Determining the Correspondence Between Covert Speech and Speech Perception

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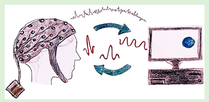
Background

Speech Perception (SP)
Discriminating, identifying, interpreting speech[3]

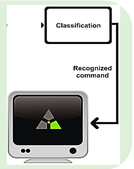
Imagined speech heard in our mind without moving the lips & tongue[2]

Brain-Computer Interface (BCI) System



1. Measurement of electrical brain activity via **EEG**

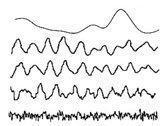
2. **Signal processing and translation** of collected EEG signals



Previous Research

CS & SP produce similar **activation patterns** in common **language processing** brain regions[5][6][7][8][9]

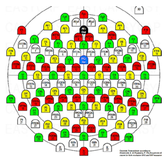
CS & SP share a **correlation** for certain **neural oscillations** (frequencies)[4]



Objective

Determine the topographical and frequency-related correspondence between CS and SP

Method & Analyses

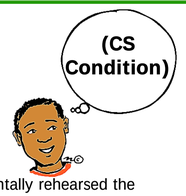


Used EEG with a 64/128 channel cap

(SP Condition)

Arch
Archbishop
Gran
Grandmother
Kin
Kindergarten
Mar
Marketplace

Participants heard 8 words



Mentally rehearsed the word they just heard

1. Hierarchical Clustering
(groups EEG channels into clusters with shared features)

2. Principal Component Analysis
(identifies most explanatory features in each cluster)

3. Ridge Regression
(fits a model between CS & SP)

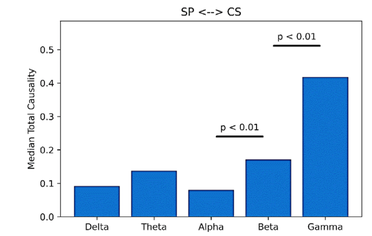
4. Permutation Importance Test
(determines which CS features contribute most to the ridge regression)

5. Event-related Causality
(detects causal relationships = if CS reliably causes SP & if SP reliably causes CS)

Passively Training a Thought Decoding Brain-Computer Interface Can Facilitate Versatile Communication Amongst Children With Disability

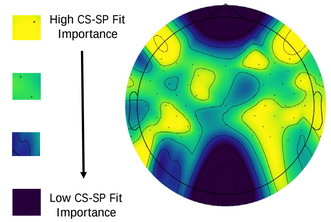
Results

Causality Indices for CS-SP At Different Frequencies



Low gamma-band activity (30-60 Hz) was responsible for most **CS-SP causality**[1][4]

Scalp Topographical Map



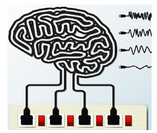
The regression found **corresponding relationships** in **various channel clusters**: temporal, frontal, centro-parietal[1][4]

Conclusion

Determining a generalizable CS-SP model requires:

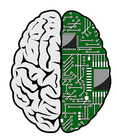
- **Gamma-band correspondence**
- ||
- **Spatial correspondence**

Next Steps



1. Use causality characteristics in various frequencies for model improvement

2. Re-train model by recruiting participants with disability



3. Construct a thought-decoding BCI device

Relevance

Children with **complex communication needs (CCN)** and speech impairments resulting from cerebral palsy (CP), autism spectrum disorder (ASD), Down syndrome, and other disabilities are **restricted** in their participation in **conversational & interactive environments**

Advances BCI technology by training a thought-decoding BCI without constant reiteration of thought = **non-taxing to users**

Our Research

Equitably promotes and supports the **inclusion & rights** of children with disability to participate in society

Enables communication & expression for kids with CCN

References
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