Decoding of User Emotions Using Electroencephalography in Voice-Based Human-AI Interaction

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INTRODUCTION

- Voice user interfaces (VUI) allow the user to interact with a system through voice or speech commands.
- Although VUI can deliver commands as if talking to a machine without any complex process, the current VUI system can only provide uniform responses to simple commands.
- Quantitative evaluation of user satisfaction while using the VUI system is necessary to develop an advanced VUI system that naturally mimic human-to-human conversation.
- In this study, we investigated the possibility of classifying emotional differences between gender and VUI design parameters to recognize the user emotions while interacting with the VUI.

METHOD

Experimental Condition

- We constructed a virtual VUI system consisting of two design parameters, such as voice (child/announcer) and information quantity (simple/reference).
- EEG data were measured from 57 scalp electrodes according to the international 10-20 system, while 50 subjects (26 males and 24 females) were interacting with the VUI system.
- Figure 1 (A) shows a single trial of the experimental paradigm, and the subjects were repeated 20 times for each condition of design parameter combination.
- In addition, the emotional states of the subjects were collected through a questionnaire for every trial.

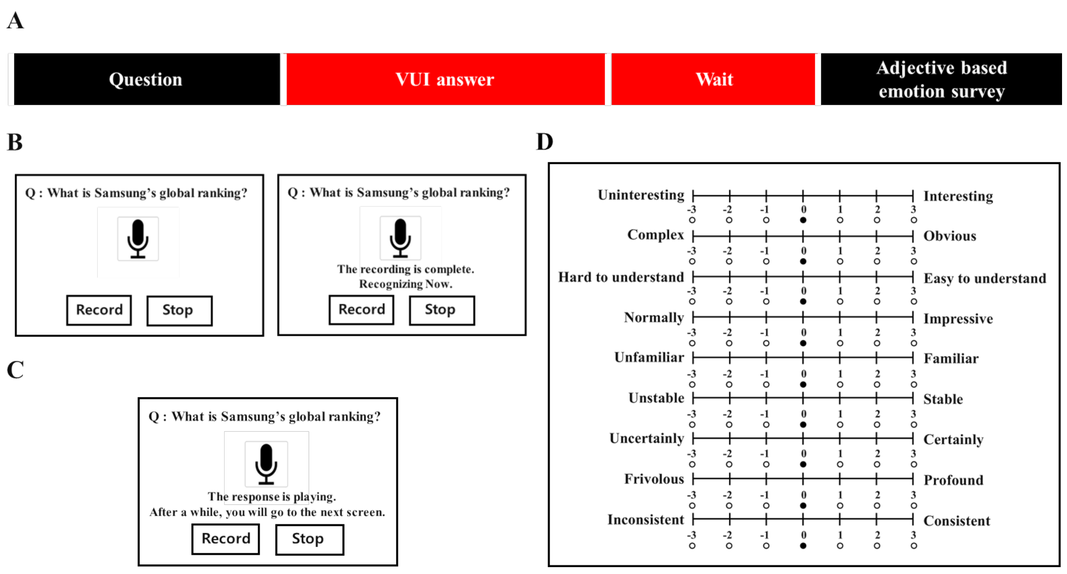

Figure 1. Experimental paradigm

Data Analysis

- After EEG preprocessing, the data were segmented for the section including 3 sec after the VUI system finished providing the answer from the start point of the response period.
- The power spectral densities (PSDs) and phase-locking value (PLV) of 5 frequency bands were estimated using EEG data.
- A 5 × 5 -fold cross-validation with support vector machine (SVM) was performed to estimate emotional classification accuracy according to gender and voice type.

RESULT

- Figure 2 shows the mean classification accuracy for all possible combinations of the two parameters.
- A **relatively high performance was obtained for discrimination between males and females (> 90%)**, whereas voice type was not a useful parameter in terms of classification accuracy (around chance level).

