

# TOWARDS RESTAURATION OF ARTICULATORY MOVEMENTS: FUNCTIONAL ELECTRICAL STIMULATION OF OROFACIAL MUSCLES

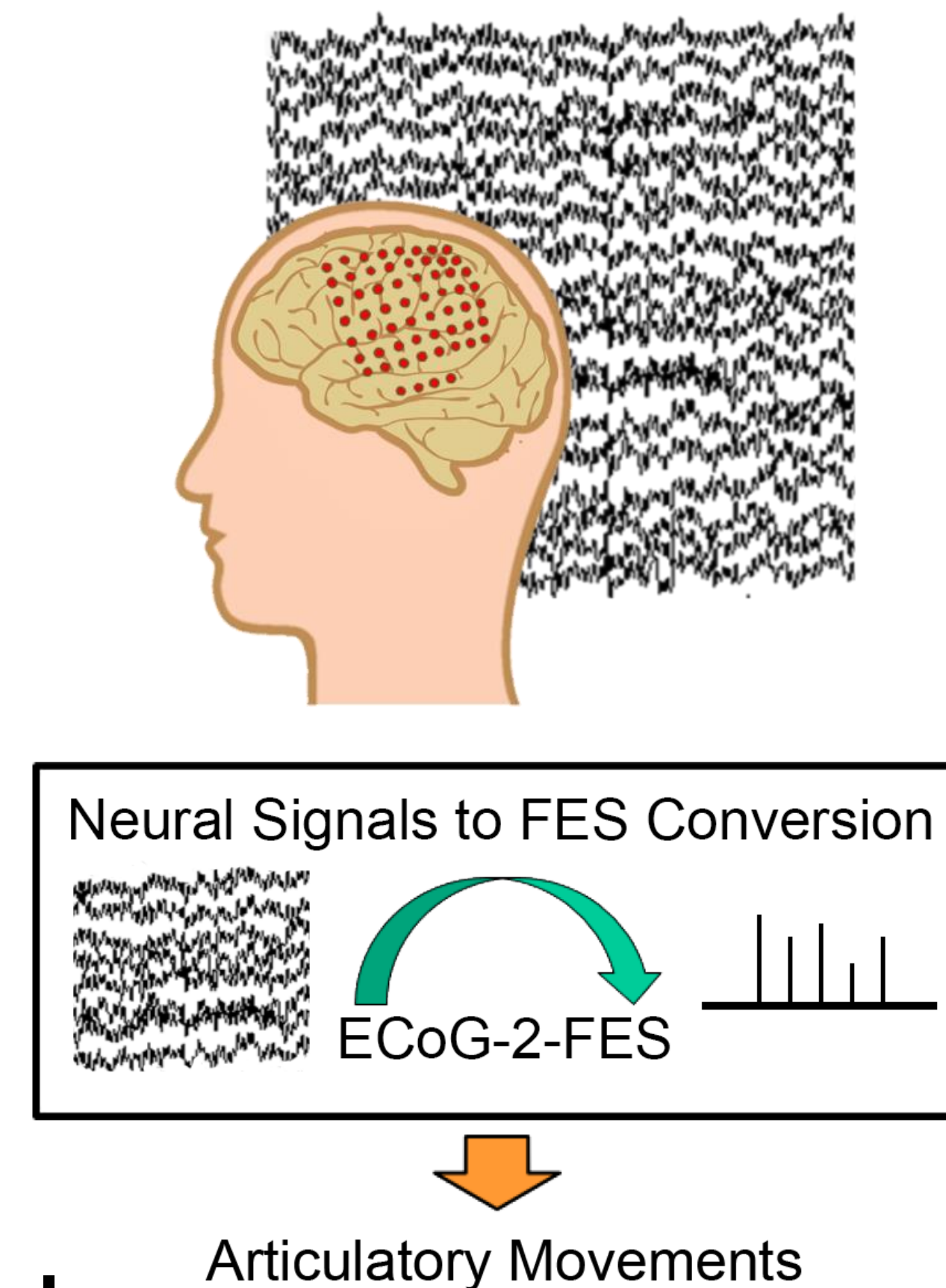
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## Motivation

