

An electromyographic study of the production of /w/ in English and Japanese

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Background

- Japanese-speaking ESL learners have difficulty in pronouncing English /w/
 - E.g. 'would'
- Different phonetic realization of /w/:
 - Japanese: unrounded bilabial approximant (Markham and Nagano-Madsen, 1996)
 - English: lip rounding (e.g. Matsusaka, 1986)

Background: anatomy

- Two muscle groups responsible for the labial pronunciation of /w/ in English (Walker, 2000; Epstein et al., 2002)
 - Orbicularis Oris (OO)
 - To purse the lips
 - Levator Labii Superioris (LLS)
 - To elevate the upper lip

Background: accent reduction

- Walker (2000): explicit instruction on the use of LLS is necessary for adult Japanese ESL learners to acquire the correct pronunciation of English /w/
- Tateno (1969), Umezawa et al. (2004): exercise of LLS muscles is beneficial in improving the intelligibility of Japanese-speaking ESL learners' English

Objectives

- To investigate...
 - Difference between the production of Japanese /w/ and English /w/
 - Difference between L1 (native English) and L2 (native Japanese) speakers' production of /w/ in English
- by quantitative assessment of muscle activity using non-invasive surface electromyography (sEMG)

Hypotheses

- There will be a systematic difference in the global activation levels of LLS and OO for pronouncing English and Japanese /w/:
 - Muscle activity of LLS and OO will be higher for the production of English /w/ compared to Japanese /w/
 - L2 speakers' pronunciation of English /w/ will be characterized by lower activity levels of LLS and OO

Methodology

- Participants
 - (3) L2 speakers: male native Japanese speakers, who acquired English in adulthood.
 - (4) L1 speakers: male native speakers of Canadian English

Experimental Stimuli

- Japanese words
 - /wa/: low/high pitch; initial/medial
 - 20 words in total
- English words
 - Various vowel contexts; initial/medial
 - Clusters: velar/coronal/s + /w/
 - 35 words in total
- Presentation: word lists with audio, timed

Speech Tasks

- Word list reading in two different styles
 - Normal speech rate
 - As clearly as possible
- “Extra hyper-speech” task
 - Pronounce /w/ by maximally exaggerating the muscular actions

Load-perturbed pronunciation task

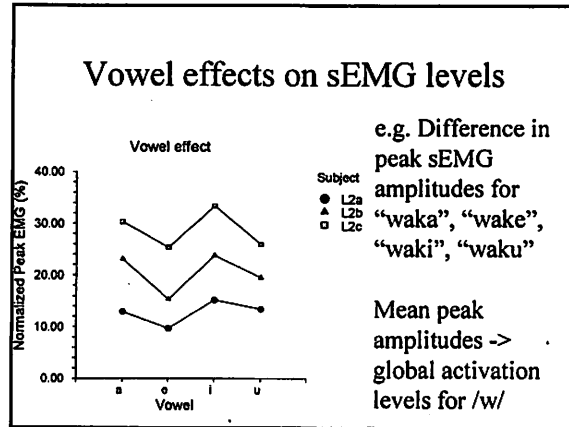
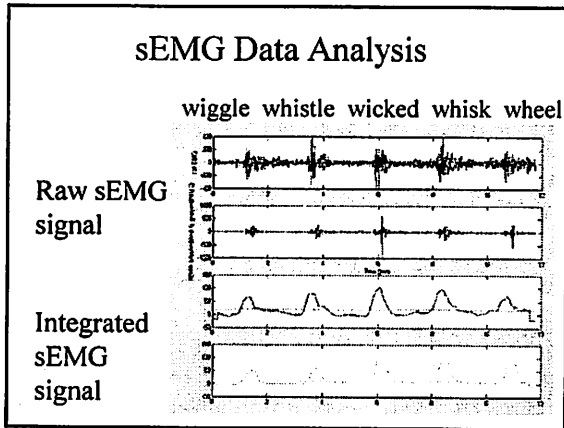
- Subjects are asked pronounce words containing /w/ with the FacialFlex® device, which provide resistance and impede lip rounding, to investigate how speakers compensate the perturbation.
- The compensation levels required to pronounce English /w/ are expected to be greater than for Japanese /w/.

