Formant-altered auditory feedback on non-native vowel production

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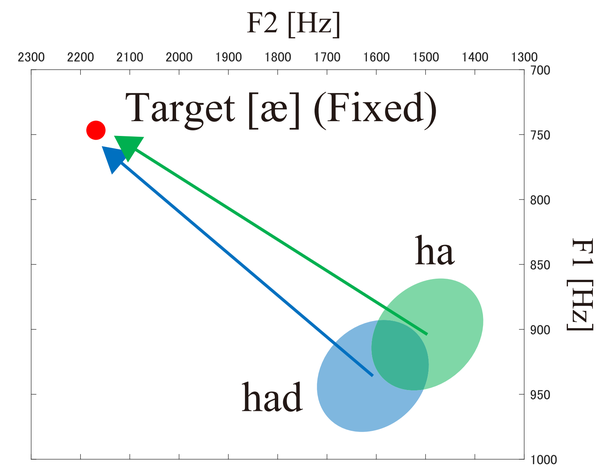
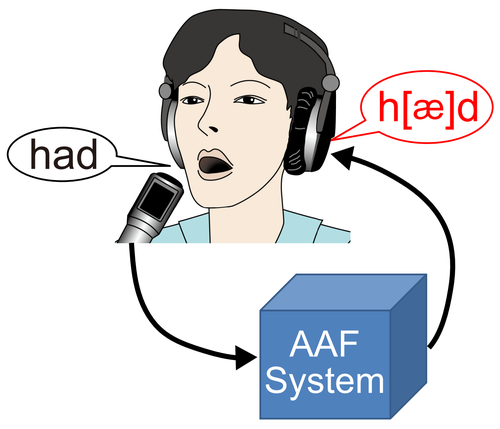
Introduction

- Auditory feedback while speaking plays an important role in stably controlling speech articulation.
- Its importance has been verified in formant-altered auditory feedback (AAF) experiments in which speakers utter while listening to speech with a perturbed formant frequency [1].
- However, few experiments have been performed in speaking the non-native languages.
- In this study, we conducted a formant AAF experiment for native Japanese speakers, which converts the vowels of English syllable “had” or Japanese mora (syllable-like phonological unit) “ha” to the same English vowel sounds [æ].
- It is expected that the difference of feedforward system by language would affect the formant change to perturbations.





Adapt to formant-clamp condition [2]

Methods

Subjects: 9 native Japanese speakers (7 females)

Experimental protocols:

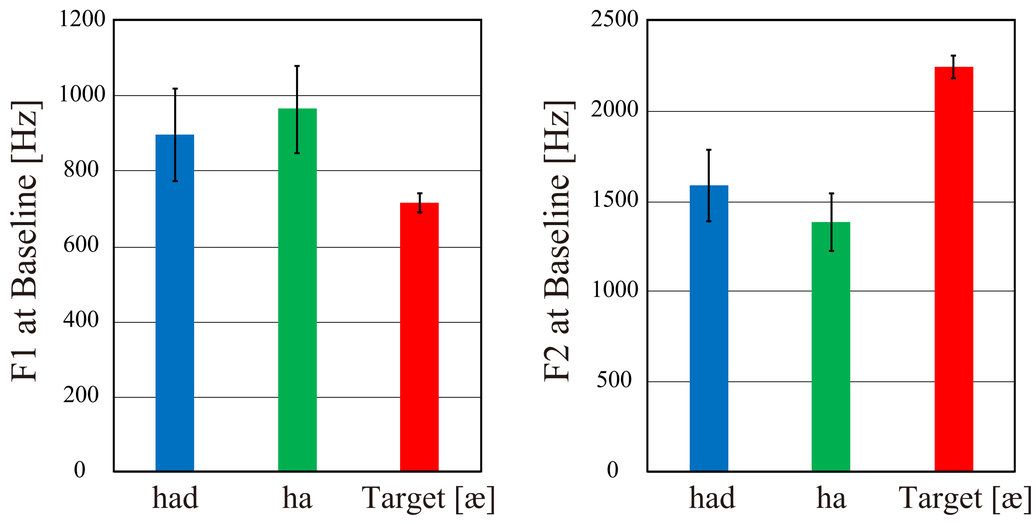
2 blocks: Uttering “had” or “ha”

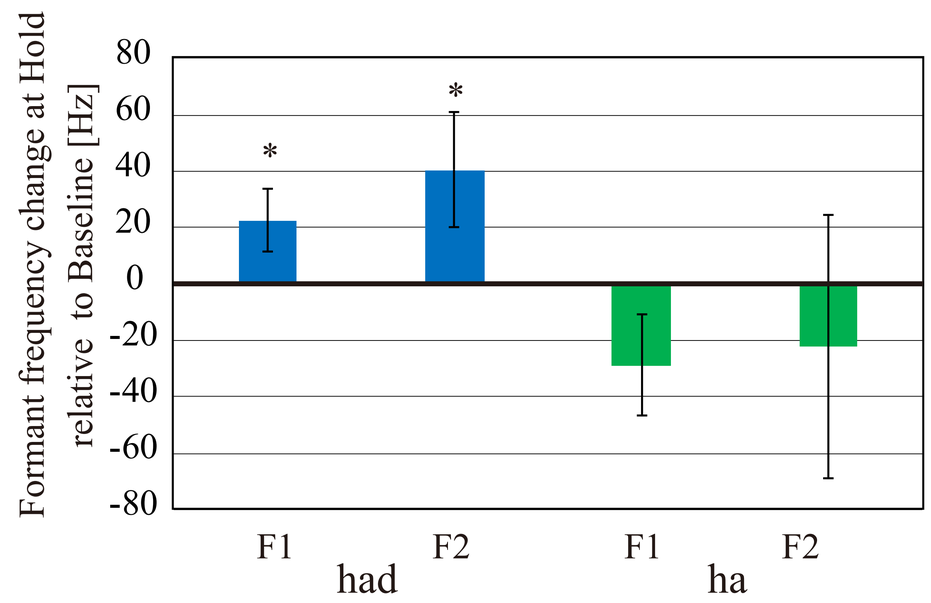
Target F1 and F2 of [æ] were varied for each subject.

