The Voice Pitch and Speed Control under Frequency Modulated Auditory Feedback Conditions in Standard Chinese and Japanese Speakers

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Abstract

Delayed auditory feedback (DAF) can cause speech dysfluency (e.g. stuttering) in healthy subjects. In the present study, we introduced frequency-modulated feedback of pitch in a sine-wave manner in order to determine whether the similar phenomenon occurs. Eighteen Chinese and 18 Japanese participated in the frequency altered feedback (FAF) and DAF experiments. Speech dysfluency was found under all changed conditions with exceptions at 14 Hz or 50 ms, Chinese subjects showed significantly larger disturbances than Japanese. The study reveals that frequency modulation can cause inconsistent voice pitch and speed changes in different language speakers.

Index Terms: speech perception, feedback, Standard Chinese

1. Introduction

Perception of one’s own speech plays an important role in fluent speech production. The Delayed auditory feedback (DAF) can cause speech dysfluency (e.g. stuttering) in healthy subjects. It is unclear whether frequency altered feedback (FAF) can also cause similar speech disruption. In previous studies, feedback frequency was changed linearly or to a constant value in FAF (Elman 1981, Burnett et al 1997, Natke et al 2001). In the present study, we modulated pitch frequency sinusoidally while Chinese speakers (tone language) and Japanese (pitch accent language) were reading texts.

2. Method

Eighteen native Chinese (7 females, ages 22-42 yrs old) and 18 native Japanese (9 females, ages 20-41 yrs old) participated as subjects and were required to read a set of sentences taken from Harry Potter (Chinese translation for the Chinese subjects and Japanese translation for the Japanese subjects). These participants were instructed to read the sentences according to their normal habit while they heard the altered feedback voice through a headphone. The modulation width of pitch (F0) of auditory feedback voice was 6 semitones, and the modulation frequencies of sine-wave were set at 0.05, 0.1, 0.5, 0.9, 2, 4, 6, 8, 10, 12, 14, and 16 Hz. In addition to the FAF experiment, we conducted a DAF experiment with delay times of 50, 200, and 400 ms. To analyze the subject's performance, F0 deviation difference ratio within 2 milliseconds was calculated in order to determine whether the similar phenomenon occurs. Eighteen Chinese and 18 Japanese participated in the frequency altered feedback (FAF) and DAF experiments. Speech dysfluency was found under all changed conditions with exceptions at 14 Hz or 50 ms, Chinese subjects showed significantly larger disturbances than Japanese. The study reveals that frequency modulation can cause inconsistent voice pitch and speed changes in different language speakers.

3. Result

Pitch change (Fig. 1)

(1) FAF Larger pitch change reduction in Chinese speakers than in Japanese: the significant differences were found between two speaker groups with the exception of 0.1 Hz.

(2) DAF There were no significant differences between the two.

Voice Speed (Fig. 2)

(1) FAF The speed of speech was slowed down in both subject groups. No significant group difference was found except for 14 Hz modulation frequency.

(2) DAF The speed of speech was greatly slowed down in both subject groups. No significant group difference was found except for 50 ms-delay.

4. Discussion and Conclusion

A greater disturbance of speech happens in participants under both DAF and FAF condition was observed in the present experiment. The FAF effect on pitch change differed significantly between the speakers while the speed of speech did not. Thus the pitch and speed might be controlled independently during speech production. In Chinese subjects, an amount of pitch change was greatly reduced and speech was flattened. The pitch control of Chinese speakers might more strongly depend on feedback (on-line control) than Japanese.

5. Acknowledgements

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6. References


Figure 1: Comparison of altered feedback effects on pitch change between two groups (n=18 each).

Figure 2: Comparison of altered feedback effect on speech speed between two groups (n=18 each).