Non-Speech Tasks

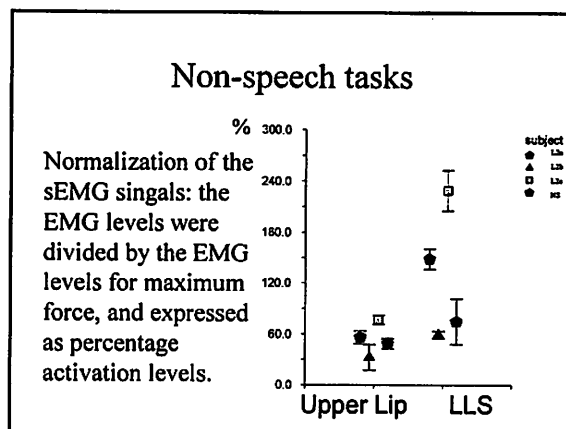
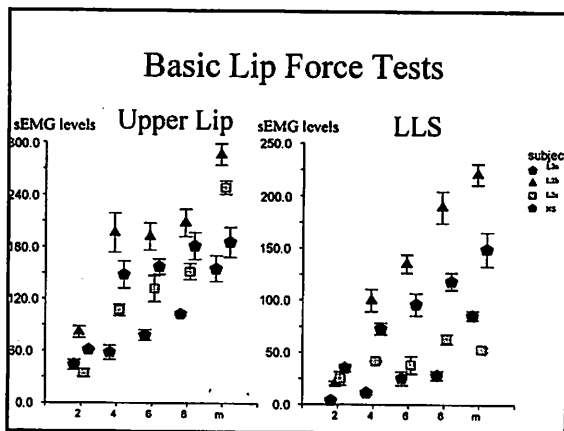
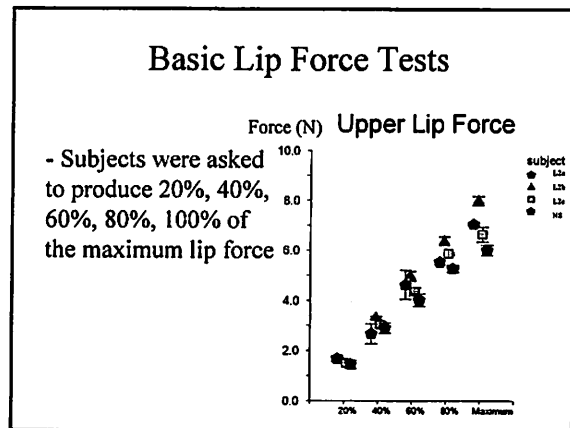
- To test if there is any fundamental difference between native Japanese and English speakers in their ability to use these muscles.
- Basic lip-force tests
- Facial expression tasks: imitate facial expressions by contracting LLS
- Pencil task: hold a pencil between the upper lip and the nose, by everting the upper lip

