Brain Computer Interface for Communication in Locked In State

Ujwal Chaudhary, Bin Xia, Aygul Rakhimkulova, Niels Birbaumer

Presenter: Dr. Ujwal Chaudhary, Ph.D. & Aygul Rakhimkulova
Brain Computer Interface (BCI)
Why do we need BCI?
Amyotrophic Lateral Sclerosis (ALS)

- A progressive motor disease.
- No Treatment
- Artificial Respiration
- Locked in State (LIS)
- Completely Locked in State (CLIS)
- Only affecting sensory and cognitive functions to minor degree.
- Communication
Unlocking the Locked-In

Brain Computer Interface to aid patients in CLIS to communicate needs and feelings to their family member/ caregiver.

- Electroencephalography (EEG)
- Near Infrared Spectroscopy (NIRS)
Electroencephalography (EEG)

- Beta (β) 13-30 Hz
  Frontally and parietally

- Alpha (α) 8-13 Hz
  Occipitally

- Theta (θ) 4-8 Hz
  Children, sleeping adults

- Delta (δ) 0.5-4 Hz
  Infants, sleeping adults

- Spikes
  Epilepsy - petit mal
Near Infrared Spectroscopy (NIRS)

BCI Design

NIRS Signal Acquisition System

EEG Signal Acquisition System

NIRS Signal for Yes and No

EEG Signal for Yes and No

EEG electrodes + NIRS optodes

Monitoring EEG for Sleep Detection

Feature Extraction + Pattern Classification

Train the NIRS classifier

ALS patient in CLIS attending to auditory stimuli

NIRS NeuroFeedback
ALS Patients
BCI Training Sessions

Play Training video
Open Questions
Result: Training and Feedback

Patient 1

Training Classification Accuracy greater than 65% for 90% of sessions. Online Feedback Accuracy = 75%
Conclusion

✩ Auditory based BCI

✩ To unlock the Locked-In

✩ Online Feedback

✩ Successful communication in 4 ALS Patients

✩ Locked in unlocked

✩ Option based menu using “Yes” and “No” signal.
Locked-In Unlocked

Thank You