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# Effects of vowel formants converted voice on Speech Production Process

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## 1 Introduction

The role of auditory feedback in speech production has been studied since the early times as the research about interaction of speech perception and production. The phenomenon which becomes louder under the noise environment than the usual utterance(Lombard's effect), and the delayed speech feedback causes the stammering and speech speed becomes slower(Delayed Auditory Feedback,DAF). these are characteristic examples of auditory feedback. And these knowledges were considered as the evidence of important roles of the auditory feedback in speech production. However, to explain the mechanism of auditory feedback by these knowledges is difficult. Thus, it is necessary to construct the experimental paradigms that enable to the quantitative analysis.(eg. convert the acoustic parameters at realtime) And we need the knowledges to understand about outline of speech production. Since there were motor control, many discovery about a nerve, and improvement in information processing technical recently, it has come to satisfy these requirements.

## 2 Aims

In this study, we consider the problem about the interaction of a speech perception and production is a motor control model that assumed the auditory stimulus as input, and speech production as output. And we aims at acquiring the knowledge for building the “formant control model”. In order to acquire the knowledge about the model, we perform the experiment based on transform auditory feedback(TAF). Formant in speech sound that uttered participants is changed in this experiment, and it is fed back to him. An utterance sound is recorded and estimate the “immediate” response characteristic by investigating it.

## 3 Experiment

In the experiment, we use continuous vowel /eaea .../ as subject sound, and vowel /e/ was change into vowel /a/ as a stimulus. Participants hears them altered voice through headphone. A start and end of utterance are told to paticipants by the start signal and end signal. Participants continues the 30-second utterance between a start signal and an end signal. Duration 10 second at the beginning, uttered sound is not changed(“normal section”), and next duration of 10 second uttered sound is changed(“altered section”), Duration 10 second at the end, uttered sound is not changed(“normal section”). The above experiment was conducted 3 times for all participants.

## 4 Results

We used the short-time spectrums of the uttered sound for analysis. In this study, as analysis, We conduced spectrum analysis based on unbiased estimation method. which can acquire an unbiased estimator for estimation of a spectrum. The tendency for change of two subjects’ utterance sound to become large in “altered section” has been checked in as a result of analysis.

## 5 Discussion

From the analysis, we conclude that change the feedback sound affects speech production. This result supports a possibility that change of feedback sound affected utterance operation. And those responses change by participants. We can consider as one of the reason that the individual difference from speech acquisition process etc. The following things can be considered as a conclusion of this research. (1) Usually, utterance operation is controlled by utterance using “feedforward control”. (2) However, the control by feedback which used the information on formants at the time of utterance is also used simultaneously. Consequently, we can consider that “formant control model” and “fundamental frequency( $f_0$ ) “ control model” are essentially same in the meaning called parallel operation of “feedback control” and “feedforward control”.

## 6 Future Work

- Measurement using information other than a sound.(eg.Camara,EMG etc.)
- Construction of the experiment paradigm which stops or weakens feedforward(eg.Using the vowels and the syllables which are not used usually,using visual feedback etc.)
- Construction of the experiment paradigm which stops feedforward.
- Quantitative analysis and evaluation.