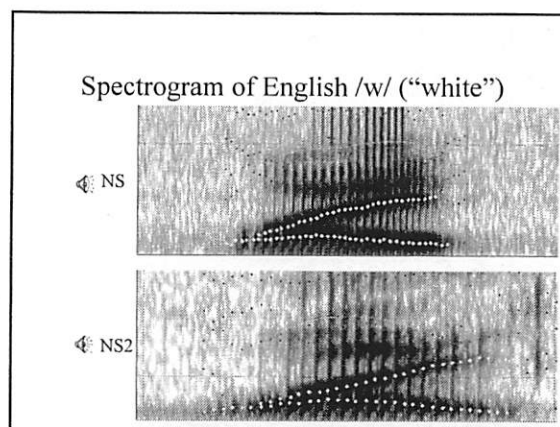
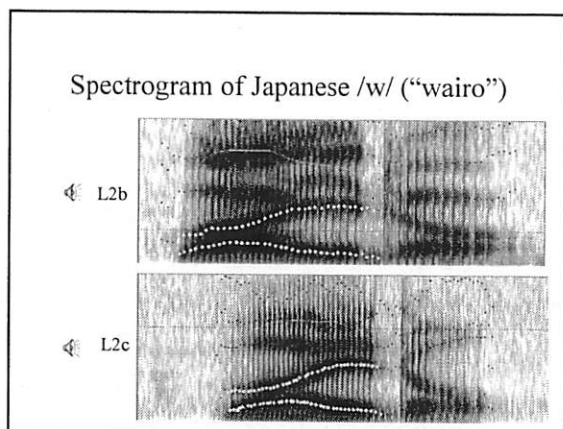
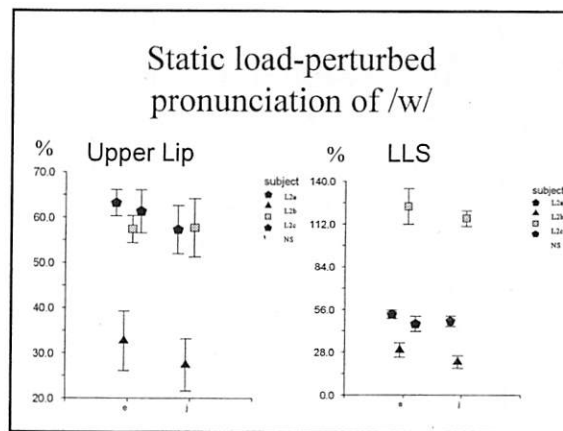
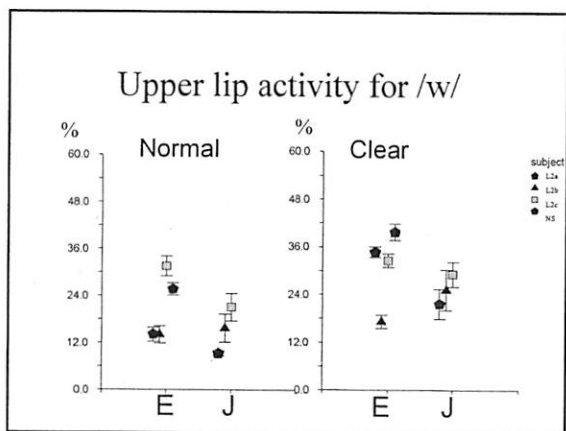
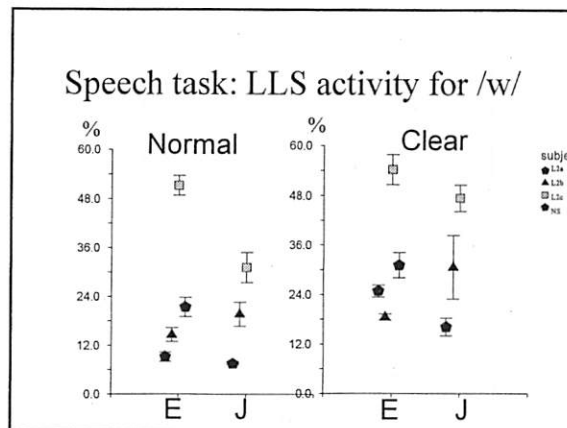
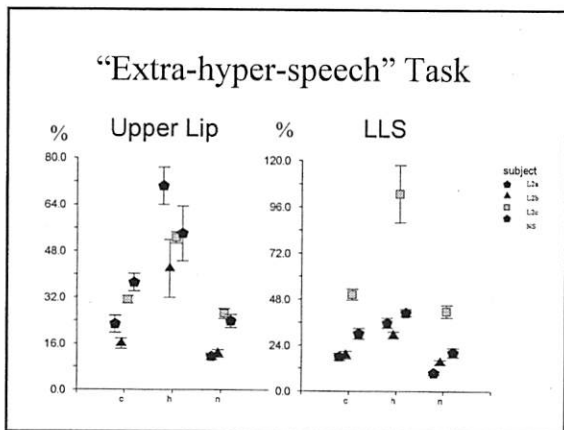
Data acquisition methodology