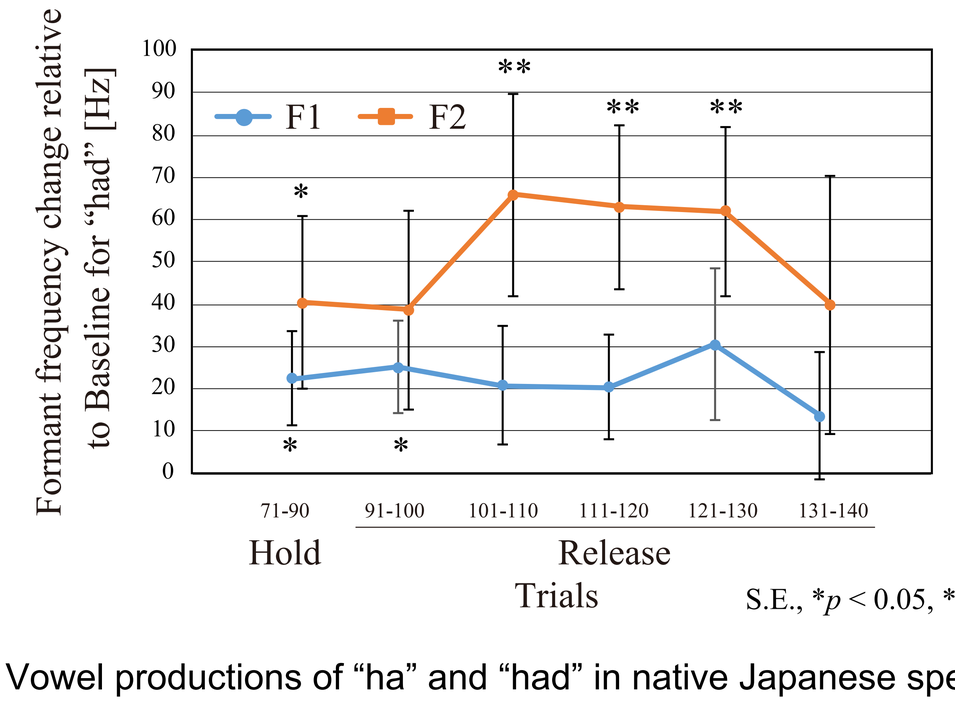
Perturbation patterns

Robust formant estimation: PEAR (Phase equalization-based autoregressive exogenous model) [3,4]

Results







S.E., *$p < 0.05$, **$p < 0.01$

- Vowel productions of “ha” and “had” in native Japanese speakers were almost the same, but different from English vowel [æ]. This means that native Japanese speakers have transferred the English vowel [æ] to the Japanese vowel “a.”
- In “had,” the formant frequencies significantly changed in both F1 and F2. On the other hand, no significant changes were observed in F1 and F2 in “ha.”
- In F2 of “had,” the formant frequency change was even larger in the perturbed direction in Release (101-130 trials) than in Hold.
- In “ha,” formant frequency did not change in Release.

Discussion

- Since “ha” is the native language for native Japanese speakers, a feedforward system of speech production has been established in the brain and it produces stable speech production.
- The fact that there is no change for the native language supports the result in the formant-clamp condition of [2].
- On the other hand, since “had” is the non-native language, a feedforward system of speech production has not been well established, and it is somewhat likely that speech production was affected by auditory feedback.
- Formant frequency change in Release in “had” suggests that the pronunciation of [æ] has been learned.

Conclusions

- We conducted formant AAF experiments to convert vowels spoken by native Japanese speakers into English vowels [æ].
- It was found that the following response in F2 was observed and increased after adaptation for non-native vowels.
- Our results suggested that speaking a non-native language may be more affected by auditory feedback than native language.
- This finding may be useful for learning pronunciation of foreign languages.

References

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[2] Daliri, A., and Dittman, J. (2019). “Successful auditory motor adaptation requires task-relevant auditory errors,” Journal of Neurophysiology 122(2), 552-562.
[3] Oohashi, H., Hiroya, S., and Mochida, T. (2015). “Real-time robust formant estimation system using a phase equalization-based autoregressive exogenous model,” Acoustical Science and Technology 36(6), 478-488.
[4] Uezu, Y., Hiroya, S., and Mochida, T. (2020). “Vocal-tract spectrum estimation method affects the articulatory compensation in formant transformed auditory feedback,” Acoustical Science and Technology 41(5), 720-728.