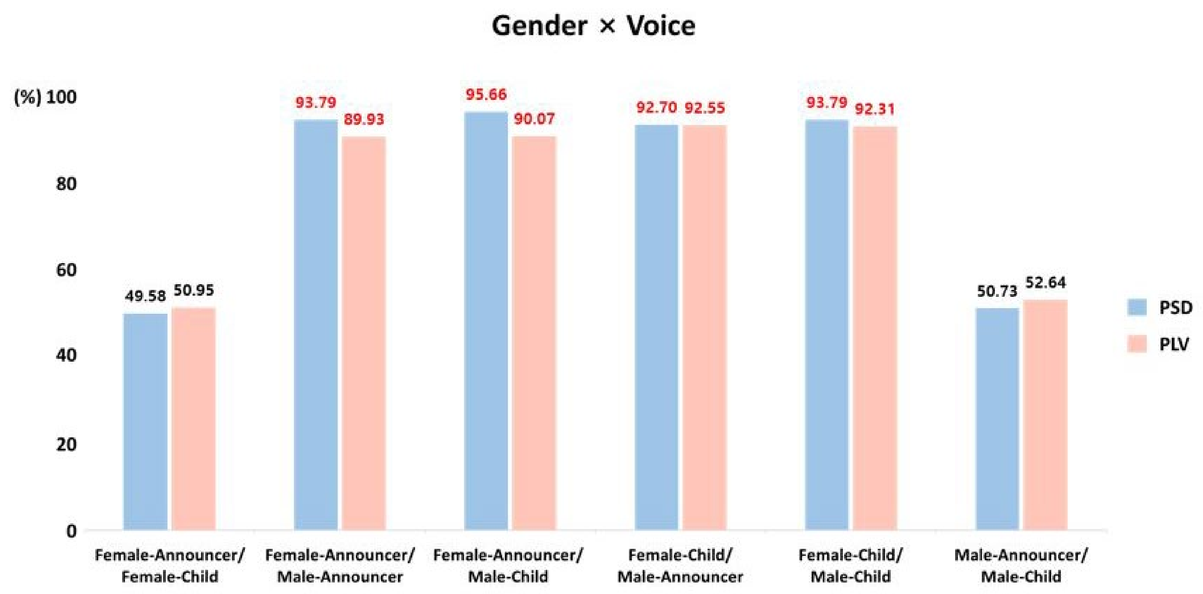

Figure 2. Mean classification accuracies for each condition.

- Figure 3 shows the grand averaged topographical maps of power spectral density of 5 frequency bands for gender effect.
- It shows **a statistical difference between the male and female conditions in theta band** (two-sample t-test, $p < 0.05$).

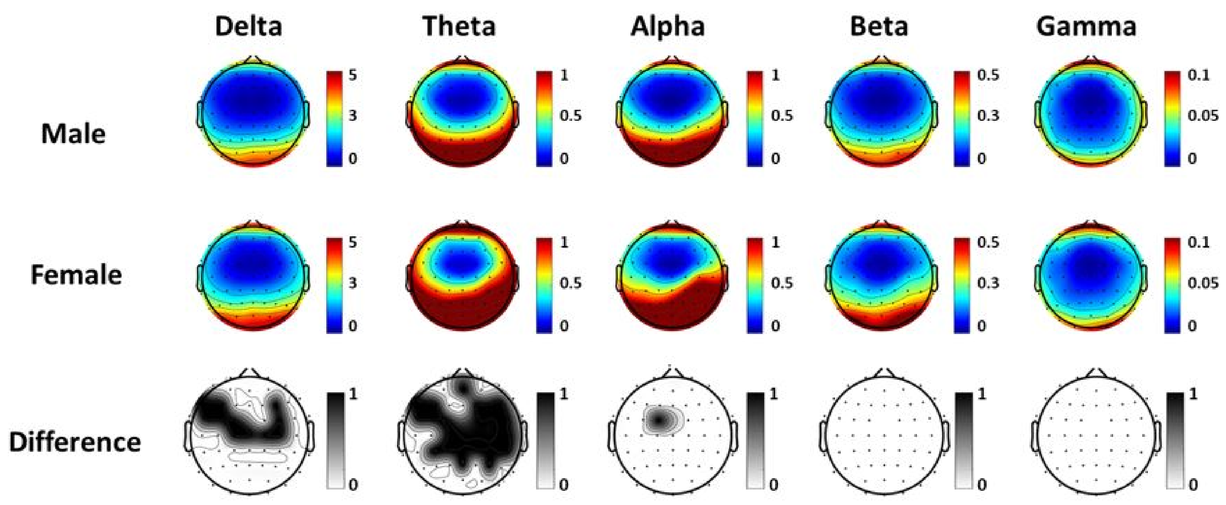

Figure 3. Grand averaged topographical maps of power spectral density for gender effect

CONCLUSION

- In this study, we confirmed **that gender is an important factor that significantly affects emotions.**
- In our future work, we will attempt a neurophysiological interpretation of the difference in performance of emotional classification by gender.
- In addition, we plan to develop an individually customized VUI system.

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