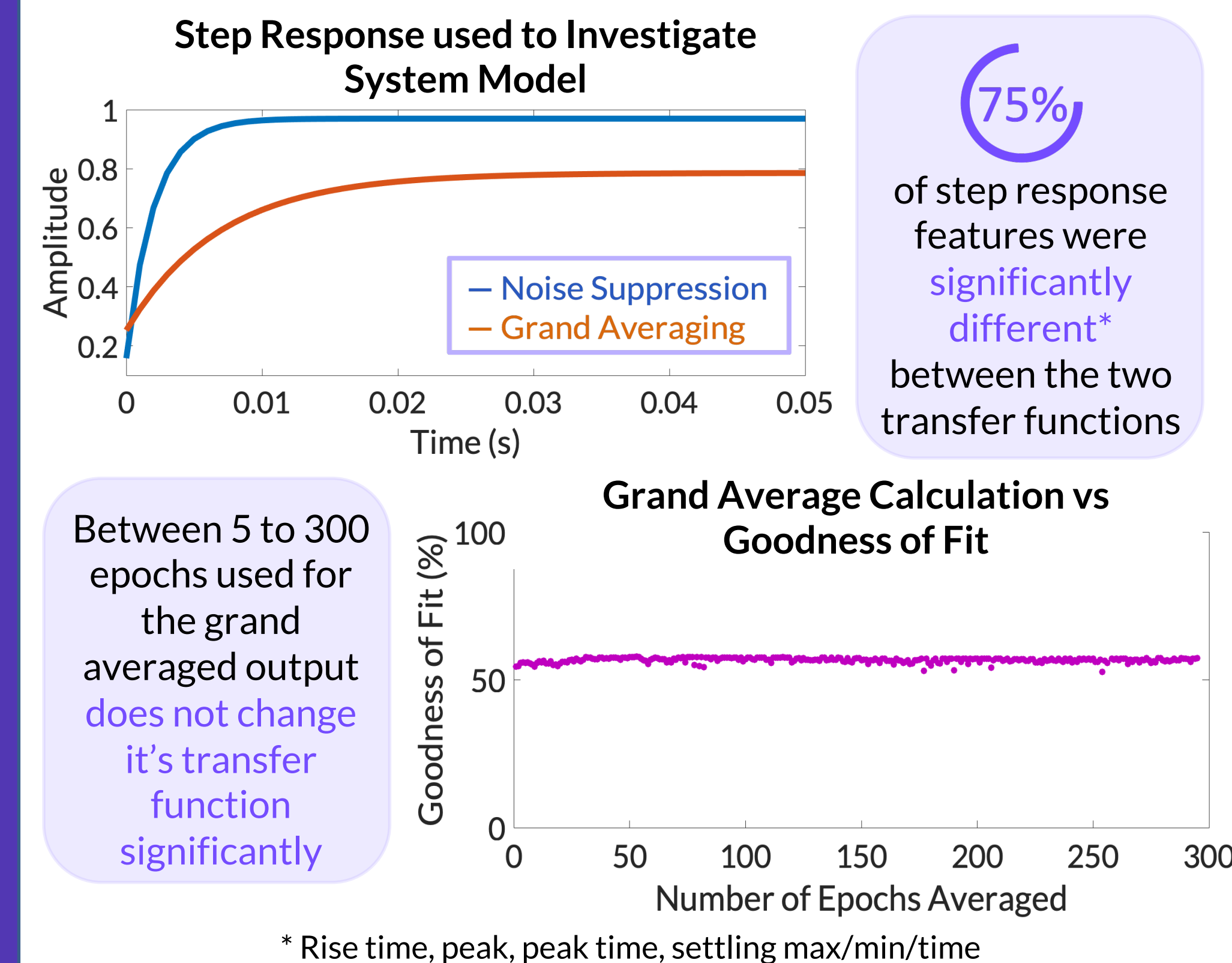
MATLAB → signal processing, simulate inputs and calculate outputs
SEREEGA /EEGLAB → simulate input EEG signals [1]

# Transformation Methods Allow Brain Signals to be Read More Accurately to Improve Brain-Computer Communication

## Comparison of Transformations

**Step Response used to Investigate System Model**



— Noise Suppression
— Grand Averaging

**75%** of step response features were significantly different* between the two transfer functions

Between 5 to 300 epochs used for the grand averaged output does not change it's transfer function significantly

**Grand Average Calculation vs Goodness of Fit**



* Rise time, peak, peak time, settling max/min/time

## Conclusion



Grand averaging not only suppresses noise, but also transforms EEG signals, no matter how many epochs are used to calculate it

## Next Steps

1. Find signal transformation of grand averaging after noise suppression

2. Model transforms with more accuracy

3. Try on real participants

## Relevance

BCI's are commonly used for kids with complex communication needs, including:
- Locked-in syndrome (LIS)
- Amyotrophic lateral sclerosis (ALS)
- Cerebral palsy (CP)
- Spinal cord injury

This discovery helps further BCI technology

Enable communication and expression for those with complex communication needs

Promote and support people's human rights, inclusion, and equality in participating in society

Reference: [1]L. Krol, J. Pawlitzki, F. Lotte, K. Gramann and T. Zander, "SEREEGA: Simulating event-related EEG activity", Journal of Neuroscience Methods, vol. 309, pp. 13-24, 2018. Available: 10.1016/j.jneumeth.2018.08.001 [Accessed 16 July 2020].