

Linguistic Rhythm in Foreign Accent

Jiahong Yuan

Department of Linguistics, University of Pennsylvania, USA

jiahong@ling.upenn.edu

Abstract

This study investigates the influence of L1 on L2 with respect to linguistic rhythm. The L2 English of French, German, Italian, Russian, and Spanish speakers is compared with L1 English. The results show that the linguistic rhythm of L1 transfers to L2. Compared to L1 English, L2 English has shorter stressed vowels but longer reduced vowel. Stressed vowels in the L2 English of stress-timed languages have a higher pitch contour than those in the L2 English of syllable-timed languages.

Index Terms: Foreign Accent, rhythm, duration, pitch

1. Introduction

It is observed that spoken languages have different durational characteristics. Three impressionistic rhythm categories were proposed in the literature [1], i.e., stress-timing (e.g., English, German, and Russian), syllable-timing (e.g., Italian, French, and Spanish), and mora-timing (e.g., Japanese). Although no phonetic evidence has been found to support a strict distinction between rhythm types, many studies demonstrated that languages could be differentiated based on particular rhythm metrics such as vocalic vs. consonantal intervals [2] and the durational differences between successive syllables [3].

The influence of the first language on second language rhythm has also been studied. [4] investigated the contribution of rhythm to the reduced intelligibility of foreign-accented utterances. The study showed that the intelligibility of Chinese-accented English phrases was improved significantly (from 39% to 58%) after the duration of the segments in the phrases was modified to align with the same phrases spoken by a native English speaker, while retaining the spectral and source characteristics of the Chinese speaker. [5] demonstrated that although non-proficient English learners of Japanese were not less sensitive than the native American English speakers in discriminating the durations of stressed vowels in English, their judgments of what is natural for a stressed vowel spanned a broader range of vowel durations than for the native speakers. [6] manipulated L2 Norwegian utterances of speakers from different L1 language backgrounds by changing the pitch and duration patterns to native Norwegian values. The study showed that the effects of the manipulations on degree of foreign accent were different for different L1 groups. The French and German L1 groups gained most from the pitch manipulation; the English, Tamil, and Chinese groups gained most from the duration manipulation; and the Russian and Persian groups were equally affected by the two manipulations.

This study investigated the influence of L1 on L2 English rhythm. [7] suggested that in stressed-timed languages some syllables are far more salient than others whereas in syllable-timed languages all syllables tend to be equally salient, and this creates the impression of different rhythms. Both duration

and pitch contribute to prosodic salience. Therefore, both of them were examined in this study.

2. Data and Method

The study utilized the GMU speech accent archive (<http://accent.gmu.edu/>). The archive contains a large set of speech samples from a variety of language backgrounds. In the archive, a phonetically balanced English paragraph was read by both native and non-native speakers of English. The paragraph is as follows:

Please call Stella. Ask her to bring these things with her from the store: Six spoons of fresh snow peas, five thick slabs of blue cheese, and maybe a snack for her brother Bob. We also need a small plastic snake and a big toy frog for the kids. She can scoop these things into three red bags, and we will go meet her Wednesday at the train station.

The phone boundaries were automatically determined, using the Penn Phonetics Lab Forced Aligner (<http://www.ling.upenn.edu/phonetics/p2fa/>).

To exclude the incompetent speakers from the study and use only fluent speech samples, two acoustic measures were calculated to determine disfluency: the number of pauses that are longer than 0.5 seconds and the (duration) percentage of silence in the speech sample. The results are shown in Figure 1.

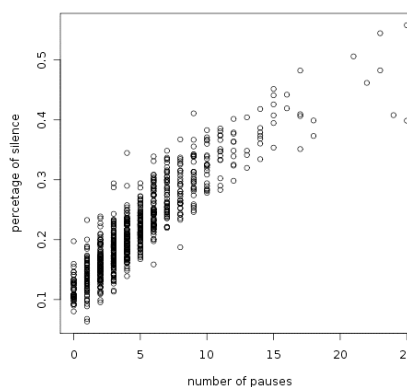


Figure 1: *Percentage of silence duration vs. number of pauses (> 0.5s).*

We can see from Figure 1 that the speech samples have a large variation in degree of fluency, and that the two acoustic measures are highly correlated ($r = 0.90$). The speech samples that have less than six pauses of 0.5 seconds or longer were selected for this study, based on a listening experiment to determine an optimal criterion that can be used to identify

fluent speech samples. Below are the numbers of the speech samples selected for the study:

<i>Stress-timed:</i>	<i>Syllable-timed:</i>
English (native): 203	French: 9
German: 14	Italian: 11
Russian: 8	Spanish: 26

The durations of the phones were calculated from the forced aligned boundaries. The F_0 s were extracted using `esps get_f0`. Both duration and F_0 were normalized and the means of the normalized values were used to compare the L2 effects. The results are reported below.