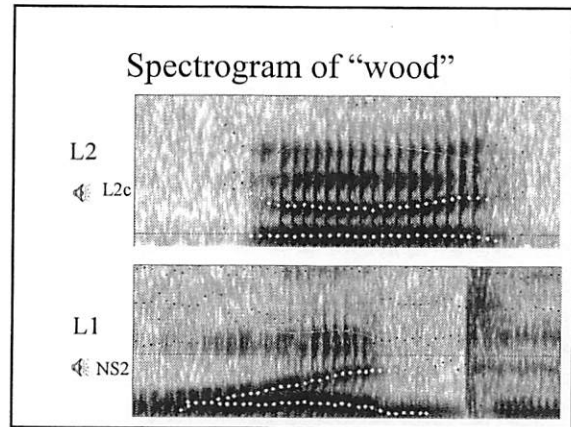
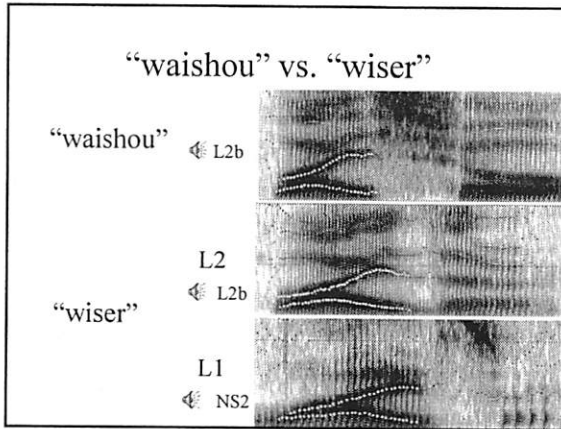
- Obtain mean peak sEMG amplitudes for a group of 5 words sharing similar environment
 - e.g. group of high front vowel
 - “wiggle, whistle, wicked, whisk, wheel”



Results







Results: Summary

- In non-speech tasks, native English and Japanese speakers behaved similarly.
- No clear differences were observed in the activation levels of LLS or OO between English and Japanese /w/, or between L1 and L2 speakers' speech.
- Acoustically, Japanese /w/ was characterized by higher F2, compared to English /w/.

Discussion

- Both OO and LLS were involved in the production of English /w/, both in native Japanese and English speakers.
- In general, lips are described as moderately active in English pronunciation (e.g. Honikman, 1964), and in Japanese lips are said to play almost no active role (e.g. Vance, 1987). This could not be observed as difference in peak sEMG amplitudes for the pronunciation of /w/.

Discussion

- The static load-perturbed task with a FacialFlex® device could not capture the difference in the production of English and Japanese /w/. Although Japanese /w/ is unrounded, the force for bilabial approximation seems to have resulted in similar activation levels of LLS and OO to English /w/.

Discussion

- The levels of lip force required for speech tasks, relative to maximum force levels, are estimated to be about 20% (Barlow, 1999) This fits nicely with the EMG levels for speech tasks found in our study compared to EMG levels in maximum force production tasks.

Discussion

- The acoustic difference between English and Japanese /w/ was not reflected in the sEMG signals as the amount of activation of LLS and OO.
- In order to capture the difference observed in acoustics, different methodology than electromyography will be necessary. E.g, kinematic recordings of lip movement.

Preliminary Conclusion

It seems that the problem is not so much at the individual muscle levels, but in selecting and executing gestural combination for vowel and consonant. If the gestures are similar but not identical, Japanese speakers seem to simply substitute with known Japanese combinations (bilabial approximant instead of rounded /w/). For a completely novel combination, there is no good substitute and they seem to ignore /w/.

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