Sentence classification based on phase patterns in EEG neural oscillation during imagined speech

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Introduction

A big picture of our research

Measuring EEG
Feature extraction
Model training
Estimation of speech

Classification of heard speech
- EEG-based sentence classification (Watanabe et al., 2017)
- Utilizing a phase synchronization to sentence rhythms

Classification of imagined speech
- Vowel classification (DaSalla et al., 2009)
- Syllable classification (L’Huillier et al., 2009)
- Word classification (Martin et al., 2015)
- Sentence classification → no research

Research purposes

(1) a phase synchronization during imaging articulatory movements of sentences
(2) accuracies of EEG-based imagined sentence classification using the phase synchronization as features

Analysis pipeline

Preprocess
- Perception data: 35 trials (subj 01), 38 trials (subj 02)
- Imagined data: 39 trials (subj 01), 42 trials (subj 02)

Synchronization analysis
- Perception: model imagined: produced
- Imagined: imagined task
- Perceived: listening task

Classification analysis
- 3 sentence classification task
- Perceived: fronto-central imagined: centro-parietal

Result

Synchronization analysis
- Perception: stronger PLV in fronto/central region
- Imagined: stronger PLV in centro/parietal region

Classification analysis

Subj 01
- Perceived: 40.0 % (rf)
- Imagine: 59.0 % (logreg/SVM)

Subj 02
- Perceived: 57.9 % (logreg/template)
- Imagine: 52.4 % (SVM)

Conclusion & Future directions

RQ. 1 A tendency of phase synchronization b/w produced speech & EEG oscillations during imagined sentences
RQ. 2 Best accuracies: [52.4 59.0 %] by SVM.

Phase patterns are reliable features for imagined sentence recognition
Future directions:
(1) Increasing number of participants
(2) Source localization of this phase synchronization phenomenon

Research questions

(1) Do EEG phase patterns during imagined speech synchronize with produced speech rhythms?
(2) How accurately do EEG phase patterns classify imagined sentences?

EEG experiment

Participant
- 1 male, 1 female (L1: Japanese)

Speech material
- 1. あなたが昨日夢中で読んでいた本はおもしろかった。
- 2. つらい二子の子が私に言ったところは本当だね。
- 3. 向こうの壁に飾っているのは彼のお兄さんが描いた絵。

Tasks
- LISTEN
- SPEAK
- IMAGINE

Research questions

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Hypothesis: imagined speech

If there is a synchronization, phase information is useful features for classification

Selected references