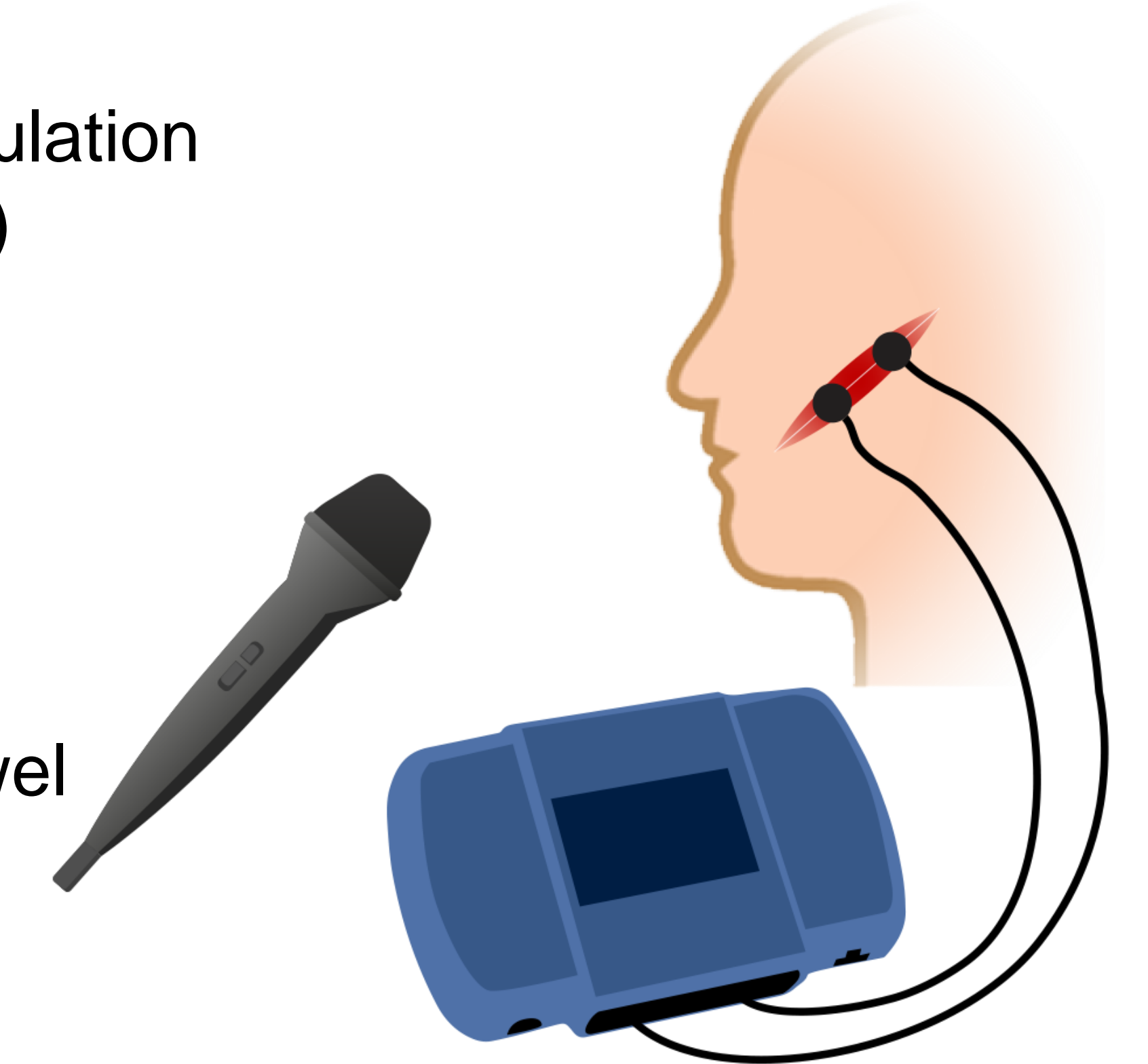
- Neurological diseases can lead to speech impairments which might result in the complete loss of speech production abilities
- Brain-Computer Interfaces could facilitate the restauration of natural communication
- So far, research focused on the conversion of neural signals into text (Brain-to-Text) and directly into speech (Brain-to-Speech).

**Here, we envision to restore speech production by using functional electrical stimulation (FES) of orofacial muscles directly inferred from neural signals**



