Scalp Maps for Hearing Impairment Detection: A CNN Model

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Objective

The goal of this project is to **utilize scalp maps** derived from spatial and temporal electroencephalography (EEG) data to **distinguish** between individuals with **hearing impairment** and **healthy individuals.**

Dataset

The dataset contains EEG data from:
- **22** healthy subjects
- **22** hearing impaired subjects

Experiment recorded each patient's **event related potentials** (ERPs) in response **to 1 kHz tone beeps** presented **at random intervals 180 times.**

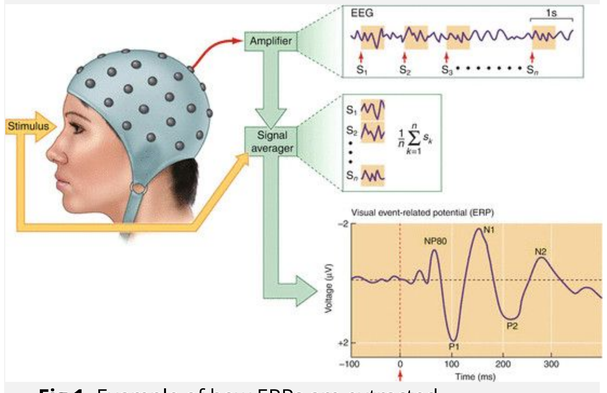


Fig 1. Example of how ERPs are extracted

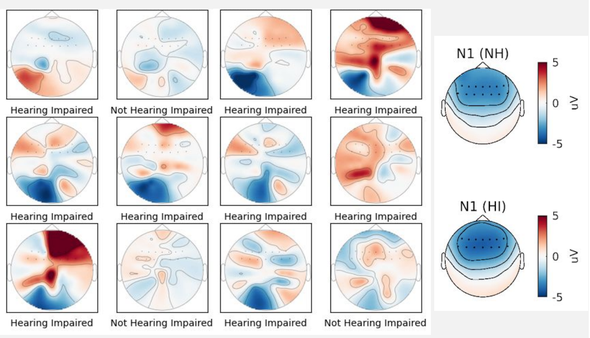


Fig 2. (left) Examples of hearing impaired and healthy scalp maps (right) Averaged scalp maps of both groups

Event Related Potentials (ERPS)

ERPs serve as the **features** utilized **for classifying** the two groups.

Acquired ERP waveform up to **400 ms** after onset of tone stimuli for each patient.

Topographical **scalp maps** were **extracted** at **10 ms intervals** within the 0 to 400 ms time range.

Total images: 1,760

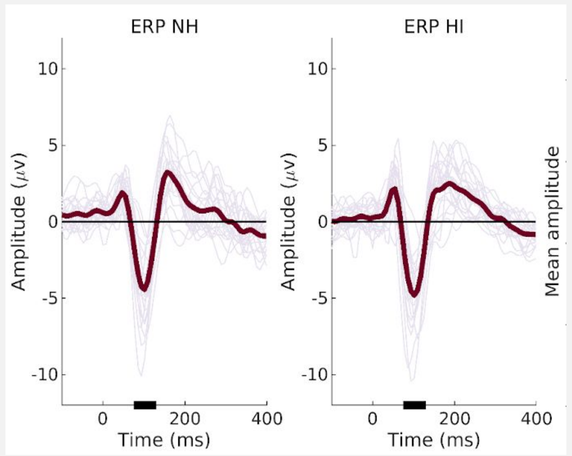
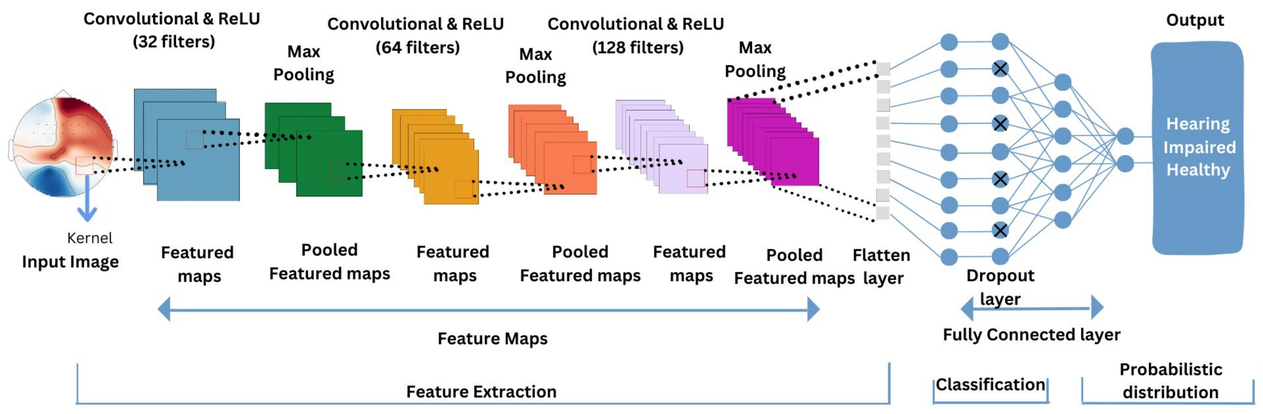


Fig 3. Individual traces of ERP data averaged over fronto-central electrode cluster. Thin lines reflect data from individual subjects. Thick lines reflect group-mean averages.

Convolutional Neural Network (CNN) Architecture



Results

The results below are the experiments for testing the CNN model on different types of data splits.

Table 1: Experiment Results

Experiment	Training Data	Validation Data	Testing Data	Test Loss	Test Accuracy
1	70%	–	30%	0.379	0.865
2	80%	10%	10%	0.227	0.950
3	70%	15%	15%	0.470	0.891

Discussion

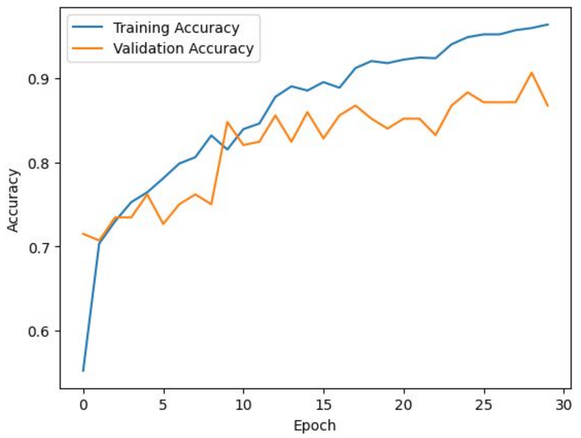


Fig 4. Learning curve for Experiment 3

CNN is effective in distinguishing between hearing impaired and healthy individuals in this study.

Averaged accuracy: 85%-95%

Conclusion

Here are some ways to **enhance** the model's **accuracy** and **generalization**:

- apply **larger** and **diverse datasets**
- exploring **alternative** machine learning **methods** (SVM, RNN, random forest)
- **fine-tuning** model parameters and optimizations (cross validation, regularization etc.)

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Søren A. Fuglsang, Jonatan Märcher-Rørsted, Torsten Dau, & Jens Hjortkjær. (2020). Selective auditory attention in normal-hearing and hearing-impaired listeners [Data set]. Zenodo. https://doi.org/10.5281/zenodo.3618205