3. Results

The durations of the phones in a speech paragraph were normalized using the total duration of the speech paragraph excluding pauses, as shown in (1):

$$Norm(duration_i) = duration_i / total_duration * 100 \quad (1)$$

Therefore, the durations of the phones in any speech paragraph sum up to 100 after normalization. Figure 2 plots the mean duration (normalized) of the stressed and reduced vowels for each L1 language:

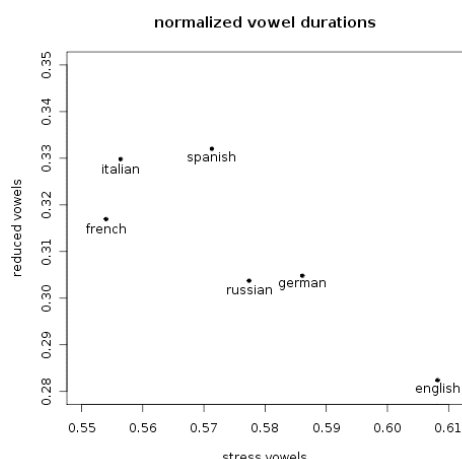


Figure 2: *L1 influence on vowel duration in L2 English.*

We can see from Figure 2 that compared to L1 English, L2 English has shorter stressed vowels but longer reduced vowels. This result suggests that the duration ratio between stressed and reduced vowels can be used to identify foreign accent in L2 English.

We can also see that German and Russian, which are both stress-timed languages as English, are closer to English on Figure 2 than the syllable-timed languages.

F_0 was converted to a semitone scale for normalization, as shown in (2):

$$Semitones = 12 * \log_2(F_0 / base_frequency) \quad (2)$$

The base frequency used for calculating semitones was speech paragraph dependent, defined as the 10th percentile of all F_0 s of that speech paragraph. Figure 3 plots the F_0 contours of the stressed vowels in L1 English and in L2 English of

different L1 languages. We segmented each vowel into four equal parts, and averaged the pitches within each quarter.

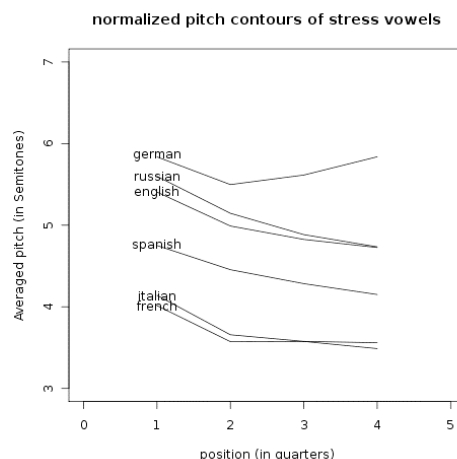


Figure 3: *L1 influence on pitch contour in L2 English.*

We can see from Figure 3 that, again, German and Russian are closer to English than Spanish, Italian, and French. Overall, stressed vowels in the stress-timed languages have a higher (normalized) pitch contour than those in the syllable-timed languages.

4. Conclusions

This study investigated the influence of L1 on L2 English with respect to linguistic rhythm, by comparing duration and F_0 in L2 English of different L1 languages with L1 English. The results show that the linguistic rhythm of L1 transfers to L2. On both the duration ratio between stressed and reduced vowels and the pitch contours of stressed vowels, the L2 English of German and Russian speakers is more similar to L1 English than that of French, Italian, and Spanish speakers. Compared to L1 English, L2 English has shorter stressed vowels but longer reduced vowel, suggesting that the duration ratio between stressed and reduced vowels can be used to identify foreign accent in L2 English.

5. References

- [1] Hoequist, C., "Syllable Duration in Stress-, Syllable- and Mora-Timed languages," *Phonetica*, 40, pp. 203-237, 1983.
- [2] Ramus, F., Nespors, M. and Mehler, J., "Correlates of linguistic rhythm in the speech signal", *Cognition*, 73, pp. 265-292, 1999.
- [3] Low, E. L., Grabe, E. and Nolan, F., "Quantitative characterizations of speech rhythm: 'syllable-timing' in Singapore English," *Language and Speech*, 43, pp. 377-401, 2000.
- [4] Tajima, K., Port R. and Dalby, J., "Effects of temporal correction on intelligibility of foreign-accented English," *Journal of Phonetics*, 25, pp. 1-24, 1997.
- [5] Mochizuki-Sudo, M. and Kiritani, S., "Production and perception of stress-related durational patterns in Japanese learners of English," *Journal of Phonetics*, 19, 231-248, 1991.
- [6] Holm, S., *Intonational and durational contributions to the perception of foreign-accented Norwegian: An experimental phonetic investigation*, Ph.D. thesis, Norwegian University of Science and Technology, 2008.
- [7] Dauer, R. M., "Stress-timing and syllable-timing reanalyzed," *Journal of Phonetics*, 11, pp. 51-62, 1983.