## FES Experimental Design

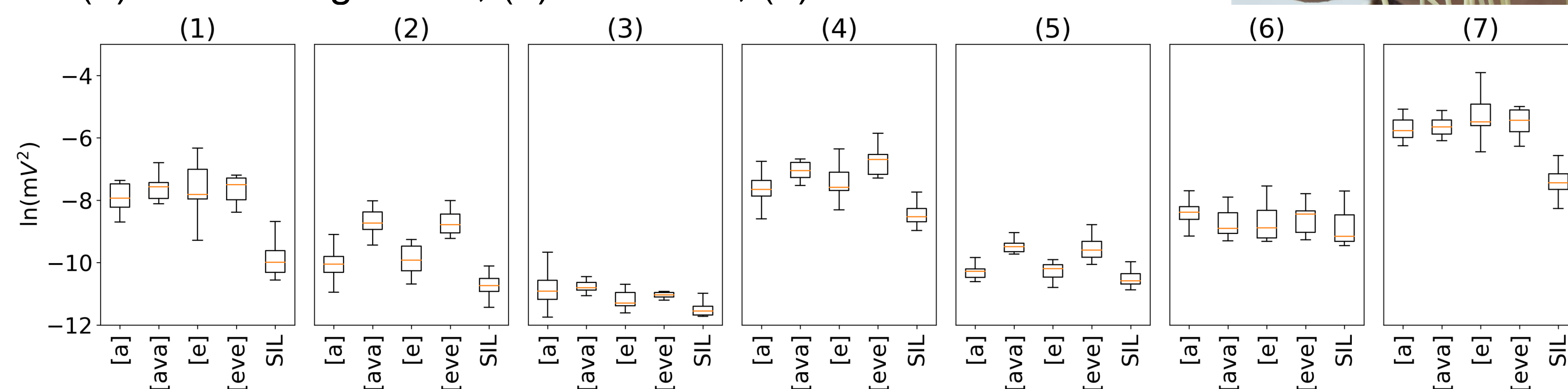
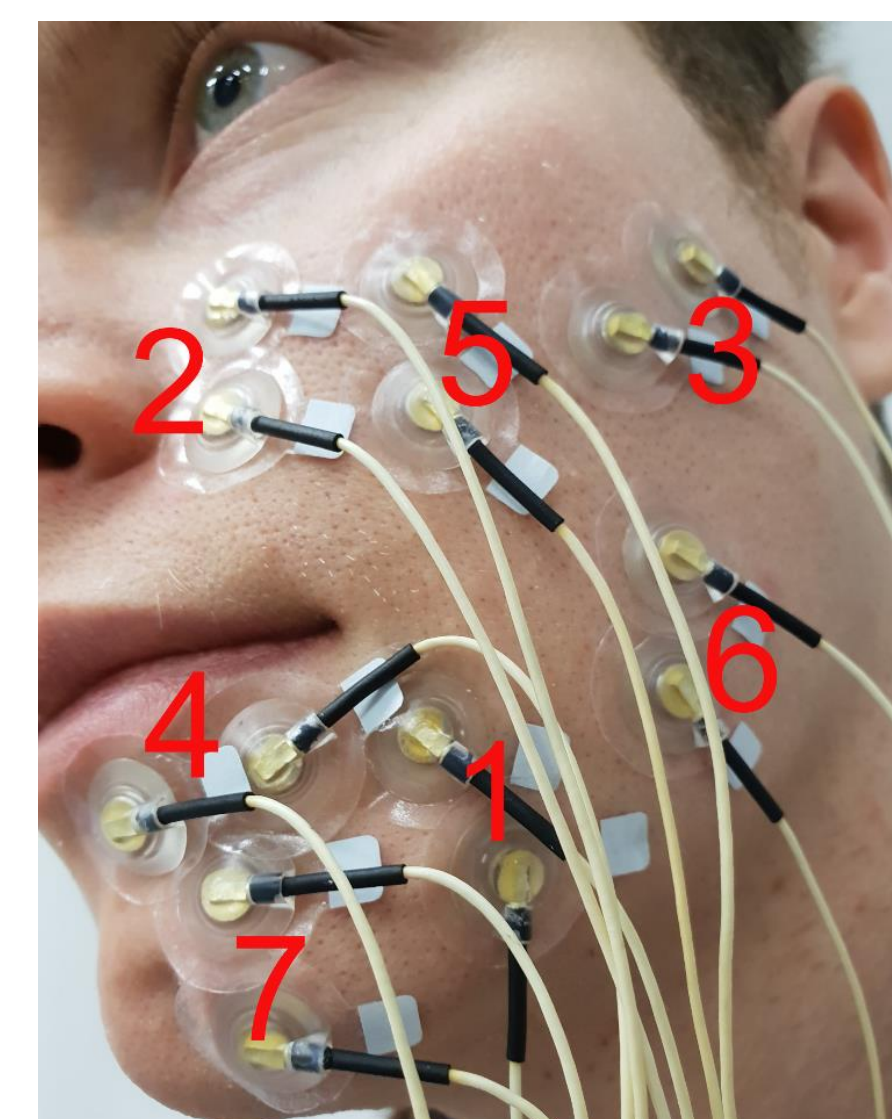
- Investigate acoustic effects of muscle stimulation
  - During self-controlled stimulation (SCS)
  - Externally-controlled stimulation (ECS)
  - No stimulation (reference)
- Five subjects participated in the study
  - Several sessions per subject
  - Wearing noise cancelling earphones
  - Subjects produce a neutral, audible vowel by voicing
- Targeted stimulation of single muscle
  - Zygomaticus major
- Evaluation refers to most promising subject



Thanks to Medel Medizinische Elektronik HGmbH for providing the MOTIONSTIM 8 device

## Pre-Analysis of Muscle Activity during Vocalization

- Identification of orofacial muscle movements relevant to articulation using electromyography (EMG)
- Voluntary production of Vowels [a] and [e]; VCV [ava] and [eve]
- Analysis of seven relevant orofacial muscles
  - depressor anguli oris, (2) levator labii superioris, (3) zygomaticus major, (4) orbicularis oris inferior, (5) levator anguli oris, (6) masseter, (7) mentalis



- FES focuses on zygomaticus major since it is relevant to V[v]V production, isolated from other muscles (reduce cross-stimulation), easy to locate, and distant from critical areas avoiding side-effects of stimulation.

## Results

- Visual comparison of spectral features between voluntary articulation, SCS, and ECS
- Correlation analysis: Pearson correlation of spectral features prior to stimulation and complete segment

**Conclusion: First insights into the challenges and potential of speech production via functional electrical stimulation of orofacial muscles**

- Voluntary articulations relatively stable across trials, SCS articulation patterns closer to REF than ECS
- Confirmed reasonable closeness by listening to stimulated speech output examples.

